Development Of A Video Call Based Real-Time Collaboration And E-Learning Platform

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Abstract— This paper presents the development of a video call based real-time collaboration and e-learning platform which aim at integrating video call module for lecture delivery, screen sharing and recording mechanisms, virtual background and resources repositories into one application. Notably, the existing application on this subject is faced with the issues of virtual background, screen sharing and video call for multiple users. The new software solution is presented to incorporate the listed mechanisms into one application to enhance e-learning and complement the existing features. The system was developed using ASP.Net Core 3.1 framework, cascaded style sheet (CSS), hypertext markup language (HTML) and MSSQL server database. The system was hosted on Internet Information Services (IIS) web server. In the software design, the Model-View-Controller (MVC) architecture was employed to ensure decoupling of the abstraction layer which enhances maintainability and scalability of the program code, and also simplifies search engine optimization (SEO). A focused group system test was conducted to ascertain the use acceptance of the enhanced features. The result obtained from the focused group test showed that the users appreciated the enhanced features. More especially, many users wanted to participate irrespective of the visual background since they could activate virtual background. Also, if there is sufficient bandwidth, multiple users were able to stream the lecture at the same time without difficulties.

Keywords— Video Streaming Platform, E-Learning Platform, Video Call, Model-View-Controller, Real-Time Collaboration Platform, Virtual Background for Video Contents

1. Introduction

In recent year, there has been a sustained surge in the adoption of e-learning and online meeting platforms all over the globe [1,2,3,4,5,6,7,8]. This has been due to the emergence of COVI-19 pandemic which required social distancing and necessitated the need for virtual meetings and virtual teaching and learning service delivery [9,10,11,12,13]. As more and diverse categories of users engage in the e-learning platforms, it has been noticed that demand for new features on the existing platforms are increasing. Among other things, some users require virtual background functionality which enable them to select video background that will appeal to them [14,15,16,17,18]. Also, some parents require virtual background for video contents to enable them select the background that will present less distraction to their wards.

Also, the ability to record live lecture videos is another feature that has attracted attention of developers of e-learning platform [19,20.21.22.23.24.25]. Accordingly, the existing notable collaboration and e-learning platforms were studied and their limitations were identified. Also, online and offline opinion polls were conducted and questionnaire was also used to sample opinion of many categories of users of collaboration and e-learning platforms. The key functionalities that were identified from the results of the user opinion poll and questionnaire were used to model the functionalities of the video call based real-time collaboration and e-learning platform presented in this paper. The details of the system design and implementation and evaluation of the new system are presented.

2. Methodology
2.1   Software Development Method and Use Case Diagrams
The main focus in this paper is the design of a video call based real-time collaboration and e-

learning platform. An iterative user-centered prototyping development method was used. In this case relevant stakeholders were identified and available related online collaboration and e-learning platforms were also identified. Focus group was formed and some online collaborators were also linked up to the focus group discussion outcomes.

