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Arrhythmia Bot: Arrhythmia Disease Prediction using Internet of Things with Machine Learning Approaches and Telegram Bot

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Abstract--Cardiac demise as of arrhythmia remains a prime cause of mortality in the world. Arrhythmia patient monitoring is a vital technique that gives customers all vital statistics regarding every day maneuver of a cardiovascular affected person. Arrhythmia is an irregular heartbeat; the troubles arises at the same time as the electric waves that harmonize the coronary heart's beats. The faulty signaling reasons for coronary heart to normal or abnormal beating. In this paper ECG assesses heartbeat rate, 5-50 Hz bandpass filter used for filtering, Stationary wavelet transform used for artifact removing. Age, Cp, Trestbps, Chol, Fbs, Rest ECG, Thlach, Exang, Old Peak, Slope, Thal, Sex, Target are the features extraction by Independent component analysis technique. Finally, support vector machines have been categorized the dataset as healthy or arrhythmia patient with 85% and above accuracy. The proposed system is design for arrhythmia disease prediction and send the result by Telegram Bot. The classification result sends to the user's emergency numbers using Bot. The main objective of our proposed system is to monitoring lonely or paralyzed peoples in their home. The proposed work can have a notable impact on paralyzed persons, old age home, health care and as well as society.

*Index Terms--*Machine Learning; Internet of Things; Arrhythmia; Bot; Electrocardiography; Support Vector Machine

I. INTRODUCTION

Oneof the severe illnesses in today's world include arrhythmia, symptoms of which include non-uniform heart beating which can cause sudden fatality if not treated on time. Due to these reasons patients with arrhythmia essentially need continual [1]. Worldwide 12% of the total fatality is reported to be caused by cardiac arrhythmia [2]. Stress can increase risk for heart disease [3-5]. Early diagnosis of

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21001 arrhythmia can lessen the life risk. Proper treatment of cardiac arrhythmia requires smart medical management that will provide suitable health facilities in this field. In ICU up to 86% of the false alerts tend to decline the standard of health care provided for which both the patients and medics are affected through retarding the time of response in time of emergencies [6]. Using IoT we can now solve the issues faced by arrhythmic patients since it has the potential to untangle the medical field by non-invasive and automatic surveillance. For predicting cardiovascular disease, IoT network recovers and processes the signals from ECG, and alerts the medics in situations of exigency via IoT connected ECG measuring structure which enables timely detection of any abnormalities. On uniform heart beats arise when electrical signals responsible for synchronizing heart's rhythm fail, this results in either fast heart rate(tachycardia) or slow heart rate(bradycardia) leading to irregular heart rhythm.

In this paper we will propose an algorithm to assist patients during home and additionally assist healthcare for arrhythmia patients. The proposed system is easy to handle, overall project cost is economical so the system will be helpful for any age of people who are suffering from arrhythmia disease.

The rest of the paper are as follows: section II for literature survey, section III for proposed work, IV for result and V for conclusion and future work.



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II. LITERATURE SURVEY

The previous published paper [7], has depicted the classification of rate of heartbeat during watching movies or sharing movie ratings in telegram bot. While watching a movie, at any point a person can experience a sudden increase in heartbeat which can adversely harm that person's health andcan even result in cardiac arrest. The ECG apprehends heartsignals caused due to electrical fields and are caught by sensors. The mentioned paper upholds the condition of heartbeat while watching the movie which was classified under Backpropagation Neural Network. Ac- cording to theobservations and analysis of the data collected and ratings of individuals who already have seen the movie, a discretionmessage will be sent via telegram about the type of the movie. Based on that a person can decide whether to watch that particular movie as per their health status. This system will be beneficial for individuals with weak heart, teens and parental guidance.

In the current paper, the ECG monitoring is done on elderly people and the alert is sent to their family members, nearest hospital and emergency services available using Telegram Bot.

In our previous published paper [8], will be discussed IoT and ML based smart system for cardiovascular disease. IoT is a popular intelligent system that manifests the non-hazardous technique of machine learning and speculates results. In the previous paper, we focused on speculating cardiovascular disease output with the help of IoT along with machine learning strategies for safety in block-chain platforms. The electrical signals were collected from the human heart by placing the electrodes on the chest – a process called ECG. The dataset collected were pre-processed by using 5-15 Hz band pass filtering and SWT and PCA used for undesired artefact elimination. SVM is used for classifying any individual as healthy or as a patient with compromised cardiovascular condition.

In the current paper, we are focusing on the health care of elderly people and we are using Telegram Bot for sending alert messages which is cost effective as well.

Izci et. al. [9], were discussed on, that Heart diseases are among the primary reasons for sudden fatality. Cardiac arrhythmia if diagnosed early and treated could help pre- vent life risk. To develop an algorithm for predicting arrhythmia based on the principle of EMD. Pre-processing, Empirical Mode Decomposition, feature extraction and classification are the four steps of this algorithm. To differentiate between signals obtained from normal and arrhythmic heart six types of arrhythmia features was used.

In this current paper, the steps of our algorithm are as follows: filtering, artifact removal, feature extraction, classification and

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Fig.1. Arrythmia Prediction using AI Tools and Bot

sending messages to the user to classify the dataset as arrythmia or healthy person.

III. PROPOSED WORK

This proposed work dataset collects signal from the heart the use of ECG sensor, and 5-50 Hz range of bandpass filter used for filtering, and SWT method used for artifact removing and ICA used for feature extraction. SVM used for classification result as Arrhythmia if features are matched, if the criterion aren't matched then the end result is proven as healthy. The result is sent to the user's mobile by using Telegram Bot. The proposed work is shown in Fig.1.

A. Arrythmia-Bot Algorithm

In this section we will design proposed algorithm name as

Arrythmia-Bot Algorithm

Start: //Variable declaration: Age= A, Sex=S, Cp=C, Trestbps=Tb, Chol=Cl, Fbs=F, Rest_ECG=R, Thalach=Tl, Exang =E, Old

1. Training and Testing dataset collected by electrocardiography sensor.

Peak=Op, Slope=Sl.

2. Filtering and artifact removal are two techniques of pre-processing



5-50 Hz range of bandpass filter used a. for filtering SWT method used for artifact b. removing: S(k) = f(k) + e(k)Features are as follows: Age, Sex, 3. Cp, Trestbps, Chol, Fbs, Rest ECG, Thalach, Exang, Old peak, Slope, Thal, Target. Which is extracted by ICA IF(A>= 18) THEN "Allow for Test" // Age as feature 1 IF (S==0) THEN "Female" //Sex as feature 2 ELSE IF (S==1) THEN "Male" IF (C==1) THEN angina disease" // Cp as feature 3 ELSE IF (C==2) THEN "atypical angina" ELSE IF (C==3) THEN "non-angina pain" ELSE "asymptomatic type of heart disease" IF (Tb>=94 && Tb<=100) THEN "Normal" //Trestbps as feature3 ELSE "Abnormal" IF (Cl>=126 && Chol<=564) THEN "Normal" //Chol as feature 4 ELSE "Abnormal" IF (F>=120) THEN "Arrhythmia" //Fbs as feature 5 ELSE "Not" IF (R>1) THEN "Abnormal" //Rest as feature 6 ELSE "Normal" $IF(Tl \ge 71\&\& Tl \le 202)$ THEN "Normal" Else "Abnormal" // Thalach as feature 7 IF(E==1) THEN "angina" ELSE "Not" //Exang as feature 8 IF (Op>=0 and Op<=62) THEN "ST depression prompted with the aid of exercise" // Old Peak as feature 9 IF (Sl == 1)THEN "Unsloping"

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21001 // Slope as feature 10
ELSE IF (Sl==2) THEN
"Flat"
ELSE (1)
"Down sloping"

- 4. SVM used to classify the training and testing dataset by following categories H(xi)=*if w*. $x + b \ge 0=+1$ "*Arrhythmiapatient*" (2) *if w*. x + b < 0 = -1 "*Healthyperson*"(3)
- 5. Send message using Telegram Bot

6. End

IV. RESULT

Experimental results of the proposed system will be discussed in this segment.

A. Dataset Collection

The training dataset collected from MIT-BIH Atrial Fibrillation database. According to the dataset, there were recordings of 23 channels of ECG of patients with arrhythmia. The frequency of ECG collected data is 250Hz accompanied by 12-bit resolution which ranges between -10 to +10 millivolts. The sample of arrhythmia disease prediction dataset are shown in TABLE I.

No	Α	s	С	Tb	Cl	FR	2	TI	Е	Ор	SI	Tar get
1	61	1	3	146	230	1	0	153	() 2.2	0	1
2	35	1	2	133	254	0	1	183	() 3.4	0	1
3	40	0	1	133	200	0	0	170	() 1.3	2	1
4	53	1	1	121	233	0	1	175	() 0.9	2	1
5	59	0	0	122	350	0	1	160	1	0.7	2	1

TABLE I

SAMPLE DATASET COLLECTION FOR ARRHYTHMIA PREDICTION

B. Classical Result

In Table II, by calculating F1 score, Recall and Precision we find that SVM is the suit- able machine learning technique for arrhythmia disease prediction. Precision is calculated by equation 4, Recall by equation 5, F1 score by equation 6 and



equation 7 is used to calculate Accuracy of Table 2 and graph shows in Fig.2.

$$Precision = \frac{True \ Positive}{True \ Positive + Fals \ Positive}$$
(4)

$$Recall = \frac{True Positive}{True Positive + False Negative}$$
(5)

$$F \text{ measure}=2*\frac{Precision*Recall}{Precision+Recall}$$
(6)

Accuracy=

True Positive +True Negative		(7)
True Positive +True Negative +False Positive +Fal	Negative	()

 TABLE II

 F1 SCORE, RECALL, PRECISION BY USING SUPPORT VECTOR MACHINE

Training Accuracy	Testing Accuracy	F1 Score	Recall	Precisi on	Time
0.923	0.812	0.88	0.87	0.88	1 Min 2Sec



Fig.2 F1 score, Recall, Precision by using Support vector machine

C. Performance Analysis

Performance of the proposed method are analyzed by McNemar's Test as shown in TABLE III.

Others Machine Learning	Proposed Algorithm	Support (Q)	Vector	Machine (SVM)
Testing (P)	n01	N1 0	Z	Comment
Back Propagation Neural Network (BPNN)	7	29	11.65	Reject
k-Nearest Neighbor (kNN)	5	28	14.78	Reject
Linear Discriminant	6	20	11.22	Reject
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Analysis (LDA)					
Quadratic Discriminant Analysis (QDA)	6	23	12.08	Reject	

The performance analysis for the proposed work is compared with different types of machine learning techniques by using MCNemar's numerical test. In this paper SVM is the control algorithm let P, another competitor algorithm as BPNN, kNN, QDA and LDA is Q. The null speculation right at this point visualizeseach procedure will distribute the identical mistakes frequency. Here the null hypothesis was neglected, when Z is going above 2.87, that's the necessary cost for χ^2 distribution for 1 degrees of freedom of possibility is 0.04. Table 3 clears that the significant variation in overall result is discovered by using McNemar's test despite the fact of comparing the currently proposed SVM system with all other 4 class methods.

D. Complexity Analysis

Training time complexity of proposed work using support vector machine is O(n2), here n is the number of input and if n is very large amount of data then it will complex. Run time complexity of proposed system is O(k*d), here k is the number of support vector and d used for dimensionality of the data.

E. Arrythmia Prediction using Bot

After all steps like filtering, artifact removal, feature extraction and classification, the next step is sending results to the user's device using Telegram Bot as shown in Fig.3.



Fig.3 Screenshot of Telegram Bot



V. CONCLUSION AND FUTURE WORK

Conclusion and future work will be discussed in this section. The current proposed model is an end to end model, data collected from a wearable ECG device, pre-processing is done by two steps: filtering in the range between 5-50 Hz band, artifact removal using SWT, feature extraction and selection using Independent component analysis. Support vector machine used to classify databases as arrhythmia patients and healthy people. After classification results are sent to the end user by using Telegram Bot. The proposed system accomplishes the performance of arrhythmia detection using ECG signals and machine learning techniques.

In the future we will apply different machine learning and deep learning techniques for different types of disease prediction.

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VII. BIOGRAPHIES

Sima Das was born in Durgapur, West Bengal, India. Sheis M.Tech in Computer Science and Engineering on August, 2020 from Maulana Abul Kalam Azad University of Technology (Main Campus), West Bengal, India.



Her employment experience included theshe is former Assistant Professor of Camellia Institute of Technology and Management, Hooghly, West Bengal India and Currently working as an Assistant Professor of Bengal College of Engineering and Technology, Durgapur, West Bengal, India. Her special fields of interest included Artificial Intelligence, Machine Learning, Deep Learning, Internet of Things,

Cyber Security, Smart Healthcare.

Sima Dashas awarded the Research Excellence Award from Global Innovation & Excellence Award 2021. She is Associate Member of Institute of Engineers and Professional Member of IEEE. She has many books, book chapters, conferences and journals. She is also an editor and reviewer of different international journals.

SayantanMalick was born in Singur, West Bengal, India. He is completed her M. Tech in Computer Science and Engineering on August, 2014 from Maulana Abul Kalam Azad University of Technology, West Bengal, India.



His employment includes that he is Assistant Professor of Camellia Institute of Technology and Management, Hooghly, West Bengal India and former employee as a Lecturer of Bidyanidhi Institute of Technology and Management, Malda, West Bengal, India. His special fields of interest included Web Development, Artificial Intelligence, Machine Learning, Internet of Things, Robotics, and Image Processing.

SayantanMalick has attended many tech fests as participant. He helped students of the institution to build many robotics projects that are commercially successful. He has vast experience on the projects of real time data processing and imageprocessing.

Souvick Majumder was born in Purba Burdwan, west bengal, India. He is studying B.tech now from Camellia Institute of Technology and



Management .He is a final year student of B.tech in Computer Science and Engineering . He is very interested in technology.He has habituated some computer languages like C ,C++, JAVA , python , Java script etc. He also likes to learn new technical things, for that He has recently started studying Artificial Intelligence, Machine Learning, Cyber security etc.

He also has some knowledge about web development and web designing is his one of favorite things, some smaller websites, clones of some famous websites belong to his project works. And his life goal is to become a fullstack developer.

