A Prototype on Immersive Education

Rohan Bhattacharjee, Amartya Mukherjee, Indrajit De and Ayan Panja

[1] ***Abstract*– With the advancement of information technology throughout human history, traditional education has been modernized. Over the last decade, the immersive experiences have sparked significant interest in a variety of applications (including entertainment, commerce, and cultural tourism). It is clear that the usage of immersion in the education industry has opened up new avenues for learning and imparting knowledge. In this work, we offer a prototype for an immersive experience that serves as a preview of a larger picture. The immersive experience comprises a simulated institutional atmosphere with students outfitted with 3D characters that will serve as their way of engagement. The world is to be equipped with many features including a virtual assistant chatbot that will aid students in assisting in their daily tasks such as planners, reminders, todo, notices and others. The main goal is to provide an immersive form of education which is not constrained within physical walls and can be remotely accessed from everywhere.**

***Index Terms*– Education; Immersive education; Metaverse; 3D**

I. INTRODUCTION

What if we could enter a personalized and immersive digital world with limitless potential? An environment where we can explore different spaces, meet individuals from all over the world, and even go on with our regular work and commercial operations without leaving the comfort of our own homes? This is what the word "Metaverse" refers to in essence. But what is it exactly? It is a visually immersive virtual reality arena where people can communicate with one another, attend events, explore worlds, buy and sell virtual items, and access a range of services.

In this project we aim to create such an immersive virtual experience that replicates the physical campus, enhancing the learning experience, fostering community engagement, and transforming the way we approach education and student life.

A. Related Works

The way we see it, immersive educational experiences have been a hot topic all around the globe. Few institutions have planned and tested such immersive experiences. Some of the related works that have been under discussion or published are mentioned below:

- Edorble, a virtual world platform designed specifically for online education and collaboration, allowing teachers and students to interact and learn in a virtual environment.
- Cornell University's Virtual Embodied Laboratory, which uses an immersive environment to study how people learn and interact with virtual objects in 3D space.
- A university in Florida proposed to create an immersive experience for their college campus as mentioned by EuroNews in one of their Youtube videos on Jan 14, 2022

II. METHODOLOGY

We are aiming to create an immersive world from scratch using design skills and feature functionalities. This requires an extensive use of resources and application of concepts with efficient integration. As we explore more features we will be required to adapt and extend our current flow of procedures. The discussion below is targeted towards creating the prototype of the system.

A. Proposed Plan

We tried to figure out a proposed plan for the enormous workflow broken down into smaller steps.

R. Bhattacharjee is with the Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning) of Institute of Engineering and Management Kolkata, D -1, Street Number 13, EP Block, Sector V, Bidhannagar, Kolkata, West Bengal 700091, India (e-mail: rohan.bhattacharjee.77@gmail.com)

A. Mukherjee is with the Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning) of Institute of Engineering and Management Kolkata, D -1, Street Number 13, EP Block, Sector V, Bidhannagar, Kolkata, West Bengal 700091, India (e-mail: amartya.mukherjee@iem.edu.in)

I. De is with the Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning) of Institute of Engineering and Management Kolkata, D -1, Street Number 13, EP Block, Sector V, Bidhannagar, Kolkata West Bengal 700091, India (e-mail: indrajit.de@iem.edu.in)

A. Panja is with the Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning) of Institute of Engineering and Management Kolkata, D -1, Street Number 13, EP Block, Sector V, Bidhannagar, Kolkata West Bengal 700091, India (e-mail: ayanpanja1992@gmail.com)

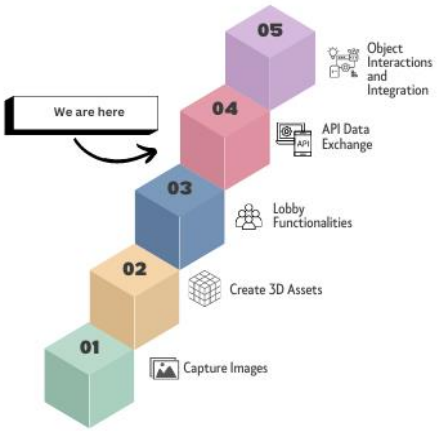

Fig. 1. A naive workflow in creating the prototype model

However it is to be noted that the workflow represented in Fig. 1. is not native and can be customized variedly.