Notably, paper (low fidelity) prototyping approach was used in the early stage of the requirement elicitation along with task analysis. Also, the paper prototyping approach was used to capture some user interface design layouts. The focus group discussion centered on the existing systems, their limitations and the key features that need to be introduced of enhance the functionalities and applicability of the collaboration and e-learning platform. Unified Modeling Language (UML)-based use case diagrams were used to describe the system modules and some system functionalities. The use-case diagram showing the key modules in the system is given in Figure 1.
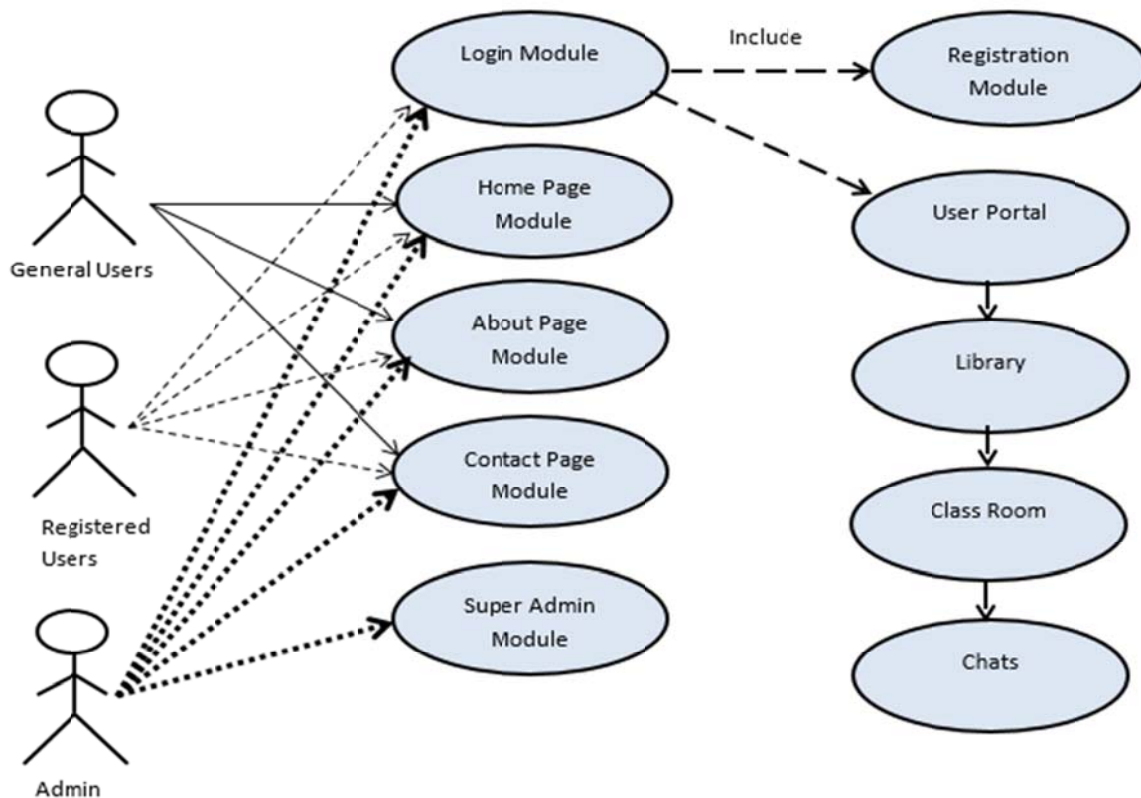

Figure 1 The use-case diagram showing the key modules in the system

The use-case diagram showing the system administrator's functionality is given in Figure 2 while the use-case diagram showing the user's functionality is given in Figure 3. On the administrator use case diagram, the administrator gains access to every part of the system and is permitted to make changes when necessary; add and remove moderation rights, allow or deny the users to draw on the white board, allow or deny the users screen sharing or recording, allow or deny audio rights to users, give exclusive audio right to self and upload files. On the other hand, the use diagram for the user's functionalities (Figure 3) shows that the user is only permitted to join the meeting when invited via an email, record screen, share screen, use the white board, and audio when given permission by the administrator.
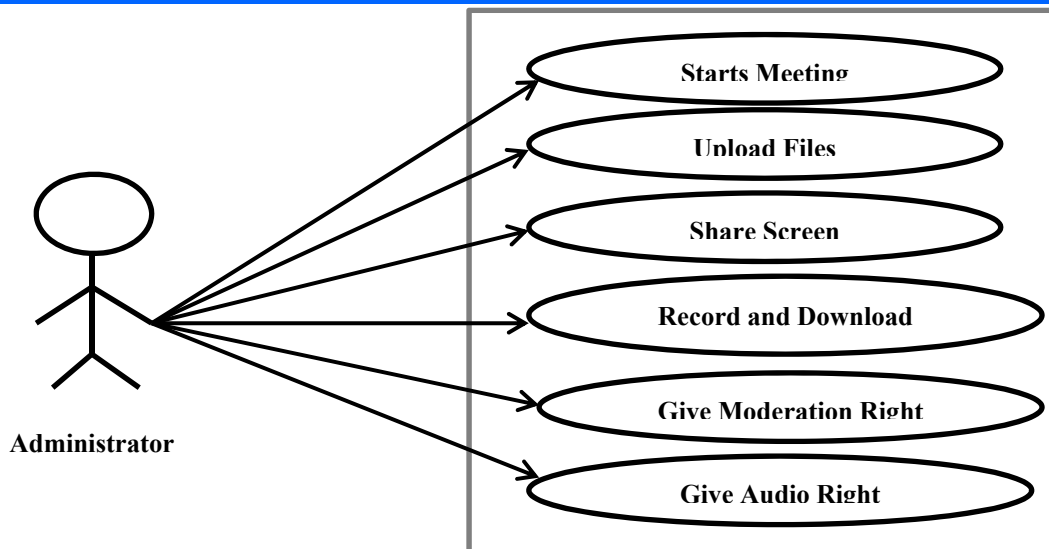
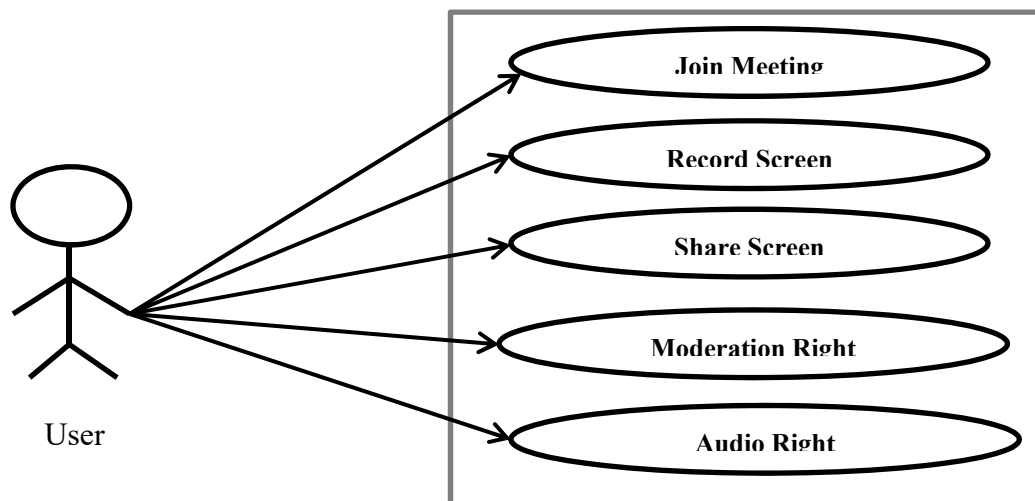Figure 2: Use-case diagram showing the Administrator's functionality