Devdip Mallick is studying B.tech now from Camellia Institute of Technology and Management .He is a final year student of B.tech in Computer Science and Engineering .He has habituated some computer languages like C, C++, JAVA, python, Java script etc.



An Integrated Approach for prototype design of a Surveillance Bot

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Abstract-Closed Circuit Television system (CCTV) is a very popular device, not only in office but also in home surveillance applications. As CCTV systems have blind spot, so CCTV systems cannot give 100% surveillance alone. For these problems, we need a machine or a tool that can be used for surveillance and don't have any kind of blind spot and can be controlled manually as well as automatically using a smart phone. To overcome these problems, we make a surveillance Bot that can be controlled via smart phone. As an additional feature it can be also controlled via voice command as well as it can move automatically also by detecting obstacle. The robot hardware based on Atmega 328P contains motor servo to actuate robotic head. The Robotic movement is controlled by Nodemcu microcontroller board and is wirelessly connected to controlling person's smartphone via inbuilt WI-FI modules of these two devices. The controller person can control the robot via a Nodemcu controller Application. The surveillance part is done by using Pi Camera Module and Raspberry Pi and the live footage can be seen remotely in any smartphone as well as in Computers.

Index Terms—Bot; CCTV; Raspberry Pi; Surveillance.

I. INTRODUCTION

This paper presents a surveillance robot using Raspberry Pi, NodeMCU and Arduino UNO that may be used for surveillance and its motion may be effortlessly managed via way of means of the use of Wi-Fi robotic controller software through your Smartphones[1]. Hence, we will say that Android smartphones will serve an awesome gain for commercial, business and different general-motive packages. The DC motors are broadly used for imparting variable pace pressure machine in commercial packages comparable to automation, electric traction, navy instrumentality, constant disk drives, way to their excessive potency, noise-unfastened operation, compactness, dependability, and occasional preservation and cost. Many connections technology is used in

recent times together with GSM, GPRS, Wi-Fi, WLANs and Bluetooth[2]. Every approach has its very own exclusive traits and packages. Among those wi-fi connections,

Bluetooth and Wi-Fi era is commonly used[3]. The machine hardware includes a controller geared up with Wi-Fi communiqué module built in within side the NodeMCU microcontroller[11][12]. It'll be related to the automobiles and different opportunity additives of robotic[7]. When the robotic app is grown to become on and is attached with the modern machine through Wi-Fi, one will perform the auto via way of means of giving Wi-Fi instructions from the app the use of the capabilities already programmed within side the app[6]. The automobile will flow all four informed directions left, right, front and back. For forward motion, motion of each motor can be within side the equal path and for backward motion, motion of the motors can be in contrary paths. For left and right movements both of the motors will rotate and to prevent each the automobiles. Instructions are given to the automobiles through the smartphones app via way of means of the users.

II. METHODOLOGY

A. Block Diagram of Movement Part of the Robot:



Fig. 1. Block Diagram of Robot Movement

Figure 1 shows block diagram for this Wi-Fi controlled car using ESP 8266. The Project is designed using Arduino



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IDLE Software. Two DC Motors are controlled L298N Motor driver

IC. If the Wi-Fi module inside the NodeMCU gets data, the NodeMCU processes and gives the voltage to motor driver pins and through the motor driver gets power and moves as per instruction[8][10].

B. Block Diagram of Surveillance Part of the Robot:



Fig. 2. Block Diagram of Surveillance Part of the Robot

From the above figure we can see, when the program starts the run timer starts and records video via camera and shows live video footage via device or if it does not get instructions it checks for instruction.

C. Circuit Diagram of Movement Part of Robot



Fig. 3. Block Diagram of Movement Part of Robot

The figure3 shows the schematic diagram of Wi-Fi Controlled Car part of the mechanism. Two DC motors are controlled by L1298 Motor Driver IC, which is a high power motor driver capable of running 5V to 35V DC Motor of 25W. 500 RPM DC motors are used in this application. ESP8266 Board connects and controls the complete circuit and equipment.

D. Circuit Diagram of Surveillance part of Robot



FOSET special issue on Recent Innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21002 Fig. 4. Block Diagram of Surveillance part of Robot

To develop the surveillance part, we have used a motor servo to move the neck and face of the robot. We have used Pi camera as visual sensor, Microphone as the sound sensor and Arduino Uno Microcontroller as controller of the actuator and this whole circuit is connected to Raspberry Pi 3B Microcomputer where the database is stored and processing of the images and other surveillance operations are done. Raspberry Pi 3B is connected to a power bank to power the whole circuit.

III. RESULTS

The project has been finished with success with the utmost satisfaction. The constraints square measure met and triumphs over with achievement. The system styled is meant is intended as find it irresistible was set within the layout section. The project gives clever plan on growing a fullfledged utility fulfilling the person needs. The device is extremely versatile. This code encompasses an easy display screen that lets in the person to apply without any inconvenience. Validation assessments iatrogenic have substantially decreased errors. Provisions are created to improve the code. It has been examined with live records and has supplied a prosperous result. Thence the code has tested to determine expeditiously. The device created met its objectives, with the aid of using being truthful to apply. This code is advanced with measurability in mind. Further modules can't be really different as soon as necessary. The code is advanced with popular approach. All modules inside the device are examined with legitimate records and invalid records and the entirety paintings with achievement. However, there is nonetheless plenty of scope for future development and accessories in practicality. A wide variety of the most ones being cell utility improvement for extraordinary cell software program package. It is displaying live video footage to the controlling person's device and the motion of the Robot is likewise great.



Fig. 5. Prototype



IV. OBSERVATION TABLE I

	Command	Motor Output					
Port	(Node	With Comm	out and	With Command			
	MCOJ	Vin	Vout	Vin	Vout		
3	RIGHT REVERSE	0.01 V	0.01 V	9.89 V	9.76 V		
4	RIGHT FORWARD	0.01 V	0.01 V	9.79 V	9.70 V		
7	LEFT REVERSE	1.01 V	0.01 V	9.95 V	9.91 V		
8	LEFT FORWARD	0.01 V	0.01 V	9.88 V	9.76 V		

V. APPLICATIONS AND FUTURE SCOPE

The Robot can be used as a surveillance equipment.

2. The Robot can be used to film videos of something.

3. Robot cars also getting used for military weapon to destroy enemy territories.

4. Robot cars are also getting used for stealth purposes.

5. Engineers are trying to convert these robot cars to a fullblown War- machine.

VI. CONCLUSION

To develop this project, we have learnt Python language and its OpenCV library which are one of the most important and trending parts of modern coding. With the success of this project. we would like to continue our research work in this field and develop much more advanced robots which can solve real life problems. In the end we would like to thank our mentor Mrs. Sanghamitra Layek Madam for her great contribution in our project, without her this project wouldn't become a success.

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VIII. BIOGRAPHIES

Raktim Dutta was born in Madhyamgram in India on November 27,2002.



He passed 10th examination from Madhyamgram Acharya Prafulla Chandra Vidyayatan in 2018, and passed 12th Examination from Madhyamgram Acharya Prafulla Chandra Vidyayatan. He us currently pursuing his BTech degree in Electronics and instrumentation engineering department at Narula Institute of Technology, Agarpara.



Sayan Mondal was born in Chittaranjan, Paschim Bardhaman of India on April 24, 2000. He passed his secondary education from Burnpur Riverside School, Chittaranjan in 2016. He went to many places for higher studies and currently pursuing his Bachelor's Degree in Electronics and Instrumentation from Narula Institute of Technology, Agarpara



Sanghamitra Layek was born in Kolkata in India on December 16,1979. She passed ME in Biomedical Engineering from Jadavpur University on2007.Now she is working as Assistant Professor in Instrumentation Engineering Discipline in Narula Institute of Technology under the Maulana Abul Kalam Azad University of

Technology, West Bengal, India. She has 15 years of academic experience.



Bansari Deb Majumder is working as Head of Electronics and Associate Professor in Department of Instrumentation Engineering in Narula Institute of Technology under the Maulana Abul Kalam Azad University of Technology, West Bengal, India. She has more than 10 years of academic experience. Her research area includes multi-sensor systems, development of

multi-functional sensors, instrumentation, and control, design of controllers for industrial solutions; IoT based solutions. She is a member of the IEEE Instrumentation and measurement society, IET Kolkata Network, and Institution of Engineers.





Fabrication of Flexible Energy Storage Dielectric Material from Bio-Wastage

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Abstract-- Fossil fuels are a leading source of global warming pollution. Even the waste products are hazardous to public health and the environment. Considering the business cost and environmental concerns, the technology of 'Bio-waste-to-Energy' is recognized as an increasingly important renewable source of energy. Here we have potassium hydroxide (KOH) activated produced microporous carbon from tea wastage. We have fabricated flexible Polyvinyl alcohol (PVA: easily processable, cheap and eco-friendly polymer) based films using Activated Carbon (AC) as nanofiller with different weight percentage. Conductivity observation of the sample was done to study their prospect as the dielectric materials in energy storage, microwave absorption applications. Depending upon the results, we can apply the Activated Carbon (AC) based polyvinyl alcohol (PVA) dielectric film to make flexible, environmental friendly energy/storage devices, microwave absorbents.

Index Terms-- Activated Carbon; Biowaste Material; Dielectric Characterisation; Energy Storage; Polymer Film; Tea Wastage.

I. INTRODUCTION

C ARBON is an interesting material for more than a century. The allotropy of carbon makes it useful and applicable in different field of science and technology. In the very past, nanostructured carbon materials such as microposous AC, carbon nanotube (CNT) and graphene have

been applied in various fields due to their distinct properties

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FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21003 including mechanical, optical, electrical and electrochemical characteristics [1]. Nowadays, considering the business cost

and sustainability of environment, the use of biowaste materials to produce higher value cactivated carbons (ACs) becomes one of the growing fields. Until now, various biomass materials, such as dates' stones, coconut shells, wood, rice husk, and banana peel were used as the precursor materials to produce ACs. The as-obtained microporous ACs have been used effectively in super-capacitors, catalyst carriers, solar energy conversion, electrode materials and adsorbents [2]. In India, a large amount of tea-wastage is produced in daily basis. India is the second largest producer of tea (famous Assam tea and Darjeeling tea) in the world after China. According to the Assocham report released in December, 2011, India, as the world's largest consumer of tea uses nearly 30 percent of the global output [3].

The tea-wastages usually are usually disposed by burning or by deposition in landfills that cause environmental harms. In this situation, conversion of tea-wastage to environmentfriendly higher value products such as porous carbon/ activated carbon would be more preferable.

The magnificent properties of AC makes it suitable candidate for high-performance polymer composites. In order to increase the application range of polymers, nanofillers can be incorporated into the polymer matrix. The fabrication of flexible polymer based dielectrics with AC as filler element is very much desirable in the applications related to microwave absorbing property such as antenna techniques, protection of humans and other biological objects from the harmful effect of the electromagnetic waves, military application [4].

Here we have produced potassium hydroxide (KOH) activated porous carbon from tea wastage and studied its physical characterization with XRD, UV-Visible spectra. Also we studied the electrochemical properties of the activated carbon. The cyclic voltammetry, galvanostatic charge discharge and electron impedance spectroscopy measurement was done. We have fabricated flexible Polyvinyl alcohol (PVA) based nanocomposite films using AC as nanofiller with different weight percentage. Electrical characterisation of the films was

done to study their prospect as the materials in energy storage, microwave absorption applications.



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II. EXPERIMENTAL SECTION

A. Synthesis of Activated Carbon

At first the tea wastage was collected from household. The pre-treated tea wastage was mixed with potassium hydroxide (KOH) at a ratio 1:1. The mixture was placed in porcelain boat and put in a furnace under constant Argon and heated at a temperature 1023 K. The whole process was done under Argon atmosphere. The sample was washed several times with deionized water and filtered. Then the sample was heated at a temperature 338 K. By crushing it in smooth powder, the activated carbon was achieved.



Fig. 1. Flowchart of digital images of synthesis of KOH activated carbon

B. Synthesis of Flexible Polyvinyl Alcohol (PVA) Nanocomposite Films Using Synthesised Activated Carbon (AC) Nanofillers

The flexible PVA nanocomposite films with AC as nanofillers were processed by the solution casting method. The solutions (PVA with inclusion of 2 wt % AC, 4 wt % AC)were poured into glass petridice and dried in natural environment for 6 days. Pure PVA is marked as R_1 . R_2 is 2 wt % AC-PVA and $R_3 - 4$ wt% AC-PVA.



Fig. 2. PVA solution under continuous stirring at the rate of 430 rpm

C. Characterisation Methods

UV-Vis absorption spectroscopy of TW and AC has been done in the wavelength range from 200-800 nm, using UV-Visible spectrophotometer (HITACHI-3010). Electrochemical measurement of synthesised activated carbon (AC) is conducted in a three electrode cell using an

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21003 electrochemical workstation by several procedures such as cyclic voltammetry (CV), galvanostatic charge discharge (GCD) and electrochemical impedance spectroscopy (EIS). The 3-electrode electrochemical cell is made up of a working electrode, Ag/AgCl reference electrode and platinum counter electrode. With the help of LCR meter, electrical properties of the prepared film samples are measured.

III. CHARACTERIZATION, RESULTS & DISCUSSIONS

A. UV- Visible Analysis

The optical absorption spectra of the tea wastage and activated carbon were measured using a UV spectrophotometer. Ethanol was used as the solvent for the measurement. Figure 3 shows the absorption peaks for raw tea wastage and KOH activated carbon. For the raw tea wastage, we see one major absorption peak from 250 nm to 290 nm, with the peak at 273 nm. This absorption peak is assigned to functional groups attached to aromatic ring, which includes -OH (270 nm). There is also another peak around 410 nm which is the characterization peak of β carotene which is an antioxidant that converts to vitamin A. There is another small peak around 664 nm which is due the presence of chlorophyll [6-11]. For the UV spectra of activated carbon, there is only one peak is visible which is at λ =270 nm. This peak corresponds to aromatic compound presence in the activated carbon. Peak around 270 nm also represents the π - π * transition in aromatic compound.



Fig. 3 (a) UV-VIS spectroscopy of tea wastage and activated carbon, (b) Tauc plot (Direct transition) of Activated Carbon

From the Tauc Plot [Fig. 3 (b)], it is obtained that E_{nano} = 3.08 eV. Determination of band gap demonstrate that activated carbon behaves as semiconductor material and therefore also as a photoactive material in the presence of UV light as the $E_g < 4$ eV [12]. So activated carbon can be



used as a as a photoactive material in application in optoelectronics.