B. Technologies

- Blender - This is a 3D Modeling software that is required to create the model assets for the system involving the environment, characters and others as per requirements.

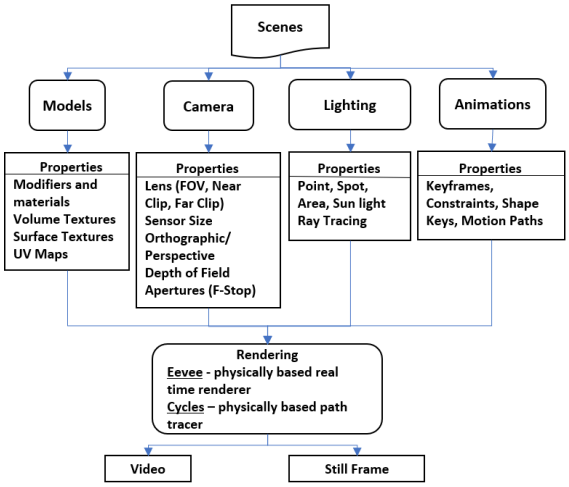

Fig. 2.1. Sample Workflow for Blender 3D

- Unity - Unity is a 3D/2D game engine and powerful cross-platform IDE for developers. This software enables us to encapsulate the static models with scripts and integrations.

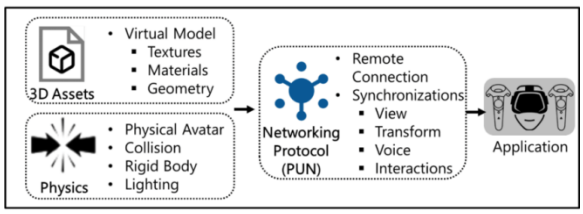

Fig. 2.2. Development Workflow inside Unity Engine

- API Usage - The use of Unity Networking Services provides us with working with various APIs. These custom APIs will respond to user requests and provide data for handling.
- Database Concepts - Database concepts are required to efficiently store, fetch and handle students' data as well as data pertaining to a particular feature.
- Programming Concepts - Python and C# are tentatively the primary programming languages required. C# works with Unity to provide scripts for the engine and Python is required to create Flask APIs or to integrate various features.

III. PROGRESS

The prototype is in its budding stage, however we could work with the very initial steps pertaining to its completion. These are listed below in further subsections.

A. Environment Model

Our first step was to capture the real-life stills from the college campus and model it into a 3D schema using Blender.

Fig. 3.1. Captures from the first floor Auditorium of Institute of Engineering and Management, Kolkata.

Fig. 3.2. Captures from the first floor Corridor of Institute of Engineering and Management, Kolkata.

We gathered many pictures from the first floor of the IEM Management House building and started working on reproducing it in the 3D form.

We started off with building smaller assets like chairs, tables, fans, projectors, etc. Typical 3D models start with the default cube. This default cube is then modified by scale factoring, shaping, transforms and many more. In the Edit mode, the major functions used involve Extrusion of regions, loop cuts, bevels, face insertion along with certain modifiers like boolean and solidify.