Figure 3 : Use-case diagram showing the user's functionality

2.2 The System Functional Decomposition and Flow Diagrams

The system functional decomposition is presented in Figure 4 where the key modules include; Registration / Login, Open Meeting, Forum / Blog, system administrator, lecture repository and course management modules. The decomposition of the modules into submodules are presented also. Some of them include functional decomposition for open meeting in Figure 5, functional decomposition for administration submodule in open meetings in Figure 6 and functional decomposition for conference options submodule in Figure 7. Also, Unified Modeling Language (UML)–based class diagram for the conference room management submodule is shown in Figure 8. The class diagram shows the system's classes, the system attributes, the systems operations or methods, as well as the relationships that exists among the classes. The flow chart diagram for open meeting management module is presented in Figure 9 while the video calling party flow diagram with traffic controller Implementation is presented in Figure 10.
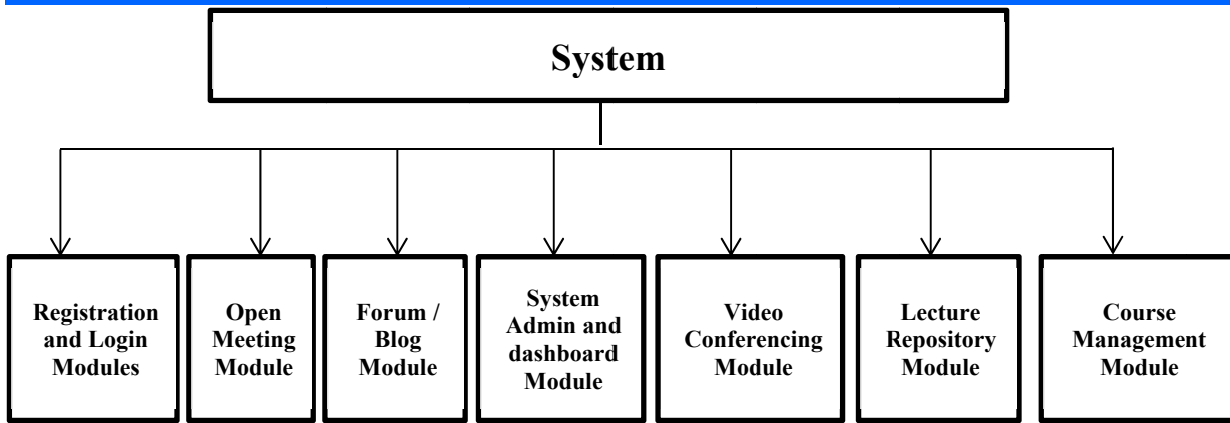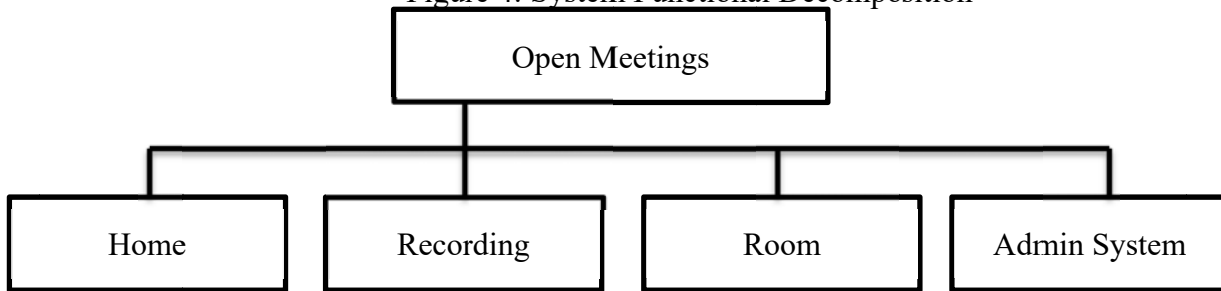
Figure 4: System Functional Decomposition