B. Electrical Measurement (Cyclic Voltammetry)

The most valuable property of a supercapacitor is its ability to supply energy density & electrochemical analysis. To find the electrochemical performances of activated carbon, the cyclic voltammetry measurement was done which is a type of potentiodynamic electrochemical measurement. The measurement was done at room temperature between the potential range of 0 to 1 V. Figure 4 shows the CV curves of activated carbon at various scan rates. The shape of the curves up to the scan rate 100 mV/sec are rectangular which represents a good capacitor like characteristics and also electric double layer capacitance [7]. But the rectangular curve gets deformed after the scan rate 200 mV/sec. It is also noticed that as the scan rate increases, the current density also increases. It is also found that there are no peaks in CV curve which means the supercapacitive property is free from redox reactions.



C. Electrical Measurement (Galvanostatic Charge Discharge)





Figure 5 shows the Galvanostatic Charge Discharge (GCD) curves for activated carbon recorded for different current densities. As seen from the figure, for all current densities, the curves show similar symmetrical triangular curves. As the current density increases, the charge discharge time becomes lesser. As seen from the curves, a drop in discharge arises due to the diffusion-limited mobility

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21003 of the electrolyte ions [6]. The GCD curves show that the KOH activated carbon is behaving like a typical carbon based supercapacitors.

D. Electrical Measurement (Electrochemical Impedance Spectroscopy)

Figure 6 shows the EIS data expressed as Nquist plots in frequency range 100 Hz - 106 Hz for KOH activated carbon. In high frequency region, small semicircle represents resistive nature of supercapacitive system.



Fig. 6. EIS curve of Activated carbon using 1M H₂SO₄ as electrolyte

E. Conductivity Study

Frequency variation of total conductivity is being investigated in the range of 20 Hz - 2 MHz above room temperature for the nanocomposite film samples (R₂, R₃). When frequency is low, then the conductivity remains unchanged with the variation in frequency. This phenomenon suggests the dominance of DC contribution. But the frequency dependence of conductivity is noticeable in the higher frequency range. Using Arrhenius equation, activation energies of the film samples are calculated and indexed in Table 1. According to Jonscher, the conductivity relation can be written as follows, [14]

$$\square \square(f) \square \square_{dc} \square \square_{ac}(f) \square \square_{dc} \square \square f$$

The frequency exponent *S* have been extracted from $\ln \Box \Box$ (*f*,*T*) vs. $\ln f$ plot. From figures, *S* decreases when we increase the temperature. Here, the nature of *S* shows Correlated Barrier Hopping (CBH) model type conduction where, mobile charges hop over a potential barrier between two defect sites. The modified equation of frequency exponent *S* is given as [14],

$$S = 1 - \left(\frac{6 k_B T}{W_m}\right)$$

(2)

where k_B , Wm are Boltzmann's constant and maximum barrier height respectively. From the result it can be concluded that the maximum barrier height is least in AC-



(Table 1).

PVA (2 wt %) nanofillers loaded PVA nanocomposite film



Fig. 7. EIS curve of Activated carbon using 1M H₂SO₄ as electrolyte.

TABLE I Samples of Times Roman Type Sizes and Styles

Samples	Maximum Barrier Height (w _m)	Activation Energy (EA)
R ₂	35 meV	0.88 eV
R ₃	31 meV	0.28 eV

IV. CONCLUSION

In conclusion, we successfully converted tea wastage collected from household and prepared activated carbon (AC) by potassium hydroxide (KOH) activation process. Then the physical characterizations of the prepared AC were done using UV spectroscopy. Also the electrochemical property of the activated carbon was studied and the results were similar to a carbon based supercapacitor, which was expected. Also the electrical transport properties were studied. Depending upon the results, we can apply the Activated Carbon (AC) and AC-PVA film to make flexible, environmental friendly storage devices, microwave absorbents.

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V. ACKNOWLEDGMENT

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VII. BIOGRAPHIES



Dr. Monalisa Halder (PhD, B.Ed., M.Ed.) is currently working as an Assistant Professor of Physics in an engineering college in West Bengal, India. She has done her PhD in Science (Physics) from National Institute of Technology Durgapur, India in 2020.

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An Automated Wheel Chair: A Step towards Innovation

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Abstract: There are 8 billion people on the earth. Among them, there are 650 million people who have disabilities. Their disabilities are different. Among them, more helpless are those who cannot move for their disabilities. Besides them, some people have difficulties in mobility for the sake of their ages. For the past few decennary the automation of the wheelchair and its technical advancement has been the top most priority to the scientists and researchers. This unique and automated "Automated Wheel-Chair" can be the solution to the problems of those disabled peopleregarding their mobility. In the wheelchairobstacle detection is implemented using ultrasonic sensors, location tracking by GPS and many more. It provides the rider with a comfortable seat. The design of this wheelchair can provide the feature of self-control with the help of Infrared Sensor or IR sensor. The microcontroller (Arduino Uno) based circuitry design allows sending emergency messages to the mobile application of the user's family through IoT technology.

Keywords:Aged peoples; Disability of movement; IoT; sensors; Obstacle detection.

I. INTRODUCTION

A huge number of people in our society are unable to move due to their disabilities. These disabilities may be caused by different reasons; some may be caused by birth or some may be caused by accident. According to Nayak and his team [1], 650 million people have a disability.



Fig 1: Percentage of distribution of disability [2]

In this research paper, we have worked on the disabilities of mobility and tried to solve their challenges.

A wheelchair helps persons, who have movement disabilities, to move from one place to another. But in a

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21004 normal wheelchair rider have to operate the chair by whim/herself or he/she has to take help from others. An automated wheelchair can solve this problem.

The advancement of technology has solved many difficulties in our everyday life. Using advanced technology, we can solve the movability problem for those disabled persons.

In this research paper, we have discussed an automated wheelchair which can be operated automatically as well as manually as per riders' choice. This paper presented various objectives which highly differentiate the ordinary wheelchair. Generally, an ordinary wheelchair cannot run automatically or cannot be traced out. But this wheelchair has a sensor which will detect the obstacles in front of it and will move safely. Also, a GPS will help the chair with tracking. In addition, the seat belt will give the rider a safe ride.

II. LITERATURE SURVEY

A team of renowned researchers and scientists have been working on the automation of wheel chair and its technical advancement for the past few years. Many of them have described different bases of wheelchairs and advanced automated wheelchairs which are using different technical parameters. reference we can say, Hartman and his team [9] have presented awheelchair as a chair with wheels that helps people who facedifficulty in walking independently. Wanluk has described [10] an automated wheelchair in which a GPS system is used for location tracking. PU and his team have given an idea [11] on the obstacle detection of the wheelchair using IR sensors, IR camera sand ultrasonic sensors.

III. METHODOLOGY

In everyday life, the wheelchair is helpful to physically disabled people as it helps them to roam around here and



there, without the help of any other person as it has an interface with assistive nature.

There is a microprocessor (Microchip PIC6F88 microcontroller) which helps control the speed and direction simultaneously [3].

A. System Architecture:

- Joystick: The manual operation of The Automated Wheel is very simple. The joystick helps the chair in manual movement.
- GPS module: GPS module is used to track the wheelchair as well as to locate the destination if the user wants to go from one place to another.
- DC motor: Give the wheelchair auto-mobility.
- IR sensors: It is used to detect the obstacles on the way.
- A switch for controlling the height of the footrest: A single switch is added to change the height of the footrest of the wheelchair as per the user's comfort.
- Mobile app-based control: A mobile app-based tracker and controller is also installed for extra safety. For any kind of malfunction or glitch of the system the family of the user can track or control the wheelchair through the mobile application.
- Drivers: The drivers are used to control the motor.
- Push-Buttons: The push buttons are used to set the destination in auto mode.

B. Description of proposed methodology:

- IR sensor: IR sensors are used to detect any obstacles in the way of the wheelchair. The sensor detects the obstacles and sends a signal to the system [4]. The chair moves according to the signals. For better results, we have used two IR sensors here.
- GPS module: For the tracking [5] of the wheelchair or to set the destination while the user is going from one place to another place the GPS parameters such as longitudes and latitudes are used. For any malfunction, the system can send the notification to the user's family members through the mobile app.



Fig 2: GPS module

• Ultrasonic sensor: For providing extra safety to the user an ultrasonic sensor is also added to the system. It also helps to detect [6] the obstacles on the way.

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Fig 3: Ultrasonic sensor

- Joystick: To roam with the wheelchair in manual operation mode joystick helps [7] the user to operate. Here we proposed to use Reinforced Joystick 3.2 for the working purpose.
- DC motor: A DC motor is an electrical device that converts direct current electrical power into mechanical power. It supplies powerfor the movement of the wheelchair. The specification [8] of the used DC motor is: 24V DC motor, required current 15.4 A, rated power of 280W and 2750 RPM.
- Battery: A secondary (means rechargeable) Lithium-ion battery is used to supply the power to the dc motor and the other equipment.

C. Working principle:

There are few steps through which an automated wheelchair can detect the obstacles on its way. The steps are:



Fig 4; Steps for obstacle detection of an automated wheelchair. Now, with the help of a simple flow chart, we can easily understand the working procedure of a wheelchair. The flow chart is given below:





3 Fig 5: Algorithm for Obstacle detection

IV. RESULT AND DISCUSSION

As we are implementing the both automated and manual mode operation technology in this automated wheelchair, there might occur few complications about the command. Though the destination is set previously in the mobile application; but when the user will use the wheelchair on the

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21004 way to the destination there might happen some changes in the situation. Depending on the situation user have to made some decision to change the direction of the wheel chair. So, the first command preference will be the command of joystick.

As for example we can say that, to reach the destination mobile app gives the command to go to the right. But depending on the situation user moves the joystick towards left. In this situation the wheelchair will take the command of the joystick and will go as per user's command from the joystick.

The implementation of the project of The Automated Wheel Chair will help those physically disabled people to roam independently. Sometimes it has been seen that some depression is seen among them due to their disability. But this independent roaming can also cure their mental health. Moreover, The Automated Wheel Chair can be used for the roaming purpose of old age people who cannot freely roam around for their ageing factor.

V. CONCLUSION

In this paper, we have proposed the basic concept of The Automated Wheel Chair which will be able to operate indoors as well as outdoor. The GPS tracking system can ensure the safety of the user. We tried to make the life of a handicapped person a little bit easier. Before the automated wheelchair is widely used there are a few challenges which should be solved. After marketisation, the automated wheelchair will be very useful for physically challenged persons as well as for old age persons.

VI. FUTURE AMELIORATION

In this paper, we have discussed a few basic features of the automated wheelchair. We plan to add more features to this automated wheelchair such as a Heartbeat monitoring system, Blood pressure measure system, body temperature measurement, foot massage system which will help the user in good blood circulation as they can't walk by them, weather detection system and its consequence actions like in sunny or rainy-day automated shading over the user and so on.

We can give every wheelchair a unique serial no through which it will connect to the mobile app and it will also be registered to the hospitals. If any abnormalities occur in the heart rate; if body temperature or blood pressure increases above the normal level, then the user's family will get an alarm or notification on their mobile application through IoT





technology. And they will be able to take the required action.

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VIII. BIOGRAPHY



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Semiconductor Industry & India's Possibilities

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Abstract - The journey of development of semiconductors following Moor's law is a fascinating topic over past few decades which forms the basis of semiconductor industry globally. But participation of India in this development is not at all encouraging. In this work main focus is projected on the current status of India's semiconductor industry, related issues and hurdles, the possibilities and the future projects with government intervention.

Keywords: Moor's Law; Semiconductor Industry; Projects in India; Government Intervention

I. INTRODUCTION

Semiconductor is one such element that works between Conductor & Insulator so far as conductivity is concerned. There are primarily two different types of semiconductors, the intrinsic semiconductor and the extrinsic. Silicon and Germanium are examples of intrinsic semiconductors and various impurity (Group III/ V elements of the periodic table) /doped semiconductors (Group IV) fall under the category of extrinsic type. Semiconductors are developed at a much faster rate in present days since its innovation [1]. In this context it may be mentioned that Gordon Moore's prediction regarding the development and growth of semiconductor is ultimately turned into famous Moore's Law, which states that the number of transistors used per square inch in the Integrated Circuit's (ICs) is doubled in every two years. So the scale gets smaller (Table 1) and the performance of microprocessor shows an exponential growth.

The importance of the law was evident. The semiconductor manufacturing industry had created a predictive roadmap entitled, The International Technology Roadmap for Semiconductors which spans from 1971 to 2020 (Figure 1). This roadmap was established by five geographic regions that represent almost every chip manufacturers of the world.

The contribution of Moore's law has reduced the robust structure of the devices to handy gadgets over recent decades. All the smallest smart devices like smart phones, tablets, smart watches, etc. are the gift of the development of semiconductor. Table 1 MOSFET Scaling [2]

Sl. No.	Year	Scaling
1	1971	10 µm
2	1974	6 µm
3	1977	3 μm
4	1981	1.5 μm
5	1984	1 μm

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6	1987	800 nm
7	1990	600 nm
8	1993	350 nm
9	1996	250 nm
10	1999	180 nm
11	2001	130 nm
12	2003	90 nm
13	2005	65 nm
14	2007	45 nm
15	2009	32 nm
16	2012	22 nm
17	2014	14 nm
18	2016	10 nm
19	2018	7 nm
20	2020	5 nm
1	2023 (Future)	3nm

Roau	мар
Year	Image
1874	
1904	- Statistic
1947	
1961	
1971	
	Year 1874 1904 1947 1961 1971

Figure 1 Semiconductor Roadmap

II. INDIA'S SEMICONDUCTOR INDUSTRY ISSUES

India is a powerhouse of semiconductor design. Almost every major semiconductor company has its presence in India, which design some of the world's most advanced chips. But once thosedesigns are completed, they are sent to USA, China, South Korea and Taiwan for fabrication which raises the big question regarding the development of semiconductor industry in India. There are some major issues.