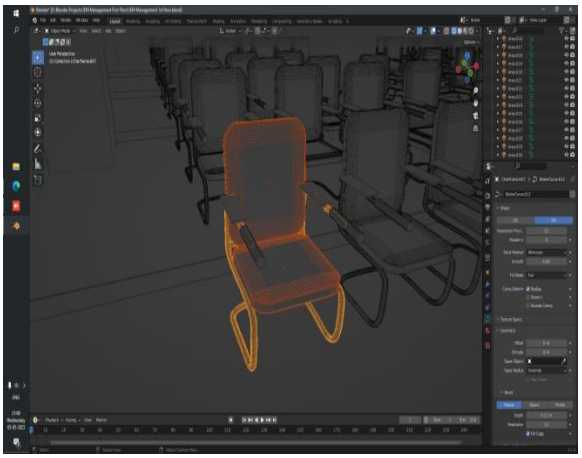

Fig. 3.3. Wireframe view of a chair

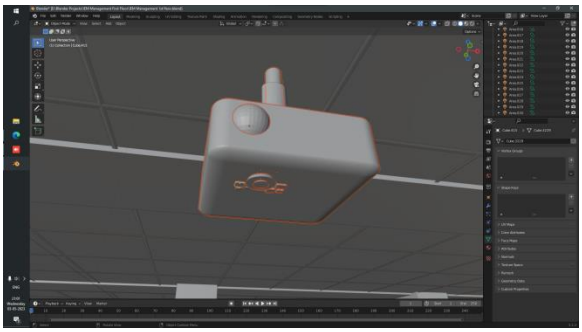

Fig. 3.4. Solid view of a projector

Then we started compiling these smaller assets and replicated them into corresponding rooms - a meeting room, four classrooms and an auditorium replicated from the original building's layout.

Fig. 3.5. Solid view of the Meeting room

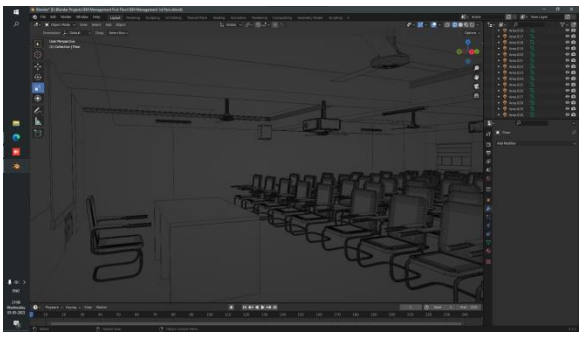

Fig. 3.6. Wireframe view of a classroom

Finally we scaled these rooms and combined them to form a contiguous floor plan. After several weeks of constant designing and redesigning we could come up with a naive model environment.

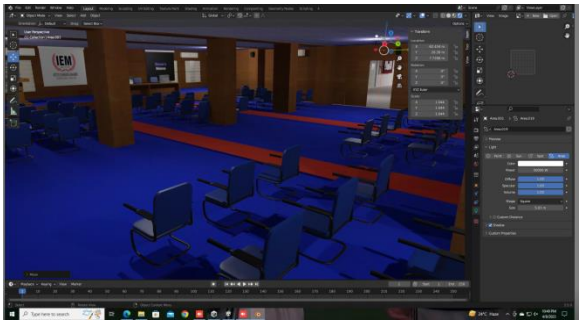

Fig. 3.7. Render view of Auditorium

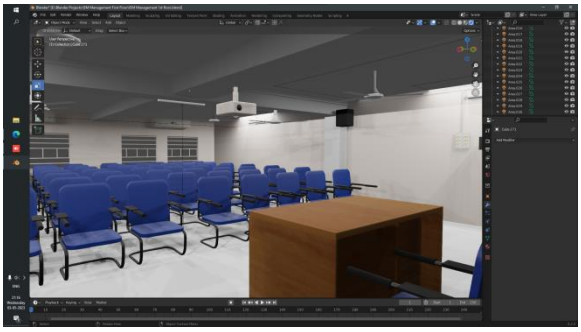

Fig. 3.8. Rendered view of a classroom

B. Lobby System using Alteruna SDK

The Unity Asset Store provides a wide range of libraries and SDKs that are integrated in today's games. One such SDK we are using for the lobby system is Alteruna SDK. This seamlessly helps us work on test servers to create and join lobbies.