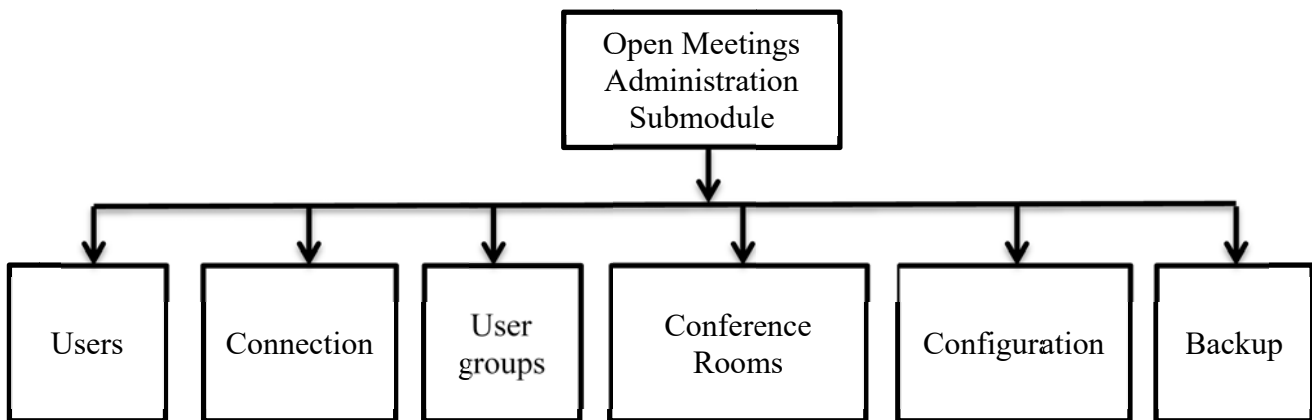Figure 5: Functional Decomposition for Open Meeting