A. Lack of Proper Infrastructure



According to data, India currently imports all of its semiconductor chips as its manufacturing is a difficult job. SemiconductorFabrication plants, commonly known as FABs manufacture mainly various integrated chip circuits and silicon wafers which requires huge expenses to set up as manufacturing equipment depreciates fairly quickly. So no big industry or set-up is available in India at present where government have to play a proactive role by allocating the required budget. Actually, setting up a FAB can cost at least \$(3-4) billion [3] and all the logistics and allocation of human resources may add up to even more. Also infrastructural requirements must include upgradation of the equipment constantly and their maintenance need an uninterrupted power supply and access to millions of litres of pure water where most of the river is polluted due to over growing population.

Fabrication plants also need long time to become profitable [4]. It may take at least (10-15) years' continuous operation of the plant to get a profit, otherwise end up losing thousands of crores of rupees.

B. Environmental Issues

The world giant industry Global Foundries makes chips through a complex process which needs clean environment along with expensive factory equipment. India, being a developing country most of its parts are polluted because of over-growing population. So, it is hard to find the clean environment required for making semiconductor.

C. Shortage of Resources and Electricity

Silicon is the main material that is used for making semiconductor. India don't have enough stored Silicon as compared to China, though India is the 3rd biggest country according to the no of Silicon production (370 Thousands of tons per year) [Table 2]. But the demand is greater than production [5].

Rank	Country	Silicon Production Rate (thousands of tons per year)
01	China	4,500
02	Russia	600
03	India	370
04	United States	320
05	Brazil	210

Table 2 Major Silicon Producers

Shortage of Electricity is another barrier. India don't have enough electricity to supply. But for the production of Semiconductor, electricity is main resource. At present India faces 1% of power shortage as of April-June period of this fiscal year, with an overall supply of 400.65 billion units against the requirement of 404.76 billion units [4]. But for establishment of semiconductor industry, the required uninterrupted power supply as per production rate,

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21005 arrangement for huge power production units needs to be established.

D.No-Response Issue for Industry Establishment

The electronic usage saw a massive rise in 1970s throughout the world. America took the opportunity to set up its first semiconductor manufacturing industry resulting in the emergence of the Silicon Valley. While the US was mainly involved in the design phase, the manufacturing work was handed over to Taiwan owing to its cheap labour costs. India at that time was mainly reliant on the US and USSR (later Russia) for import in this sector and so lost the opportunity to capitalize the existing void in semiconductor industry. It was mainly because of the country's industrial policy of not investing the capitals in this sector at that time, made India's technological progress in this area way behind the developed nation .

So, India is seriously lacking in these departments. Also India's knowledge of Research and Developmental (R & D) activities for semiconductor manufacturing front end fabrication and back end assembly [5] is not so advanced. These factors played major role so far as foreign investors' financial assistance for establishment of semiconductor set up units were concerned in India.

III. SOLUTIONS FOR INDIA

However, the global chip shortage caused due to the COVID-19 pandemic have changed the situation as globally sizable parts of daily economic and essential activities are arranged online which is highlighting the importance of the chip-based computers, smartphones, and other electronic gadgets for daily use. The global education system is largely dependent on online communication mode. That's why the demand of electronic devices is increased a lot all over the world along with India. Earlier as the demand was too low to go for big semiconductor set-up, it was not initiated in developing country like India. But now it becomes a great opportunity for India to take advantage of this global chip-shortage situation to establish its own set up. Recent China-Taiwan geopolitical crisis gives the world an opportunity to rethink about the overdependence on China-Taiwan for semiconductor chips. India have to capitalize this golden chance to be a chip maker from chip taker [6,7]. For that purpose, few areas are pointed out here.

A. Long Term R&D Activities and Investment

Here case of Israel can be considered which become the bedrock of innovation as every semiconductor company has their R&D center in Israel. The reason is their investment on R & D. In 2022 they spend 4.8 % of their GDP in research while India's expenditure on research was only 0.7% of GDP [6]. India can't achieve success without focusing on scientific research and development on semiconductor sector progress



which may help India to gain a successful talent pool for semiconductor production. C2S (chips to start-up) program taken by Government will train 85000 young engineers to work for chip manufacturing. India currently have limited facilities like SCL(Mohali), GAETEC (Hyderabad), SITAR(Bengaluru).

B. Infrastructural Development

State-of-Art infrastructure is a necessity for semiconductor manufacturing. It needs continuous electricity supply for running 24X7. Entry level semiconductor factory needs 20+ million liter ultra-pure water per day. Also pollution-free environment as a single particle of dust can force a chip to compromise.

C. Investment and Government Incentives

Initiative taken by central or state governments and private investments.	Ongoing & Future semiconductor chip related projects
Karnataka government initiative	ISMC signed a MOU with state government this year with an investment more than 22000 crore for chip manufacturing facility.
Gujrat government Initiative	Under the umbrella of national semiconductor mission Gujrat state government introduce plan for establishment of DHOLERA SEMICON CITY in DHOLERA SIR .
Maharashtra government initiative	Foxconn(Taiwan) and Vedanta(India) are planning for a \$22 billion investment for chip manufacturing facility in Talegaon of Pune.
Central government initiative	NSDC(National Skill Development Corporation) set to collaborate with Infineon Technologies for strengthening local semiconductor ecosystem.
Private Company collaboration.	American chip company Freescale already has R&D in India. Aricent (USA) acquire Indian chip design company Smart-Play with \$163.06 million.
Central government initiative	IESA and Singapore semiconductor industry association signed MOU for the development of both countries chip industry.
Private investment	INVECAS set to invest \$15- 20 million for chip design centers.

Despite achieving success in designing, India's experience as a leading semiconductor manufacturer is not good at all. In 2007 due to the lack of industry policy, Intel, moved to China

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21005 and Vietnam though initially had shown interest for India. Approaches by HSMC and Jaypee group failed to find success. But the announcement of \$10 billion subsidy under PLI (production linked incentives) has the ability to be a game changer. Government have to assist in developing secured manufacture, friendly environment so that leading semiconductor companies can extend their hands in semiconductor industry initiative. Also state governments should take necessary steps like Karnataka and Gujrat Government to win the trust of foreign investors (Table 3).

Table 3 Ongoing and Future Projects (Government Initiatives)[8]

According to the reports by IESA (India Electronics and Semiconductor Association)India's semiconductor component market will reach \$300 billion during (2021-2026) period. But with locally sourced semiconductor components which are still less than 5% in 2021, it will take years when projected cost hike will be \$5-6 billion for a fabrication unit. So Indian government have to ensure its big Tech companies about the chance of profit from those investments.

D. India's Focus Area

To take care of the problems related to proper infrastructure, huge investment, lack of proper talent pool, low R & D budget and lack of local-made semiconductor chip related start-up [8], India should focus to strengthen its chip designing service capability as India already have an ecosystem for that with 24000 design engineers. In India, DRDO and ISRO develops semiconductor chips but only at strategic levels (Space and Defence). India lacks the capability to develop these chips at a commercial level. Thus, investment by local companies and collaborating with foreign partners should be emphasized on. It can also focus on collaborating with OSAT (Outsourced Semiconductor Assembly and Test), ATMP (Assembly, Test, Marking and Packaging) where being major chip designer and vendor, they capture almost 50% of global chip supply chain and India can be a part of this supply chain. Here Central government scheme can inspire setting up of semiconductor fabrication units/ OSAT facilities/ sensor FABs / ATMP/ and silicon

E. China-Taiwan Crisis and India's Opportunity

Recent China Taiwan geopolitical crisis and the possible invasion in Taiwan and China-QUAD cold war forced chipmakers to rethink about semiconductor supply chain. To reduce over dependency on imported semiconductor, USA government recently passed most awaited CHIPS ACT with \$52 billion funding to combat China technologically [8,9].

USA and EU may rely on India as a replacement of China. As the global chip shortage becoming acute in post pandemic world, TSMC (World's largest semiconductor foundry) can



make its manufacturing plants in India to end the global chip shortage as India have world's 2nd largest workforce. It is hoped that with help of PLIscheme, 'MAKE IN INDIA' initiative, and with foreign direct investments, growth in research and Development India will be a chip taker to chip maker.

IV. CONCLUSION

From smart phones to data centers, personal computers to mighty supercomputers, from today's popular electric vehicles to future auto-driven cars, at the heart of these revolution is a piece of technology - Semiconductor. Semiconductor chip brings life in our daily used machines. Our very familiar silicon is that magic material that makes semiconductor chip revolutionary. This days to make semiconductor chip, more capable scientists are betting on new material like Gallium oxide. In this review paper India's current position and possibilities to be a chip maker is highlighted. India is looking for long term R&D policy, foreign investment and selffinancing possibilities. The government policies and efforts to ensure India's future journey to be a potential chip manufacturing hub is also highlighted. Finally it is expected that addressing the major issues as discussed here, India will develop its own semiconductor industry in near future when its ambitious projects make India a leading semiconductor manufacturer in the world.

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VI. BIOGRAPHIES



Anurag Ghosh was born in Chittaranjan, West Bengal in India, on December 23, 2002. He completed his secondary and higher secondary education fromBurnpur Riverside School, Chittaranjan, West Bengal and is currently graduating (B.Tech) at Guru Nanak Institute of Technology with specialization in electronics and communication engineering.

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Dr. Sucharita Bhattacharyya, was born in Kolkata in the state of West Bengal, India. She graduated in Physics from Burdwan Raj



College and obtained her Masters Degree from Burdwan University in 1989. She did her Ph.D. from Visva-Bharati University.

She is currently working at Guru Nanak Institute of Technology, Kolkata as Professor of Physics. Her working area was low & medium energy Physics during her Ph.D. tenure. She received national scholarships and CSIR andDST Research Fellowship.

After Ph.D., Dr. Bhattacharyya worked as research assistant at Oak Ridge National Laboratory in their National Project

on Nuclear Internal Conversion study and was awarded fellowship from University of Tennessee, USA (2001). Later she shifted to work in the area of Computational Electromagnetics and was awarded research grants from UGC, AICTE, and DST. She supervised Ph.D. work as empaneled supervisor of MAKAUT successfully. She has authored more than 50 publications in peerreviewed journals and conferences.



Active Bio-Enzyme Based Mist Sprayer Semi-Automatic Floor Cleaning Machine

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Abstract-- Now days, the automatic floor cleaning machines are mostly used to make our life comfort. The use of those automated machines are more acceptable in the markets with the advancement of technology but these are not very popular due to their complex design, high cost of machine and power tariff. A semi-automatic floor cleaning machine is proposed in this paper which is able to clean the floor effectively. This semiautomatic floor cleaning machine is designed for cost reduction and user friendly. The Arduino based semi-automated floor cleaner containing active bio enzyme based sanitization process is designed here which is very useful to improve our life style.

Keywords: Semi-automatic floor cleaning machine, Arduino, Sanitizer mist sprayer, dry-wet cleaning, low cost and low efforts, easy fabrication technique.

I. INTRODUCTION

These days humans lead a very hectic, enlightened and recent life. People are facing long working times. In this hectic situation everybody will want to get time saving technologies. In this regard we can give the tasks manually to the robots. For the working women, it becomes more problematic to manage home and office together [1-3]. For these problems we are going to present a cleaning machine or robot. This paper deals with floor cleansing machine which is semi-automatic. We all know that Cleaning is a very important and time consuming work in our daily life [4-5]. Also it's essential for our health. In developing countries, floor cleaning by machine is not so popular so it costs much amount of money. So we thought to build up a semi-automated cleansing device which will do dry cleaning as well as wet cleaning. It has obstacle detection also. As well as it will reduce the cost of machine [6].Not only in household works it will help to clean large apartments like hospitals, offices, banks etc. This Autonomous robot reduces much time in lifestyle. As it contains both vacuum cleaner and mob, we can use it in summer, rainy season and also in winter. Though bio-enzymes have gained immense popularity in these recent years, they are helping us to move towards our major goal - the achievement of a sustainable life. These are an organic solution which are prepared by fermenting vegetable or fruit peels and was first developed by Dr. RosukonPoompanyong who was the founder of the organic agricultural association of Thailand. The usage of bio-enzyme has also proved to be of viable potential in cleaning the contaminated water as they are known to improve the water quality parameters, thereby making them a cost effective bio-remediator.

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V. Bhute et. All [7] have made solar operated multifunctional floor cleaning machine while N. Shah et. All [8] also have designed semi-automated solar floor cleaning machine with higher efficiency. Whereas P. Ravi kumar [9] have fabricated solar powered unmanned cleaning robot.

First of all it is semi-automatic and as well as it is cost-effective. In market the full automatic machine is available in the range of minimum 25-30k (approx). But our proposed project has been made of around 5K. So it is affordable to everyone. Due to its low cost.

The area of our cleaning device is 21X28 cm. It can be accessible within a single room (10X10 ft). The energy charges that a single battery can hold 1200 mH. In our project, here we have used 4800mH charging capacity (approx).

100	HC-05/06	2x TIP31C/TIP122	
Tuorpm	Bluetooth module	NPN power	
Geared motors	(Fig. 2)	transistors	
Wheels for	L293D motor	12V Sealed lead	
wheels for	driver board (Fig.	acid rechargeable	
motors	3)	battery	
Arduino UNO	Standard servo		
(Fig 1)	motor (180 degree	Base (Fig. 4)	
(115.1)	rotation)		
Malefemale	Bread board	12V Water nump	
jumper wires	Bieda ooura	12 · · · ator pump	
Male/female	Nuts and Screws	A 600ml plastic	
headers	Truts and Selews	bottle	

II. REQUIRED COMPONENTS

A. Components Description Arduino UNO R3

Here, we have used Arduino UNO R3 (Fig.1) as microcontroller which has 20 input or output digital pins of which 6 are PWM outputs and 6 are analog inputs. We have loaded program into it by computer software. Arduino will control the full system. It will receive signal from mobile application via Bluetooth and the floor cleaning machine will work when we need.





Fig. 1. Arduino Uno

HC-05 Bluetooth module

In our proposed model, we have used a HC-05 Bluetooth module (Fig. 2) to make a wireless connection between mobile app and the hardware system. When we require, app will give instruction, Bluetooth will receive signal and will give it to Arduino. Then our floor cleaner will start to work. It has 6 pins - key/EN, TXD, RXD, VCC, GND and state.



Fig. 2. Bluetooth module

L293D Motor driver board

In our project, our main motto to use L293D motor driver board (Fig. 3) is to drive the machine in any direction. It has 16 pins. These pins can control the two DC motors in any direction. Signal will be given by mobile app and the motor IC will help to move our machine.