Upon installation of Alteruna via Unity, we are provided with sample prefab models. The RoomMenu prefab is one of them. This comes with a simple User Interface for starting or joining a server. Once a server is running, the server names appear in the list.

There are prefabs for ThirdPersonCharacter controllers and required scripts. An example player model character has been associated with the scripts. This allows users to create or join lobbies and with the attached player model. The Alteruna SDK documentation provides a useful guide to integrating these libraries in a project. Finally a sample project is 'built' through Unity into a .exe application package for Windows.

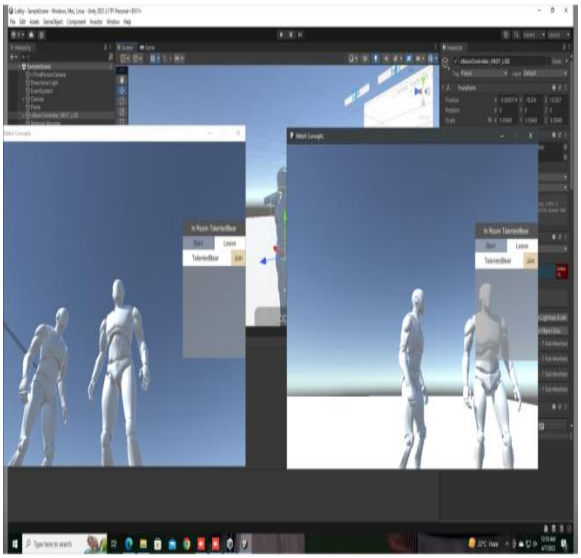

Fig. 4.1. Standalone Applications with separate users

C. API Usage Testing

As mentioned above Unity Networking Services is a native Unity library that seamlessly integrates the networking system into the game engine. Through this we had to implement a networking script to perform "GET" and "POST" operations on a public API for testing.

The API shown below is a public API which has both GET and POST endpoints. The networking scripts were implemented for each endpoint. For GET endpoint, a getter script is applied which works on creating a coroutine to constantly create a webrequest and to yield fetched data.

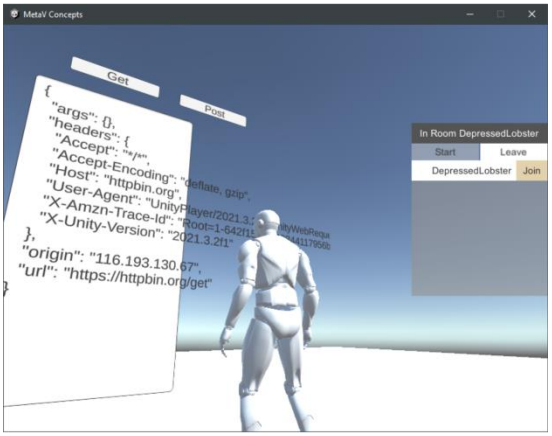

Fig.5.1. Preview of GET and POST

D. Results

The 3D environment made using Blender can be exported into .glb or .fbx format and imported back into Unity while keeping all the scripts and backend consistent. One such capture is shown below:

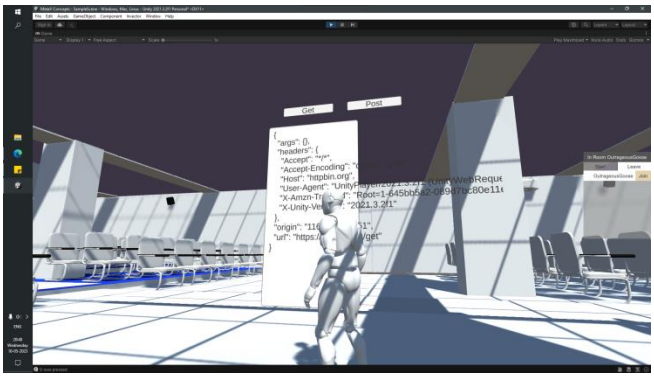

Fig. 6. A naive integration of Blender and Unity Projects

Please note that the environment appears white in Unity due to incompatible texture formatting in .fbx and this can be fixed by texture-to-texture mapping.