Fig. 3. Driver Module

Base of floor cleaner

Here, we have used a chassis board as base (Fig. 4). It is used to keep all the circuits and electronic devices. It gives a support to other components.

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Fig.4. Base of Floor Cleaner

100 rpm Geared Motor

Here we have used 100 rpm – 12Volts geared motors (Fig. 5) attaching with a simple DC motor with gearbox. 3 mm threaded drill hole is present in the middle of the shaft which makes it easy to connect internally with wheels or any other mechanical appliances for controlling purpose.



Fig.5. 100 rpm Geared Motor

12V Water Pump

This DC 12V Water Pump (Fig. 6) is very cheap in cost and small in size. It's capacity is 120 lit/h with low current consumption (220mA). We can connect motor outlet with tube pipe and immerse it in water. Thus results to power it & make high water level. We have to remember that the dry run may damage the motor can be damaged due to heating in terms of dry run and generate noise.



Fig.6. 12V Water Pump

Standard Servo Motor

Here we have used a rotational or translational Servo motor (Fig.7) whose power is supplied by a servo amplifier and can be used to apply torque or force to a mechanical system similar to an actuator or brake. It is applied to control precisely in terms of angular position, acceleration, and velocity which is associated with a closed-loop control



system. The result considers the current output & alters it to the desired condition. The speed can be calculated from the frequency of the applied voltage & the number of magnetic poles.



Fig.7. Servo motor (180 degree rotation)

B. Preparation of Bio-Enzyme

Bio-enzyme is produced by the fermentation citrus fruit peels in presence of jaggery and water. Large container with screw cap is preferred to keep the mixture. Usually this mixture kept in dark for 90 days and in initial month the cap is opened in every single day for a minute to release the accumulated gas. After a month gas production is reduced so, cap is opened once in the end of a week. Orange color liquid is obtained after completion of 90 days with some particles and undigested precipitate in the container. The liquid obtained after filtration in the container contains bioenzyme.

III. PRACTICAL CIRCUIT & BLOCK DIAGRAM



Fig. 8. Practical Circuit

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We know that fully automatic floor cleaning machines and robots are already exist in market. But those are so expensive. So it's not possible for everyone to afford those products. That's why we need to think for a machine which fulfills our desires at a reduced cost.

IV. OUR PROPOSED MODEL FOR THIS SOLUTION

We have designed as emi-automatic bottom drawing machine (Fig. 9) which can be the cover of fully automated machines, where as some of the factory will have to be done by manually, but still it will save the time and also will be helpful for people (10-11).

At first we need a chassis board and we have connected motors into that. One motor is connected in front of the board with the mop and other two motors are connected with the machine. also we have placed a broom on the chassis board. also, a water pump is connected with the board and a water tank is attached with the pump.

The mop is used for wet cleaning purpose. The motor helps the mop to work. Other two motors are helped the machine for working. The water pump is used to supply water for cleaning. We use water tank to store water. also, we are using broom rather of vacuum suction motor to reduce some capitalist. After brooming we have to put the dust or dry waste in tip but if we use vacuum cleaner also we have to clean this manually. So some manual work will be demanded but cost is low which is more profitable.

Now, we need a control system. also, we have used an Arduino- UNO with Bluetooth connection. At first, we have made the connection of Arduino with Bluetooth module by shirtdress lines.

The machine controls the total system. Arduino gives the suggestion, Bluetooth makes the connection and the shaft of the motor IC helps to move the machine towards left, right, forward and backward direction(12). Leg connections(Fig. 10) are given below





After drawing the bottom by mop, we add a sanitization section containing active bio enzymes. The two stations of the sanitizer mist- spray are connected with Arduino with the help of Bluetooth controller. The total procedure is controlled by Bluetooth controller operation of android mobile

V. CONCLUSION

The application of this advanced technology reduces the cost extensively as well as the human effort also thus result cleaned floor. Active Bio-Enzyme based mist sprayer semiautomatic floor cleaning machine is designed here with higher impact for developing countries in future. Active bioenzymes are also advantageous asmicrobes in bio enzyme based sanitizer are able to reach very small cracks on surfaces that can also eliminate soiling and malodour but traditional chemicals are unable to do so.

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VII. BIOGRAPHIES



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Dr. Nabaneeta Banerjee has completed her PhD degree in Nanotechnology from IIEST, Shibpur, India in 2016. She has received her M.Tech degree in Instrumentation and Control Engineering from Applied physics department of University of Calcutta., Kolkata in 2011. Presently she is working as Assistant Professor in the department of Electronics & communication Engineering of Guru

Nanak Institute of Technology (GNIT), Kolkata. She has also three years research experience in the field of fabrication of thin film gas sensing devices. She has eight SCI and SCOPUS publications IEEE Sensor journal, Solid State Electronics (ELSEVIER), IEEE Transaction on Electron Devices, Journal of Nanoscience and Nanotechnology (JNN), Sensor Letters (ASP) etc. She has also presented her papers in eight conferences including IEEE International conference on Nanotechnology in Beijing, China, Conference on Nanotechnology and Biosensors (ICNB 2015) in Amsterdam, Netherlands etc. She has also eleven student publications till now. She has attended so many technical seminars and workshops and has software training on C, C++, Java. Oracle, SQL dot net etc.



Dr. Sreyasree Basu was born in the district Hooghly in 7 th August 1976. She was graduated from Bethune College in 1999 and did her Mester degree in the Organic Chemistry in 2001 from University of Calcutta and Ph.D degree in 2009 from the University of Calcutta. Presently she is working as Assistant Professor in Chemistry in the Guru Nanak institute of technology,

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GSM Based Smart Power Monitoring System

Barnali Kundu¹, Susovan Dutta², Rikta Majumder³, Ramanuj Bhowmick⁴, Soumik Nandi⁵

Abstract--The automation of smart metering has gone to the quick high-tech advancements and also there is a high expanded demand for an authentic and flexible smart meter reading system. This project represents the proposed design of GSM based smart power monitoring system. An Arduino UNO & ACS712 Current sensor is integrated with GSM based smart power monitoring system for monitoring the power. As electrical energy has become indispensable to human survival and progress that's why GSM based power monitoring system is a major step towards smart metering process. This paper focus on to create an automatic power monitoring meter. This system monitored the energy at anywhere without any person visiting the device. This system also assists us to identifying the losses of power to the electricity provider company.

Index Terms—Energy Meter, Automatic-Meter-Reading (AMR), GSM, Arduino Uno, Current sensor.

I. INTRODUCTION

It is laborious or sometimes it is not possible to compute Current and Watt with standard Multimeters. To hold out such a measurement dependable and precise, a wattmeter is needed. As these types meters are very costly, a less costly method is presented here based on an Arduino Uno board. This project represents the proposed design of a low-cost simple wireless GSM Based smart power monitor and its related mobile interface, for calculating and managing the metering data globally. With this method conventional meter reading can be altered and authorize the remote access of energy meter. Also, the meter readings can be calculated and monitored in regular basis without the person visiting each device [1]. To have

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21007 remotely approach over the electricity usage a GSM based communication module is connected with an electronic meter.

This feature (remote monitoring) is formed available if it will be made up of a GSM communication modem which send all details related to the meter reading via an SMS. This proposed smart metering system cannot require the GSM module. The procedure has been proposed and tested in this project assist the GSM infrastructure. It's nationwide range and SMS cell transmitting feature is wirelessly broadcast the individual device energy consumption readings [2]. This system is really pleasant to the Electricity provider company as it authorizes them to get the meter readings on a regular basis.

II. LITERATURE REVIEW

Power Monitoring system is being used from the ancient times; in that time this system is mainly used to monitor the total power using GSM Module. There are many types of definitions where the parameter powers, energy defined. If the voltage and current are not sinusoidal then how we measured the power [2]. In the year 2011 in article "Wireless Automated Digital Energy Meter" We studied about a digital energy meter which is fully automatic control. By this article we know how a digital energy meter working wirelessly. [3]

Many research and ideas are implemented on power monitoring system. According to these studies the power monitoring system. The first electricity consumption meter for accurate reading DC meter which was invented by Dr. Hermann Aron, who patented it in 1883. A power monitoring system is a device which monitored the total energy consumed by any field [4].

III. METHODOLOGY

The basic concept of serial communication of microcontrollers can be used in this system. The controller takes the meter reading and forwards it to the GSM module. GSM module is authorized by a SIM card which is used to transmit to the end user.



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IV. COMPONENTS

A. Arduino Uno ATmega-328 Pu

14 digital input/output pins are available in an Arduino board which is built with ATmega328 microcontroller board. Out of these input/output pins (For PWM outputs purpose 6 pins can be used), 6 pins can be used as analog inputs, a Universal Serial Bus (USB) connection, a ceramic resonator(16MHZ), an ICSP header, a power jack and a reset button. It is a single chip microcontroller which is formed with Atmel inside the megaAVR family.



Fig. 1. Block Diagram of proposed system



Fig. 2. Circuit Diagram of Smart Power Monitoring system

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21007 To support the microcontroller, it carries everything that is needed. To get connection of Arduino uno simply connect the Arduino uno with a laptop/computer or it can be powered with an AC-to-DC adapter/ battery.



Fig. 3. Arduino Uno Atmega-328 Pu

TABLE I Specifications of componenets

Name	Specifications
Microcontroller	AT-mega328-pu
Working Voltage	5v
Input Voltage (I/O)	7-12V
Digital Input Pins	14 pins (out of which 6 provide PWM output)
Input Pins (Analog)	6
DC Current in every input Pin	40 mA
DC Current (3.3V Pin):	50mA
Flash Memory	32 KB of which 0.5 KB used
Static Random Access Memory (SRAM)	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

Some of the main characteristics of Arduino-Uno:

- The main advantages of an Arduino Uno are it is an open source and a large circle of people using it and also troubleshooting it.
- A portable Universal Serial Bus interfaces. The chip on the Arduino uno board linearly plugs into the USB port and it record on the desktop as virtual serial port. It permits us



vice. Serial Fig. 4. GSM Modem

Use of GSM Module –

The technology usage of GSM module is increasing day by day, that exactly there is no place on earth where GSM signal is not there. In this situation GSM technology gives us scope with our finger tips to managing things remotely from any places. Also, this technology gives ease to easily convey in a stronger way.

C. ACS712 Current Sensor

Current flows need to be observed and controlled in a vast variation of applications which includes battery chargers, protection circuit for over current, SMPS (Switching Mode Power Supplies), wattmeter (digital) etc. To observe the consumed power, placement of Shunt resistor is one of the easiest methods. A minimum value of resistance is coupled with the load and the ground to evaluate the voltage drop across it. As there is a variation between temperature and shunt resistor, in fact because of Joule heating this is not constant. Due to variation in temperature and resistance value, this procedure is at all efficient to execute. In high voltage application, the load and sensing unit is lacking proper insulation in the said method. Based on the principle of Halleffect Allergo, ACS712 device can be designed in which within a magnetic field a current fetching conductor is placed. ACS712 is a current sensor device which is sensing currents for both AC and DC.Voltage is created beyond its boundaries which is perpendicular to both the present and also the field. A hall element made of a skinny Semiconductor sheet, a current carrying material is placed into a field (B) which is perpendicular to the current flow direction. The potential difference is called Hall voltage within few microvolts.



Fig. 5. ACS712 Current Sensor

V. RESULT & ANALYSIS

The components of this system arranged in the order of circuit diagram. The picture of working model is given below –



to combine with it as this was a serial device. Serial communication is a very much easy and time-tested protocol is the main advantage of this kind of setup, and modern computers makes really convenient by connecting USB.

- In Arduino Uno the built-in voltage regulation and power management system is very much appropriate. A 12v power source can be connected externally and it can modulate it to both 5v and 3.3v.
- For reserving code flash memory (32KB) available.
- In an Arduino Uno 13 digital pins are available and also 6 analog pins are there. These digital and analog pins assist us to attach between external hardware and Arduino. With these pins increasing the computing ability of the Arduino-Uno into the existent world.
- An LED attached to digital pin 13, For an easy rectification of code,
- At last, to reset an Arduino program a button in there.

B. GSM Modem

GSM implies Global System for Mobile Communications system. This is a high-level set which was implemented by the ETSI [European Telecommunications Standards Institute]. It is used to mobile phones for elaborating the protocols of 2G digital cellular networks. The Modem is an electronic device which regulates and demodulates signals as required to meet the communication requirements. It adjusts an analog carrier signal to digital signal by encoding, and also pull out this signal such a signal to the communicated information by decoding. A Global System for Mobile Communications Module is a device which regulates and extracts the GSM signals and in 2G signals. Naturally SIMCOM SIM900a modems are used in this proposed system. It is a GSM/GPRS Modem, which can be operated at three different frequencies (EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz). Basic working frequencies are EGSM 900MHz and DCS 1800MHz.



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Fig. 6. Working Model of proposed System

Some actions of AT Commands against GSM Module -

Sim900a GSM Module can be utilized for sending and receiving SMS when the module connecting it to a computer. In this system this communication GSM module used to send commands to send/receive SMS from a computer with a port which is either a serial port or an USB. Basically, these types of commands are known as AT commands. With these types of commands many types of activities can be performed. With these commands sending or receiving SMS, and MMS, can le done. Sim300 module has an RS232 interface which can l utilized to be in the communication with the compute Sim900a module generally works at 9600 baud rates, with • stop bits and 8 data bits. Some AT Commands which are needed to send or receive SMS are given below-

- For testing the condition of modem 'AT' Command can be used. This command is common prefix command for every command which is sent to the modem.
- For checking a sim is inserted or not we use 'AT+CREG' Command.
- To switch on the Echo, we use 'ATE1' Command. With this command GSM module continuously echo back to bite of data until a sense will get from carriage return character.
- To fix the communication to text mode 'AT=CMGF=1' command can be used.
- ➢ For deleting a SMS at index 1 'AT+CMGD=1' command can be used.
- To sending a SMS from GSM module 'AT+CMGS command can be used.

VI. CONCLUSION

A wireless GSM communication based smart power monitoring system is very simple to install and important for Customer as well as energy Provider. Main advantages of this

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21007 system are very lower physical cost and also make reduces the inaccuracy. This system also minimizes the problems like meter over running, over load of the meter, and also decreases thefts. This system specifies to the customer when any type of guilt occurs. When any types of faults occur customer can contact with the energy provider company and inform them about the fault. Then the energy provider Company can slash the power easily by sending a SMS to the ID number which is connected to that SIM card number. The analytical load can be utilized and this profile help the customer to control their energy consumption. This helps them to scale back their previous dues. This procedure is used even within the remote areas by changing the sort of the modem, and its range of frequency for communication. This system creates less problems to the country and supports us to boost our usage.

This system also can be built up to control the electrical devices by remote operation via SMS. The electricity division can send the quarterly/monthly bill amount over SMS to the collected unit for information to the consumers.

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BIOGRAPHIES



Barnali Kundu received the bachelor's Degree in electrical engineering, the master's Degree in electrical engineering with specialization in electrical machines, and the Ph.D. (Engg.) Degree from Indian Institute of Engineering Science and Technology (IIEST) Shibpur, India In 2003, 2007, and 2018, respectively.

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Rikta Majumder received the bachelor's Degree in electrical engineering, from NIT agartala and she completed her post-graduation from Tripura university in the year 2011.

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Ramanuj Bhowmick has completed his matriculation in the year 2016 and completed higher secondary in the year 2018 from sailendra sircar vidyalaya. He completed the Diploma Degree in electrical engineering from Guru Nanak Institute of Technology. Kolkata in 2021. He currently studies the Bachelor Degree in Electrical Engineering from Guru Nanak Institute of Technology. Kolkata. (2021-2024).He has completed few research papers in

many international conferences. He has participated many technical fest in college events. He has a Student membership of student chapter in Institute of Engineers (India).



Soumik Nandi has completed his Bachelor of Technology degree in the year 2019 in Electrical Engineering from Guru Nanak Institute of Technology. Kolkata.

He has total 3.5 years of work experience in the industry. He worked as a shift engineer at United Breweries limited. Currently he works as a system engineer at Infosys limited. He has completed few research papers in many international conferences.



Online Doctor Consulting System in Smart baby Cradle: A Step towards Innovation

Soumyadeep Ghosh¹, Soma Boral², Arun Kumar Mondal³

Abstract: A global public health emergency coronavirus disease-19 (covid-19), is currently occurring. It is more difficult for new born whose parents are both working since they are unable to spend as much time with their children. It is an urgency to take them to the doctor's office when their infant becomes ill. Since there is no vaccine for children beyond the age of eleven, it is risky to bring them to hospitals and they need special care for their health. As a result of the COVID-19 epidemic, we have integrated this online video doctor consulting system in this paper's smart baby cradle system for infants, removing the requirement for them to visit a clinic for a check-up. So, we developed a method for online video health monitoring that enables clinicians to see patients.

Index Terms: IoT, video conference system, online consultancy, web application, Smart Baby Cradle

I. INTRODUCTION

S the number of working parents in modern A families grows, they are unable to spend as much time with their infants, resulting in a considerable gap [1]. To close this gap, we created the Smart Baby Cradle and health monitoring system, which enables parents to connect with and watch over their infants while also enabling them to see a doctor online whenever they need to, from anywhere. The goal of this project is to create a doctor-patient handling management system that will assist physicians in their job while also allowing patients to plan visits and track their health [2][5]. Smart technology has recently spread throughout the world. Baby care service is a field that could also implemented these smart technologies by means of embedded system [6].

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The goal of this project is to create a doctor-patient handling management system that will assist physicians in their job while also allowing patients to plan visits and track their health [2][5]. Technology can be used by doctors to manage online appointment scheduling. Patients can reserve any open spaces online in their name. The system deals with scheduling data for many doctors on various dates and at various times. Each time a patient sees a physician, the physician enters the patient's medical data into a database. The user can review their entire medical history whenever they like the next time they check in [3][4]. A sneak peek of the patient's medical history is accessible to the doctor.

II. COMPONENTS REQUIRED

The proposed system is designed and implemented based on several new technologies modules that are both efficient and low cost. The modules and sensor used in the implemented system [7]:

- a) Arduino megaDHT11– Temperature and Humidity Sensor
- b) PIR Sensor
- c) Moisture Sensor
- d) Bread Board
- e) Mobile Phone
- f) DC Motor
- g) OV7670 camera module
- h) TFT LCD 3.5" Touch Screen Display Shield
- i) Piezoelectric sensor/Solar panel
- j) Fan
- k) Alarm
- 1) 18V Battery
- m) LM7805 IC 5V Voltage Regulator IC
- n) MAX3102 Pulse Oximeter Heart Rate Sensor Module
- o) GPRS Module

III. WORKING PRINCIPLE



A. The whole operation of the smart cradle system is shown in the diagram in figure 1 below. Several sensors, including a sound detector, a temperature sensor, a humidity sensor, a wetness detector, a PIR sensor, an OV7670 cam-module, a heart rate monitor, an oximeter, and a piezoelectric sensor are used to track the child's movements when they are placed in the cradle.



Fig 1: proposed diagram of smart cradle system

- B. The cradle is equipped with an alarm system that sounds in two different circumstances: first, when the pad is wet, which is essential for the baby's health; and second, when the infant continues to cry for a prolonged period of time, which may indicate that the baby wants attention.
- *C.* The cradle also has the ability to measure the temperature and amount of moisture around the baby, alerting the owner to the value via SMS or phone calls.
- D. In addition, we've provided video enchantment choices so that parents can watch what their children are doing. While parents are gone from their babies, they can use mobile applications to monitor and operate the cradle
- E. If the baby becomes ill, parents can use the video conference system's online doctor consulting system, which allows the doctor to see the infant as well as obtain heart rate and oximeter level data, as shown in figure 2 below.



Fig 2: Workflow of online doctor consultation

IV. COSTS ANALYSIS

According to the survey conducted by the Bureau of Electrical Energy in India, there are around 18 million agricultural pump sets, and around 0.5 million new connection per year are installed with an average capacity of 5HP. Total annual consumption in the agriculture sector is 131.96 billion kWh (19% total electricity consumption)

TABL	E 1		
Cost Analysis	of the	Pro	ject

Name of the	Quantity	Cost (Rs.)
components		
Arduino	1	2500
mega		
DHT11	2	240
sensor		
PIR Sensor	1	100
Bread Board	2	150
400 pins		
Johnson	2	740
200RPM		
DC Motor		
OV7670	1	180
camera		
module		
TFT LCD	1	1000
3.5" Touch		
Screen		
Display		
Shield		
Solar panel-	2	1800
17v		
Fan	1	100
Alar	1	30
12V Battery	4	150



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LM7805 IC	2	50
5V Voltage		
Regulator		
IC		
GPRS	1	300
Module		
Connecting	20	20
wires		
Total Cost		7590

We made our project at a cost of [Rs. 7590+ Rs 400 (allowances)] = 7990/-. We would take a profit of 25% and will sell to market a very cheaper price of 10599 rupees. In market this product with less features as compared to our proposed system is available at approx. 13999 rupees.

V. FEATURES AND FUNCTION OF SESNORS AND MOCULES

A. Cradle system

When the Sound sensor crosses the threshold level, the Cradle Swing is activated. The standard DC Motor assists in swinging the Cradle.

Algorithm for cradle swinging:

Step-1: Start the System.

Step-2: Check if the baby is crying or not.

Step-3: If yes, it triggers DC Motor which leads to swinging of the Cradle.

Step-4: It also sends the alert message for the same.

Step-5: Parents can also turn On / Off the Cradle Swing using the Android Application.

B. Moisture Detector Sensor

This Sensor, depicted in Figure 3, determines if the baby's diaper is moist or dry. If moisture is detected, it will send an alert message to the parent (and nanny). This helps to keep the baby in a safe and clean environment.



Fig 3: Moisture sensor

Algorithm for checking diaper wetness: Step-1: Start the system.

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Step-2: Keep checking if the baby's Diaper is Wet or Dry.

Step-3: If yes, notify the same to the parent (&nanny) via message.

Step-4: It also send message to parents (&nanny) that the baby's diaper is wet.

C. Temperature Detector Sensor

Figure 4 shows a sensor that measures the steady temperature change within the cradle. It notifies parents about the temperature change.



Fig 4: NTC Thermistor Temperature sensor

Algorithm for Temperature checking: Step-1: Start the System. Step-2: Keep checking the Temperature of Baby's surrounding. Step-3: If yes, then check whether it changes with given range of temperature. Step-4: If yes, then turn ON the fan Step-5: It also sends temperature value to parents (&nanny) as a message alert. Step-6: Parents can also turn On / Off the fan using the Android Application

D. PIR (Motion Detection) Sensor

In this system, this sensor aids in the detection of motion. It decides if the infant is sleeping or not. An alarm message is provided to the parent if any odd activity is noticed. The sensor diagram is shown in figure 5 below.



Algorithm for Motion detection:



Step-1: Start the System.

Step-2: Check if there is any movement in the Cradle.

Step-3: If motion is detected, then check if the movement occurred continuously or frequently. Step-4: If motion detected continuously then message to parents (&nanny) that baby is not comfortable.

Step-5: Else motion detected frequently then message to parents (&nanny) that baby is sleeping.

E. Sound Detector Sensor

This sensor, shown in Figure 6, aids in the detection of the baby's sobbing sound. It compares the baby's sobbing to a threshold level to determine whether he is crying because he is hungry or for other reasons. If the baby screams for an extended period of time above the time limit established by the parents, a notification will be sent to the parents or nanny.



Fig 6: Sound Detector Sensor

Algorithm for crying detection:

Step-1: Start the System.

Step-2: Check if there is any sound detected in the Cradle.

Step-3: If sound is detected, then check if the sound frequency is high or low compared to threshold frequency.

Step-4: If high then swing the cradle at gentle speed and play lullaby song and start playing animated video on display.

Step-5: Else frequency is low then message to parents (&nanny) that baby feels hungry or need attention and play animated video on display.

Step-6: It also send message to parents if the baby is crying.

F. Piezoelectric Sensor

Sensor in figure 7, is responsible for charging the battery. It will charge the battery using a

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Fig 7: Piezoelectric sensor connection

Algorithm for piezoelectric sensor:

Step-1: Start the System.

Step-2: Check if the battery needs to charge or not.

Step-3: If it needs, then charge the battery by piezoelectric sensor.

G. OV7670 CAM Module

Figure 8 depicts a module that is used to keep an eye on the new-born via live video communication. In addition, this module is utilised to communicate with parents and nannies. Wi-Fi, Bluetooth, and a 2MP camera are all included in one module.



Fig 8: ESP32CAM Module

H. MAX3102 Pulse and Oximeter Heart Rate Sensor Module

Figure 9 depicts a sensor solution that combines a pulse oximeter and a heart rate monitor. It's an optical sensor that uses a photodetector to measure the absorbance of pulsing blood after emitting two wavelengths of light from two LEDs, one red and one infrared..





Fig 9: Max30100 pulse and oximeter sensor

Algorithm for piezoelectric sensor: Step-1: Start the System. Step-2: Check baby pulse and oximeter level. Step-3: Then measured reading to parents through SMS alert system.

I. GSM Module

Figure 10 depicts a GSM module, which is a circuit that allows mobile phones and microcontrollers to communicate. It sends SMS, MMS, and voice messages through a mobile network. The GSM GPRS extension enables high data transmission rates. GSM uses the time division multiple access mechanism for transmission.



Fig 10: GSM 900A module

VI. REQUIREMENTS FOR ONLINE DOCTOR CONSULTING

6.1 Software Requirements:

- Windows Xp, 7,10
- SQL 2008
- Visual studio (any version)

Automatic cost calculation: The system computes the total fee for parking based on the user's chosen booking time.

Cancellation of reservations: Users may cancel their reservations at any moment by logging into the system.

Advantages of using online consulting system: • There is no need to visit a doctor's office.

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21008 6.2 Hardware Components:

- Processor minimum Dual Core
- Hard Disk 50 GB
- Memory minimum 1GB RAM

It may have occurred so many times that you or someone you know requires quick medical assistance but is unable to obtain it for whatever reason. The Health Prediction system is an online consultation and end-user support initiative. In this study, we present a system that allows users to obtain real-time health advice from an intelligent health care system online. Various symptoms, as well as diseases and illnesses related with those systems, are input into the system. In the event that the system is unable to deliver accurate findings, it advises users to have a blood test, an x-ray, or whatever report it decides is related to the user's symptoms so that they can post a picture of that report the following time they check in. A doctor login is now available on the system, and the uploaded images are being received. Users can communicate with the system about their symptoms and difficulties. It then looks at the user's symptoms to see if there are any illnesses related with it. To determine which sickness is most likely to be the cause of the patient's symptoms in this instance, we employ sophisticated data mining tools. Modules:

• Admin Login: The system is overseen by the administrator, who also manages the reservations.

• User login and registration: Users must first register before they can log in.

The user can view the availability of appointments by clicking on spaces.

• Online appointment booking: Users may make appointments for the

desired time and date.

- The user can discuss their disease and have live video interactions with doctors to obtain the necessary pharmaceutical prescription.
- Doctors can provide priority care in an emergency case until the patient can be brought to the hospital.
- The user can look for doctor's help at any moment.



Disadvantage of using online consulting system: Everything has some disadvantage so like this online consulting is also having: • At least one doctor must be online to assist the patient, and a huge database is required.



Fig 11: Flow diagram of online doctor consultation

VII. FLOWCHART OF SOME SENSOR USED IN THE PROJECT:

7.1 Flowchart of Sound detector sensor:





7.2 Flowchart of Wetness detector:



7.3 Flowchart of OV7670 cam module:



VIII. SAFETY PROCEDURE:

Babies tend to put things into their mouth. Sensors and other circuit components might contain compounds which are harmful if not poisonous. So, to prevent this we are giving a covering to the wearable sensor to prevent the harmful effect to baby if they put sensor in mouth. We are using components like latex, vinyl, and nitrile for making rubber type cover over the sensor through which sensor can work efficiently as well as save to use in baby cradle.

IX. COMPARISON

Our proposed system is far better than others available products and it is also going to available at very affordable price so that everyone can use it. The comparison table between our proposed smart cradle and smart cradle system shows that our proposed system is much better than the other one.



sensor		
Online doctor consulting system	\checkmark	×

X. FUTURE SCOPE

In a word, the project's future scope is around the preservation of information pertaining to:

- We can provide more advanced software for Doctor Appointment System, as well as additional features.
- •Integrate numerous load balancers to distribute the system's loads
- Design the master and slave database structures to reduce database query overload
- Implement a backup mechanism to take regular backups of the codebase and database on multiple servers.