Apart from the overall view of the project, certain metrics on mapping the real environment and virtual environment can be considered:

- Accuracy - This is an overall score of how the virtual environment represents the real environment with detailed proportions, textures and overall fidelity. The accuracy score for this environment is equivalent to about 70-80% subjectively.
- Completeness - It defines whether the essential elements of the real environment are captured. The modeled environment has been made to capture even the smallest of assets ranging from round tables, chairs, boards to minuscule switches or helpline keypad.

- User experience - This revolves around gathering feedback from users through surveys, testing and observations. However this metric is yet to be evaluated once the prototype is ready to be deployed.

E. Next Steps to Consider

The progress till here is a rough component-by-component approach towards working on a larger integration. These functional components play a major role in shaping the very immersive world and help us to work on the whole with close details. However there are many other key-points that are yet to be implemented, tested and integrated. Some of them are mentioned below:

- Efficient Database Management Systems are to be implemented to handle concurrent data. Some possible approaches could be setting up a database repository and transacting it with REST calls.
- Security measures need to be added in the form of Authentication and Login systems. This ensures students to have their own share of personalization.
- Text-based and voice-based chat system functionality
- Setting up a virtual assistant based chatbot that helps to interact with students individually in the form of text responses to queries.
- Player Model interaction with user's keypresses to interact with surrounding objects and to toggle settings. Example: To '~' to enable voice chat or 'E' to interact with the chatbot.
- Overall design of the modules as well as model and code optimization.

IV. CHALLENGES

The creation of a prototype is a long journey of creating, debugging and testing. With each new advancement in the unknown domain we face multiple challenges and are still figuring out how to work around them. Some of them are:

- Model Optimization according to device configuration (PC or VR)
- Concurrent Player Handling and Server Limit
- Animation fixes for clients' end
- Complex Data Handling
- Login System and Security Measures
- Please note that the above list is not exhaustive and we are yet to face many such challenges in our way. However we are required to keep an open mind and tackle through each challenge as we progress.

V. DISCUSSION

A. Future Scope

This prototype is just a key to unlocking and harnessing a whole new domain of education. The future scope of such a prototype is endless in varied fields. Some of them are:

- Integration with Blockchain Technology to create a secure platform for managing student records, certifications, and achievements.
- Expansion to Other Educational Institutions to create global campuses
- Adding of personalized features catering to the student's performance

B. Conclusion

In conclusion, the idea of a metaverse has the potential to fundamentally alter how we interact with virtual worlds and each other. This is a game-changing idea by offering a cutting-edge educational platform that distinguishes our institution from others. Furthermore, if we succeed, we can influence the direction of education by embracing this technology and supporting its advancement, and we can build a more cohesive and welcoming community inside our college.

VI. ACKNOWLEDGMENT

I would like to extend my gratitude to our Head of the Department of CSE AIML- Prof. Amartya Mukherjee, Assistant Head of the Department - Prof. Ayan Panja and our faculty Prof. Indrajit De for ushering their constant support along the journey. I would also like to thank my batchmates namely Abhirup Mazumder and Debjyoti Ghosh from IEM B.Tech CSE for being with me in our initial stages of the prototype and contributing to it. Without them, the initiation of the prototype would have been non-existent.

VII. REFERENCES

[1] M. Akçayır and G. Akçayır, Advantages and challenges associated with augmented reality for education: A systematic review of the literature. Educational Research Review, 20 (2017), 1-11. https://doi.org/10.1016/j.edurev.2016.11.002

[2] A. Alvarez-Marin, M. Castillo-Vergara, J. Pizarro-Guerrero, and E. Espinoza-Vera, Realidad Aumentada como Apoyo a la Formación de Ingenieros Industriales. Formación Universitaria, 10 (2) (2017). https://doi.org/10.4067/S0718- 50062017000200005

[3] R. Barnett, The ecological university: a feasible utopia, Routledge, Nueva York, 2017.