XI. CONCLUSION'

In order to emphasise the significance of Online health check-up Consultancy for all patients worldwide, a review of the literature was done. Additionally, the covid-19 system was created to assist patients in performing their own tests and receiving therapy for those who are afflicted. This system includes several guidelines to maintain everyone's safety and health. Lastly, more research is required to create v models for services and care. Along with a smart cradle with a baby monitoring system over IoT has been designed and fabricated to monitor a baby's vital parameters, such as crying condition, humidity, and ambient temperature. A smart baby crib has been designed and implemented based on several new technologies

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	cradle	
Baby		
movement	\checkmark	\checkmark
detection		
Alarm system	\checkmark	\checkmark
Sound		
detector	\checkmark	\checkmark
System		
Temperature		
measurement	\checkmark	\checkmark
sensor		
Wetness		
detection	✓	√
sensor		
Video player	✓	×
system		

 \checkmark

1

 \checkmark

 \checkmark

 \checkmark

 \checkmark

Table 2: Comparison table of our project with other work

Smart

System [3]

 \checkmark

 \checkmark

 \checkmark

x

x

x

Cradle

Our

smart

1. . 1. .

proposed

Features

Video

SMS

system

system

system

Heat

sensor

Spo2

Auto

monitoring system

Music player

rechargeable

measuring

measuring

alert

rate

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XIII. BIOGRAPHIES

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He recently a student of 3rd year, previously he published his paper in Prepare@4u, CCMNT-2022, and ICESD-2021 conference. He worked on nanotechnology, VLSI, robotics and artificial intelligence.

Mr. Ghosh received best paper presentation and best paper award in AICTE sponsored CCNMT-2022 conference. He also received a special award for being the department topper in college.

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Ms. Boral received Grant from UGC for Research Project on Analysis of the Impact of Channel Noise on MIMO ad Hoc Network Utility Maximization for QoS provisioning of 2years duration, received on March 18, 2014.

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His employment experience includes the Sonodyne Electronics Co. Pvt.Ltd., and Bells Control Ltd. He also a lecturer in Murshidabad College of Engineering and Technology from 4.5 years and he currently a professor and head of the department in Guru Nanak Institute of Technology.

Dr. Mondal special field on interest includes Radiophysics and Electronics and Communication.



Smart Parking System Using Internet of Things: A Step towards Building Smart Cities

Soumyadeep Ghosh¹, Mantsiz Zinath², Surajit Basak³

Abstract--Urbanization is constantly amplifying and traffic in metropolises is getting massive every day. The population growth isn't alone a pressing issue for the administration but a tangible day-to-day fact for uttermost nationals. Road traffic is the biggest difficulty that is being confronted as the number of automobiles in urban metropolises increases. Finding parking space in big metropolises is a constant challenge for motorists. Normally, the customer invests lot of time and effort looking for available vacant space in a designated parking zone. In this paper, we approached a solution to this challenge of finding vacant spaces in parking spaces. We present an automated parking system where the available space in the parking one is to be notified to the user through the mobile application which reduces the searching time. Radio Frequency Identification technologies are being applied to avoid motor vehicle thievery. Accordingly, parking issues and traffic slowdown can be worked out by utilizing smart parking using IoT technology.

Index Term-Automated parking; internet of things; mobile application; radio frequency identification

I.INTRODUCTION

Humanity has always had a desire of creating "Smart Cities". In recent years, significant work has been made towards implementing Smart cities a reality [2]. Automated parking garages and systems for traffic management have long been critical components of smart city development. [1-2].

The enlargement of web of things. Newer opportunities for Smart Cities have emerged thanks to the Internet of Things and cloud computing.

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FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21009 The sensors used in IoT-based smart parking systems store and retrieve data from remote places with the help of the cloud, giving rise to the cloud of things (COT) [3].

Thenodes we tend to monitor and control from any location. It is employed to extend the potency of a cloud-based parking system and it is a low-cost parking system than other parking system already available in market. All through this paper, we will handle the parking issue using an IoT-based largely cloud-integrated smart parking system, as depicted in Figure 1. Users in remote locations can book a parking space using our smartphone application. The efforts made throughout this work are designed to fortify a town's parking facilities, consequently improving the quality of service to improve the level of living of its residents. [4-5].



Fig1: Sample diagram of the proposed system

II. WORKING PRINCIPLE

A. Input part

For our parking system, shown in figure 2, we have used sensors like an Infrared ray sensor. The functions of these sensors include monitoring the parking space and identifying whether or not a parking place is available. Here, we are detecting the presence of a car using infra-red (IR) sensors. The IR sensors are connected to the ESP8266 chip. A NodeMCU module comprises of Wi-Fi network and



micro-controller using a battery pack or an external power source, the sensors are connected to a 5V supply, which is connected with a solar panel for a self-recharging system. The external source being more preferable compared to solar panel.



Fig 2: Working Principle of the Smart Parking System

B. Output part

1. Mobile application

The mobile application acts as a user interface via which users interact with the system. The Angular JS Framework and JavaScript are used to create the application [5]. This framework is used to ensure that the programme runs properly on both the Android and iOS platforms. The application is connected with Amazon SQS. This mobile application's goal is to give users information about parking area availability and to let them reserve that space accordingly.

2. The cloud

The Amazon SQS server runs in the cloud. This cloud serves as a repository for all parking-related records, allowing users to use the system. It maintains track of each client who is connected to the system and records details such as the time the vehicle was parked, the time span for parking a car, the compensation given by the customer, the balance on the card, the new registration system, and the mode of payment. Continuous backup is always created of the information in the cloud as no user should face any problem while any failure in the system.

3. Circuit diagram

The circuit diagram of this smart parking system is depicted in figure 3 which consists of IR sensor, RFID Module,

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21009 NODEMCU-ESP8266, GPS Sensor, OV7076 camera, servo motor, solar panel and battery.

4. Components required

The proposed system will be designed and implemented based on several new technology modules that are efficient and inexpensive. The modules and sensors used in the implemented system are:



Fig3: Circuit diagram of smart parking system

The modules and sensors used in the implemented system are:

- The Hardware components include:
- 1. QTR sensor, 2. Radio Frequency Identification (RFID),
- 3. GPRS/GPS, 4. NodeMCU, 5. OV7670 camera module,
- 6. Solar panel and 7. Servo motor

And the Software parts include:

IoT Cloud severs, Blynk IoT platform and Online payment.

III. FEATURES OF SENSOR USED IN SYSTEM

A. QTR sensor

QTR-8RC is a reflectance sensor array however meant as a line sensor, referred to in figure 4. It can be used as a general-cause proximity IR or reflectance sensor. The tool



got here up with 5 or 8 pairs of IR LEDs. This IR array is cost effective and can perform functions of 5-8 different IR sensors alone.

Algorithm:

- I. Start operating
- II. Checks any car is present in any of the parking slots.
- III. If any car detected then availability number decrease and the particular parking slot colour changes from green to red in the mobile application.
- IV. If no car is detected then the colour remains green in the mobile application.





B. RFID

Figure 5 shows a module that detects and collects data from an RFID card. This mapping can be utilized to keep track of items. When a car enters the parking lot, the driver scans the RFID card, and the entire information on the card is transferred to administration via this module.



Fig 5:RFID card and RFID Module

Algorithm:

- I. Starts operating
- II. Permits the driver after showing the RFID card to RFID card reader module
- III. If it detects that the driver is already a user, then it cut the parking charge and give permission to enter the parking area
- IV. If it detects that the driver is a new user, then it first needs to register them and then gives them to enter the parking area.

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C. GPS

It is used to establish communication between a mobile device and computing machine and a GSM or GPRS system, given in figure 6. As like cell phones, a SIM (Subscriber Identity Module) card is required to enable communication with the network.

Algorithm:

- I. Start operating
- II. Search nearby parking area around the user
- III. Book nearby parking area slot



Fig 6: GPS module

D. NodeMCU

NodeMCU offers a variety of development environments including support for the Arduino IDE. It includes firmware running on Express if Systems' ESP8266 Wi-Fi SoC and hardware based on ESP-12 module, so the Arduino IDE can also be used to programme it. and act as a Wi-Fi access point or a can connect to one in figure 7.



Fig 7: NodeMCU

E. OV7670 camera module

This is a camera module shown in figure 8, which allows you to get the vehicles registration number plate to maintain a record of the vehicles parked at the parking slots. Algorithm:

- I. Start operating
- II. Capture images of the vehicle number plate
- III. Detects vehicle number plate using OCR algorithm





Fig8:OV7670 camera module

F. Solar Panel

Figure 9 depicts a solar panel, which is a collection of solar (or photovoltaic) cells that may be used to generate power via the photovoltaic effect. These cells are organised in a grid-like arrangement on the surface of solar panels. Algorithm:

- I. Start operating
- II. Recharge the system when needed



Fig9: solar panel

G. Servo Motor

It is a revolving device that allows for the control of both angular and linear motion given in figure 10. A servo motor is being employed in this project as a gate operator to open and close the gate.



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IV. METHODOLOGY

A. Vehicle number plate recognition

A detailed diagrammatic view is given in figure 11 where we have implemented the vehicle number recognition using Optical Character Recognition (OCR) also called Text-recognition is a program which extracts and identify data from images. Videos, and scanned documents. The basic of OCR contains identification of the text in any type of scanned documents or digital images and video and translate of those characters into code. OCR system have the parts of both hardware components like OVC7670 for scanning vehicle number plate and software which is used to convert the physical documents into machine readable documents.

B. Online Booking System

Our proposed system provides an interface for the user to book a slot online is fully diagrammatic in figure 12. The system displays how many free slots are available, and the user can choose any of them. The user can book the available slots using the graphical interface. User can also book the parking slots from anywhere and for anytime. The user has to give some personnel details and the time that he/she wants to book the slot. The information is then stored in the database. If the individual does not come at the scheduled time, the reservation is automatically cancelled after one hour from the scheduled time. After successful booking, an id is generated and sent to the mobile.

Additionally, it will alert the user if the balance decreases. Any new users who arrived to use the parking space must first register before they are allowed to access the parking area. If any registered user came then they need to show their RFID card then it automatically cut the parking charge and allows the user to enter the parking area.





Fig 12: Work-flow of online booking system



Fig 11: Work-flow of vehicle number plate recognition





Fig 13: Schematic diagram of parking system and online booking system

C. Parking availability

When the IR-sensors detects no vehicle is present in that particular parking slot then it makes the green in the mobile application which means that the parking slots is available to park the vehicle. If the mobile application is red, it means that particular parking slot is already booked. It also shows the number of available parking slot available in that parking area. A preview of the proposed system is represented in figure 13.

V. COMPARISION WORK

Already many smart parking systems are available in markets which are giving few features at high price. Our proposed system offers some additional features with affordable price so that in every parking area can use this system.

Table 1:	Comparison	of [6] with	proposed system
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Features	Our proposed	IoT based smart	
	system	parking system	
		[6]	
Auto-Rechargeable	1	×	
system	v		
Online Booking	\checkmark	\checkmark	
Cloud usage	\checkmark	\checkmark	
Mobile app	\checkmark	\checkmark	
Vehicle number plate recognition system	\checkmark	×	
Map assistant	\checkmark	x	
Cheaper system	\checkmark	x	

VI. CONCLUSION AND FUTURE SCOPE

The development of cloud and Internet of Things technology has opened up new possibilities for smart cities. Building smart cities has traditionally been centred on having smart parking facilities. By reducing user time spent looking for a suitable parking space, this study enhances performance. Contribute to addressing the growing issue of traffic congestion. This system is implemented using a lowcost infrared sensor, an OV7670 camera, a NodeMCU microcontroller, an "eParking" mobile app, and a IoT cloud FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21009 server. Through a smart phone application, users can reserve a parking place using the system's real-time information about space availability.Users can also pay for their parking online via PayPal without having to queue at a counter or ticket machine. In addition to reducing traffic congestion, the planned work offers quick payment, intelligent user management, and no additional equipment. In thefuture, users can use the other popular options to make payments instead of PayPal.

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v.

BIOGRAPHIES

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He recently a student of 3rd year, previously he published his paper in Prepare@4u, CCMNT-2022, and ICESD-

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Mantsiz Zinath born in Canin, West Bengal, India on April 15,



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current research interest is in joint routing and spectrum sharing techniques in multihop wireless networks, physical layer security and IoT in smart cities.



A Review on Flexible Printed Antennas for Futuristic Applications

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Abstract- Flexible antennas are one of the majorly used transceiver devices in modern day technologies. Due to its flexible nature it can be used ranging from healthcare industry to automobile industry, and many more. Study and analysis on flexible antennas have unveiled new dimensions in communication network and allied domains. Compact, lightweight, flexible materials make sure that the antenna can be used along with any existing electronics of any required shapes. Mainly the polymers, textiles and papers are being used as antenna substrates to incorporate flexibility. In recent times, flexible antennas are analysed vastly for futuristic bio-implantable antennas. Along with the flexible dielectric materials, conducting flexi materials are also investigated to replace the radiating portion of the antenna. A detailed review on flexible antennas by comparing on the basis of materials used and the applications, may find some interesting alternatives of the conventional applications. Also, this review work shall unearth the possibility of new fan outs of futuristic approaches.

Keywords- Antenna Review; Flexible Antenna; Polymer Substrate; Printed Antenna; Textile Substrate.

I. INTRODUCTION

Over the last several decades, the usage of Flexible Electronic Systems (FES) have been spreading like wildfire in various industries[1] as well as organizations related to biomedical[2] and healthcare purposes[3], military and defence[4], textiles[5], GPS[6], fitness monitoring[3], entertainment world[7] and many more. They have now become the assemblage of numerous devices which are composed of organic substances as a substrate [8]. Flexible electronics (flex circuits) is a technology for assembling electronic circuits by electronic devices on flexible substrates, such as, conductive polymer [9], conductive textile [10], polyimide [11], Teflon [12], liquid crystal polymers (LCPs) [13], etc. FES technology

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21010 is used for developing passive as well as active electronic devices. Flexible antennas are one of the most important

electronic devices that can be used widely as transceiver unit of a communication channel. The sphere of flexible antennas is experiencing an exponential growth due to the present-day needs for wearable gadgets, internet of things (IOT) platform [14], and wireless sensor [15] and transmitting devices[16], healthcare equipment[17] to mention a few. Flexible antennas have the ability to detect, transfer data, store energy and serve its purpose while being worn. In addition to these, flexible antennas can also accommodate the current 5G technology and ensure the accessibility of high speed, enormous capacity, and less delay in a communication channel [18]. In recent future it can be predicted that, each and every branch will prosper from 5G networks ranging from 3D imaging, military, GPS etc [19]. In recent days, state-of-the-art applications of flexible antennas has been increased worldwide due to their low-cost fabrication [16], sensing and easy configurations. Another major aspect of flexible antenna design is the choice of substrate materials. The way a particular antenna performs, depends on the material used for antenna fabrication. Depending on the adaptability to certain environment and conditions, such as, mechanical deformation, twisting, and bending, the materials can be chosen [20].

There are several techniques reported in literatures for fabrication of flexible antennas. Chemical etching (began in 1960s), usually accompanied by photolithography, is the method of fabricating metallic patterns in order to remove a selected portion corrosively [21]. The technique practiced in recent days, is the photolithography based antenna and RF circuits which depend mainly on positive resists as they show higher resolution than negative resists [21, 22]. Over the last few decades, inkjet printing has arisen as a substitute to chemical etching. This fabrication technique is most preferred for polymeric substrates like polyimide, PET and paper due to its correct and diligent prototyping fabrication method [23].



Later, another technique was introduced known as screen printing. Screen printing is a speedy, easy, cost-effective and practically applicable solution for the fabrication of flexible electronics. This technique is a woven screen-based method which has divergent thicknesses and thread densities [24,25]. Very recently, 3D printing techniques have gained popularity due to their commercially available materials of printing and the processes [26]. Polymers like thermoplastics, thermosets, are used as 3D printing materials for the applications of flexible antenna. The most common of all 3D printing technologies is Fused Deposition Modelling [27,28].

In this review paper, a detailed comparative study has been carried out for flexible antennas depending on various parameters. Firstly, flexible materials have been analysed and compared for efficient antenna fabrication. Antenna materials have been categorized into two parts, such as, conducting materials and dielectric substrate materials. Flexible substrates are essential for conformal antenna structures. Various polymers, textile materials, as well as, human skins are used for printed antennas. The choice of material also be determined based on the application and usage of the antennas. Apart from these, flexible antennas have also been compared for their parameters and performances, such as, antenna dimensions, bandwidth, gain, etc. flexible antennas are widely used for healthcare related industry as well as communication industry which includes devices which are kept in near proximity of human beings. Hence flexible antennas are compared on the basis of specific absorption rate (SAR) as well. In later sections, various comparison tables and analysis have been reported. Finally, some futuristic approach has been discussed based on the probable usages of flexible antennas.

II. MATERIALS FOR FLEXIBLE ANTENNAS

Flexible antennas consist of conductive layer and dielectric layer. Conductive layer prepares the radiator and ground of an antenna, whereas, the dielectric layer forms the antenna substrate. Choice of materials decides the method of fabrication for flexible antennas [29]. The selection of the conductive layer decides the performance of the antenna such as, radiation frequency [30] whereas, the dielectric layer or substrate is selected based on their dielectric properties, resistance to mechanical deformations (such as bending and twisting) and tolerance to harsh environment conditions [9].



Fig. 1. Classification of materials used in flexible antennas. *A. Conducting layer*

The understanding of conductive patterns with the best electrical conductivity is significant for ensuring high gain, bandwidth as well as efficiency in wireless applications [9].Conducting layer forms the ground plane and radiating element [29].Conductive material protects the antenna from deterioration due to mechanical deformation [9].

There are certain criteria that need to be fulfilled, in case of conductive materials:-

- They should have low resistivity or in other words, high conductivity [29].
- They should possess flexibility in order to be resistant to the deformation due to bending, stretching and crumpling [29].
- They should have the capacity to tolerate tremendous pressure [29].
- They should possess the ability to be integrated with textiles (the material can sewed to other textiles) [29].
- They should have resistance to harsh weather conditions and environmental factors such as corrosion and oxidization [29].

Keeping these properties in mind researchers have reported various materials for fabricating flexible antennas. Conducting material for an antenna can be



traditional polymer based substrate or recently developed conductive ink. Conductive polymers such as polypyrrole (PPy)[30], polyaniline (PANI)[31], poly(3,4-ethylenedioxythiophene)[32] polystyrene sulfonate are considered to be more reliable for flexible antennas [10]. On the other hand,conductive ink, comprised of carbon or metal particles, is a favorable material for flexible antenna structure. Conductive inks have the merits of fabrication simplicity, compatibility with inkjet printing and screen printing process and low cost [33].

B. Dielectric Layer (Substrate)

The dielectric layers (or the substrate) are mainly used to brace the conductive layer of the antenna [29]. Electrical properties of this layer, along with the antenna dimensions, determine the operating frequency of the antenna. The material chosen as a dielectric layer should possess high thermal conductivity, minimum dielectric loss, low coefficient of thermal expansion and low relative permittivity[34]. Different kinds of flexible substrates are adopted depending on the nature of the conductive materials used in the design [29].

Among a large variety of substrate materials, it can be preliminary categorized into three subdivisions depending on the physical properties. Those are, plastics or polymer substrates, thin glass, and metal foils. Although thin glass is bendable, its utility has been restricted by the intrinsic brittle property. Metal foils can tolerate high temperatures and allow deposition of inorganic materials on them. However, their high cost and roughness of the surface restrict their applications [35]. Plastic (or polymer) materials are best suited for flexible antenna applications. Some of them include:

- Thermoplastic semicrystalline polymers Polyethylene terephthalate (PET)[36], polyethylene naphthalate (PEN) [37].
- Thermoplastic non-crystalline polymers Polycarbonate (PC)[38], polyethersulphone (PES) [39].
- High glass transition temperature materials Polyimide [40].
- Other than polymer substrate, paper substrates are used widely as well. Paper substrates are most suitable for screen printing and inkjet

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21010 printing processes on the basis of conductive inks [41].

• In very recent times, textile in clothing (nonconductive fabric) can be used as a material for flexible antennas, especially when braced with metal-plated textile conductors. Different types of textiles are involved such as: cotton, silk, wool etc. Their relative permittivity is highly dependent on how they are knit or woven, materials involved and thickness. Certain materials have anisotropic features like, Cordura and Ballistic fabrics. Thus, being aware of the parameters is crucial for the chosen textile clothing prior to designing of the antenna [42].

III. STUDY ON FLEXIBLE ANTENNAS

A. Antenna Performances

The performance of a flexible antenna depends on several parameters like gain, bandwidth, specific absorption rate (SAR), etc. Selecting a suitable dielectric material iscrucial for antenna performance [48]. While the permittivity of the dielectric substrate defines the operating frequency, the gain is reduced for a higher value of loss tangent of the dielectric substance [49].

Here are some parameters mentioned below which decide the performance of the antenna:-

- **Gain** Gain (or absolute gain) is defined as, "The ratio of the radiation intensity in a given direction to the radiation intensity that would be produced if the power accepted by the antenna was isotropically radiated" [50]. This ratio is expressed in decibels with respect to an isotropic radiator (dBi).
- Bandwidth Bandwidth is another fundamental parameter of flexible antennas. It describes the range of frequencies over which the antenna can properly radiate or receive energy. Bandwidth is typically quoted in terms of Voltage Standing Wave Ratio (VSWR) [51]. Antenna researchers have set a maximum VSWR value as 2 for efficient radiation of the antenna. This VSWR corresponds to about 10 dB return loss characteristics. Hence the bandwidth can be calculated from the S₁₁ parameter graph of a specific antenna application [52].



Specific Absorption rate – Specific absorption rate (SAR) is a measure of the amount of energy is absorbed per unit mass by a human body when exposed to a radio frequency (RF) electromagnetic field. In other words, it is defined as the power absorbed per mass of tissue [53]. Its SI unit is Watts per kilogram (W/kg) [54][55].According to the Federal Communications Commission (FCC), an independent agency of the United States of America (USA), has crafted a strict regulation for maximum SAR value of a radiating device that is essentially exposed to human beings. According to the FCC norms, the maximum permissible limit of SAR is 1.6 W/Kg for a 1g unit tissue model [56].

B. Advantages of Flexible Antennas

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There are certain advantages that make flexible antennas so popular in the industry. Some of them are:-

- They are easy to manufacture [29]. Simple chemical etching or inkjet printing can felicitate the batch production of antenna.
- They are compact [29]. Hence, these antennas can be clubbed with existing electronic devices as transducer unit. Less layout spacing makes these applications as well [66].

TABLE I Comparing properties of dielectric materials used for flexible antennas.



defencetohealthcare industries. A few of them

Ref	Material	Dielectric Constants	Dielectric Loss	Antenna Type	Operating Freq.	Area of Usage
[36]	Polyethylene Terephthalate	3.4	0.01	monopole antennas	60 GHz	Millimeter wave application
[37]	Polyethylene Naphthalate	2.9	0.025	monopole with omnidirectional	60 GHz	RF, HF and millimeter-wave Applications
[39]	Polyether-sulphone	3.2	0.022	slotted monopole	20- 40 GHz	Millimeter wave application
[43]	Polydimethylsiloxa ne	42.92	1.562	dual-ring slot antenna	2.45 GHz	Bio-implantable Application
[44]	Jeans	1.67	0.025	Ultra Wide Band antenna	5 GHz	Wearable Application
[45]	Polyester	1.44	0.01	Patch antenna	2.4 GHz	Wearable Application
[46]	Curtain	1.47	0.04	Patch antenna	12.125 GHz	Ku Band application
[46]	Fleece	1.04	0.02	Patch antenna	12.932 GHz	Ku Band application
[47]	Leather	1.8	0.01	Patch antenna	2.45 GHz	Military applications
[47]	Silk	1.2	0.02	Patch antenna	2.40-2.50 GHz	Wearable application

• They have low profile and come with low cost [29]. Hence, flexible antennas are used vastly for various industries, such as, healthcare, defence, communication, etc.

C. Applications of flexible antennas

Due to the advantages mentioned in the previous section, flexible antennas are being used massively in various fields, ranging from military and

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21010 include:-

• Military and defence – Flexible antennas are used in a wide range of military applications like communication satellites and for "find and track" missions. While the recent uses of antennas bring up challenges with respect to isolation, frequency variation, directionality and testing for the design, dielectric materials have shown a viable way to deal with the shortcomings in military and defence [4].



for flexible antennas has increased in biomedical

• Biomedicine and health - Nowadays, the need

Ref.	Types of Antenna	Dimension (mm ²)	Operating Freq. (GHz)	Bandwidth	Antenna Gain
[57]	Dual-Band Antenna	15 x 14	2.5/4.5	600 MHz–1 GHz to 2.25 GHz– 2.95 GHz	5 dB
[57, 58]	Poly-Imide Based Single Band Antenna	26.5 x 25	2.4	305 MHz	-0.6 dB
[57,58]	Poly-Imide-Based Dual Band Antenna	35 x 25	2.5/5.2	290 MHz-280 MHz	-0.4 dB
[57, 59]	Textile Antenna	180 x 150	2.2/3	100 MHz- 110 MHz	
[57, 60]	Paper-Based Antenna	46 x 35	2.4	600 MHz	1.2dB
[61]	Microstrip-based Koch fractal	$39\times39\times0.508$	2.45	2.36 GHz-2.55 GHz	2.06 dB
[62]	Microstrip patch.	$60 \times 60 \times 0.110$	4.5	4.43–4.76 GHz	5.18 dB
[63]	Elliptical quasi-dipole antenna	46 × 45	2	1-5 GHz	2.3dB
[64]	Multilayer microstrip fractal patch antenna	22 × 31 × 0.125	N/A	4.79–5.04 GHz	4.5 dB
[65]	CPW-fed Hybrid Shaped patch	$0.4 \times 38 \times 70$	3.5, 6.7, & 12	3.06–13.58 GHz, 15.9–20.5 GHz, & 20.9–22 GHz	1.69 dB

TABLE II

Comparing flexible antenna parameters presented in various literatures.

applications. The antennas are a major component in monitoring regulation of organ functions, in implementing vivo monitoring of major signs, intracranial sensors, drug delivery systems etc [38][63].

• Automobile industry – Flexible antennas are becoming more and more popular in the automobile industry [64]. They play a pivotal role in establishing and sustaining an efficient cordless connectivity in and among the networks within. They are not only employed to provide a safe driving environment but also to improve the run-time efficiency [64].

• **Textile industry** – Embedding flexible antennas into clothing makes the attire transform into smart interface for the communication

FOSET special issue on Recent innovations in Engineering, Science and Technology Volume 1, Issue 1 https://doi.org/10.15864/ajac.21010 between the user and the network. The antennas should be lightweight, resistant to washing and of low cost for manufacturing and advertising [11]. Conductive textile materials are needed for

the conductive layer (ground plane) and nonconductive textile materials are required for the dielectric layer [67].

• **Telecommunication** – As the world is heading towards 5th generation (5G) wireless mobile communication, flexible antennas are responsible for enhancing its possibility. 5G is providing enormous data bandwidth, humongous capacity of networking, and a fabulous signal coverage to enable high range of good quality individualistic service to the users[66]. Flexible antennas are crucial for radio wave communication. They are



a stepping stone for 5G network as it requires outstanding flexibility and intelligence in terms of spectrum sharing, millimetre wave communication, integrated access of Internet of Things (IoT), huge multiple input and multiple output system (MIMO), transferring of big data etc[68].

IV. CONCLUSION

In this review paper flexible antennas are being compared on the antenna materials based and antenna performances. Also the flexible antennas have been analysed by categorising the flexible materials as conducting materials and dielectric materials. Also extensive study reveals that the flexible antennas can be used for several applications, such as automobile, healthcare industry, military and defence, and many more. Researchers are attempting early detection of disease and continuous monitoring of massively ailed patient by using flexible implantable antennas. The only drawback of this technology is that, the flexible antennas are new and vastly untested over various applications in longer time. However, flexible antenna is the need of the future and it enlightening the new dimensions in the relevant research fields.

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VI. REFERENCES

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