[4] J. Barroso and O. Gallego, Producción de recursos de aprendizaje apoyados en Realidad Aumentada por parte de los estudiantes de magisterio. Edmetic. Revista de Educación Mediática y TIC., 6 (1) (2017), 23-38. https://doi.org/10.21071/edmetic. v6i1.5806

[5] H. Bicen and E. Bal, Determination of student opinions in augmented reality. Determination of student opinions in augmented reality, World Journal on Educational Technology: Current Issues, 8 (3) (2016), 205-209. https://doi.org/10.18844/ wjet.v8i3.642

[6] J. Cabero and J. Barroso, The educational possibilities of Augmented Reality. NAER. New Approaches in Educational Research, 5 (1) (2016), 44-50. https://doi.org/10.7821/ naer.2016.1.140

[7] J. Cabero and J. Barroso, Los escenarios tecnológicos en Realidad Aumentada (RA): posibilidades educativas en estudios universitarios. Aula Abierta, 47 (3) (2018), 327-336. https://doi.org/10.17811/rifie.47.3.2018.327-336

[8] J. Cabero, J. Barroso, and O. Gallego, La producción de objetos de aprendizaje en realidad aumentadapor los estudinates. Los estudinates como prosumidores de información. Tecnología, Ciencia y Educación, 11 (2018), 15-46.
[9] K-H. Cheng, Reading an augmented reality book: An exploration of learners' cognitive load, motivation, and attitudes, Australasian Journal of Educational Technology, 33 (4) (2017), 53-69 https://doi.org/10.14742/ajet.2820.
[10] T. Chiang, S. Yang, and G. Hwang, Students' online interactive patterns in augmented reality-based inquiry activities. Computers & Education, 78 (2014), 97-108. https://doi.org/10.1016/j.compedu.2014.05.006 Higher education in the face of the push of new technologies 259
[11] H. Cooper, B. Nye, K. Charlton, J. Lindsay, and S. Greathouse, The effects of summer vacation on achievement test scores: A narrative and metaanalytic review, Review of Educational Research, 66 (3) (1996), 227-268.
[12] J. Cubillo, S. Martín, M. Castro, and A. Colmenar, Recursos digitales autónomos mediante realidad aumentada. RIED, 17 (2) (2014), 241-274. https://doi.org/10.5944/ ried.17.2.12686
[13] J. Dewar, University 4.0: Redefining the Role of Universities in the Modern Era, Higher Education Review, (2017) agosto, https://www.thehighereducationreview.com/magazine/university-40-redefiningthe-role-of-universities-in-themodern-era-SUPG758722027.html.
[14] D. Díaz Nogueras, P. Toledo, and C. Hervás, Augmented Reality Applications Attitude Scale (ARAAS): Diagnosing the Attitudes of Future Teachers. The New Educational Review, 50 (4) (2017), 215-226.
[15] A. Estapa, L. Nadolny, The Effect of an Augmented Reality Enhanced Mathematics Lesson on Student Achievement and Motivation, Journal of STEMEducation, 16 (3) (2015), 40-48
[16] A. Peachey, J. Gillen, D. Livingstone , S. Smith-Robbins (2010 The Open University) Researching Learning in Virtual Worlds. Springer Publications.
[17] G. S. Contreras , A. H. González , I. S. Fernández , C. B. Martínez Cepa & J. C. Z. Escobar (July 15, 2022) The Importance of the Application of the Metaverse in education https://doi.org/10.5539/mas.v16n3p34
[18] G. Sanglier, C. B. Martínez, I. Serrano & J. C. Zuíl, (2020). Higher Education in the phase of the push of new technologies. Virtual, Augmented and Mixed Reality in the Teaching Environment. Contemporary Engineering Sciences, https:/doi.org/10.12988/ces.2020.91601
[19] G. Sanglier (2021). Gamification applied to Physics teaching in Higher Education. An alternative to achieve better results, https:/doi.org/10.12988/ces.2021.917861975.

VIII. BIOGRAPHIES

Rohan Bhattacharjee is a dedicated undergraduate student pursuing a B.Tech in Computer Science and Engineering (AIML) at the Institute of Engineering and Management, Kolkata, West Bengal, India. Born on June 6, 2001, in Kolkata, he has been passionate about the field of Computer Science and the myriad of technologies associated with it. His journey in academia commenced in 2020, and he is set to graduate in 2024. During his academic pursuit, he undertook two enriching internships, which broadened his horizons. He served as a content writer intern at mealdeals.co, honing his communication and writing skills. Additionally, he explored the fascinating realm of Augmented Reality and Virtual Reality (ARVR) as a Research Intern at IEMA R&D Pvt Ltd. In collaboration with his peers, Bhattacharjee contributed to the academic community by publishing a review paper titled "A Review on Hyper-Parameter Optimization by Deep Learning Experiments" in the Journal of Mathematical Sciences & Computational Mathematics (JMSCM). This publication showcased his enthusiasm for research and his interest in deep learning experimentation.His research interests encompass diverse fields, including ARVR (Augmented Reality and Virtual Reality), artificial intelligence, cloud computing, and data analytics. Rohan Bhattacharjee continues to explore and learn, aspiring to make significant contributions to the ever-evolving landscape of computer science and technology.

Amartya Mukherjee is an M.Tech (NIT Durgapur) , Ph.D. (Pursuing) from Maulana Abul Kalam Azad University of Technology (Kalyani). He is currently the HEAD OF THE DEPARTMENT in the department of Computer Science & Engineering (AIML), Computer Science & Business Systems in Institute of Engineering and Management Kolkata. He has above 14 years of experience of teaching in the field of Computer Science.
Prof. Mukherjee has written numerous Books and Research articles in the field of IoT, Embedded application development, Wireless Communication, Smart Systems in various renowned publication houses like IEEE, Elsevier, Springer, Taylor & Francis. His book "Embedded Systems & Robotics with Open Source Tools" is one of the best selling books in embedded application development.

Indrajit De is a PROFESSOR in the Department of Computer Science and Engineering (AIML) , CSBS at Institute of Engineering and Management, Kolkata. He has completed his B.Tech from Calcutta University and subsequently completed his M.Tech in Information Technology and Ph.D(Engineering) in Computer Science and Technology from IIEST, Shibpur, India. He is currently the elected Vice Chair of Internet Society Kolkata Chapter as well as advisor of India Internet Foundation(IIFON) which is a flagship organization promoting awareness related to Internet protocol standards in the community. Dr. De has authored publications in major international journals, conferences and edited books. He has been reviewing some major journal articles in publications like Applied Soft Computing, Machine Vision and Applications, IEEE Access etc for many years. He has also contributed as one of the founder coordinators in IICB – a flagship Internet standards awareness building project in India funded by Internet Society, Kolkata Chapter and approved by MeitY(earlier DeitY), Govt, of India. Moreover he has completed three consultancy projects from RABT Technologies, MHRD etc. He has visited as well actively participated in premier conferences like IETF 94, 103, INSIG and ISOC – APAC Chapter meetings as invited fellow many a times across different parts of the World. He is a GATE scholar and recipient of several awards and scholarships.

Ayan Kumar Panja is M.Tech (CU), Ph.D.(Pursuing) from Jadavpur University. He is the ASSISTANT HEAD OF THE DEPARTMENT in the dept. of CSE(AIML), CSBS of Institute of Engineering and Management, Kolkata..
Prof. Panja has written several books on WSN, Medical Systems in renowned publication house like Elsevier.