Figure 6: Functional Decomposition for Open Meetings Administration Submodule
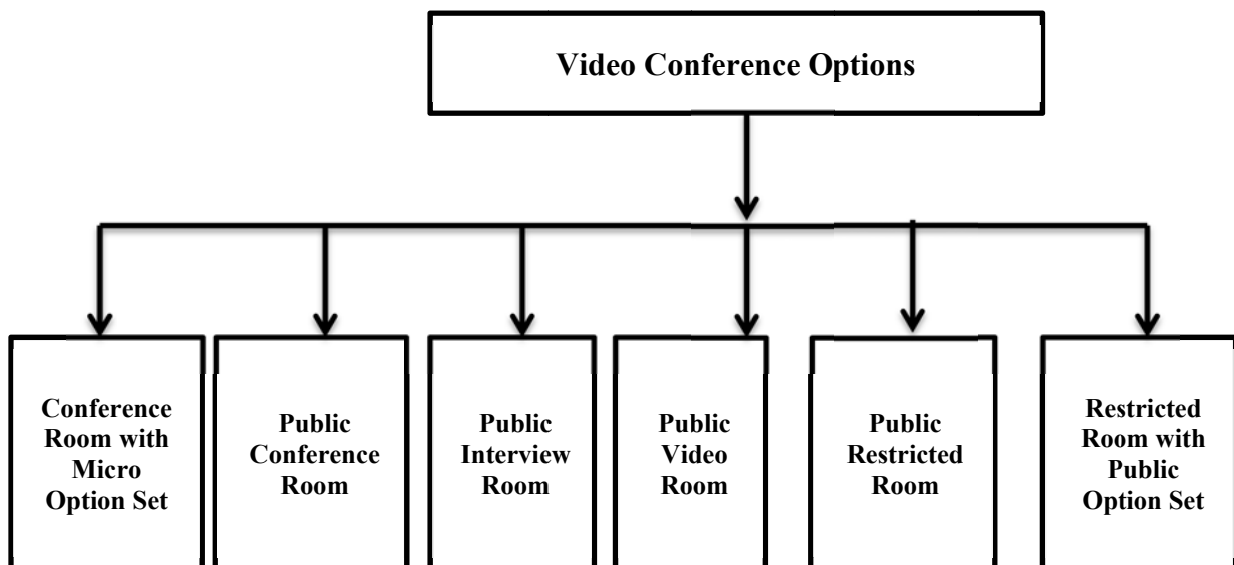
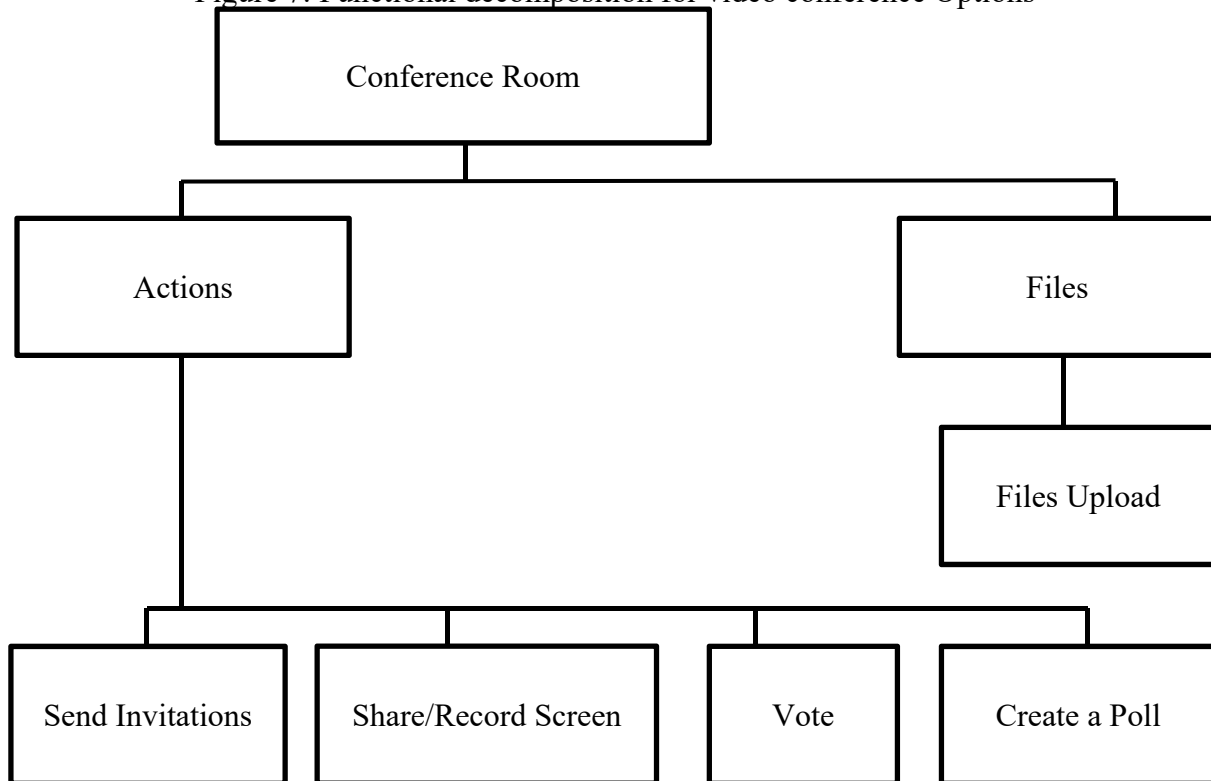Figure 7: Functional decomposition for video conference Options

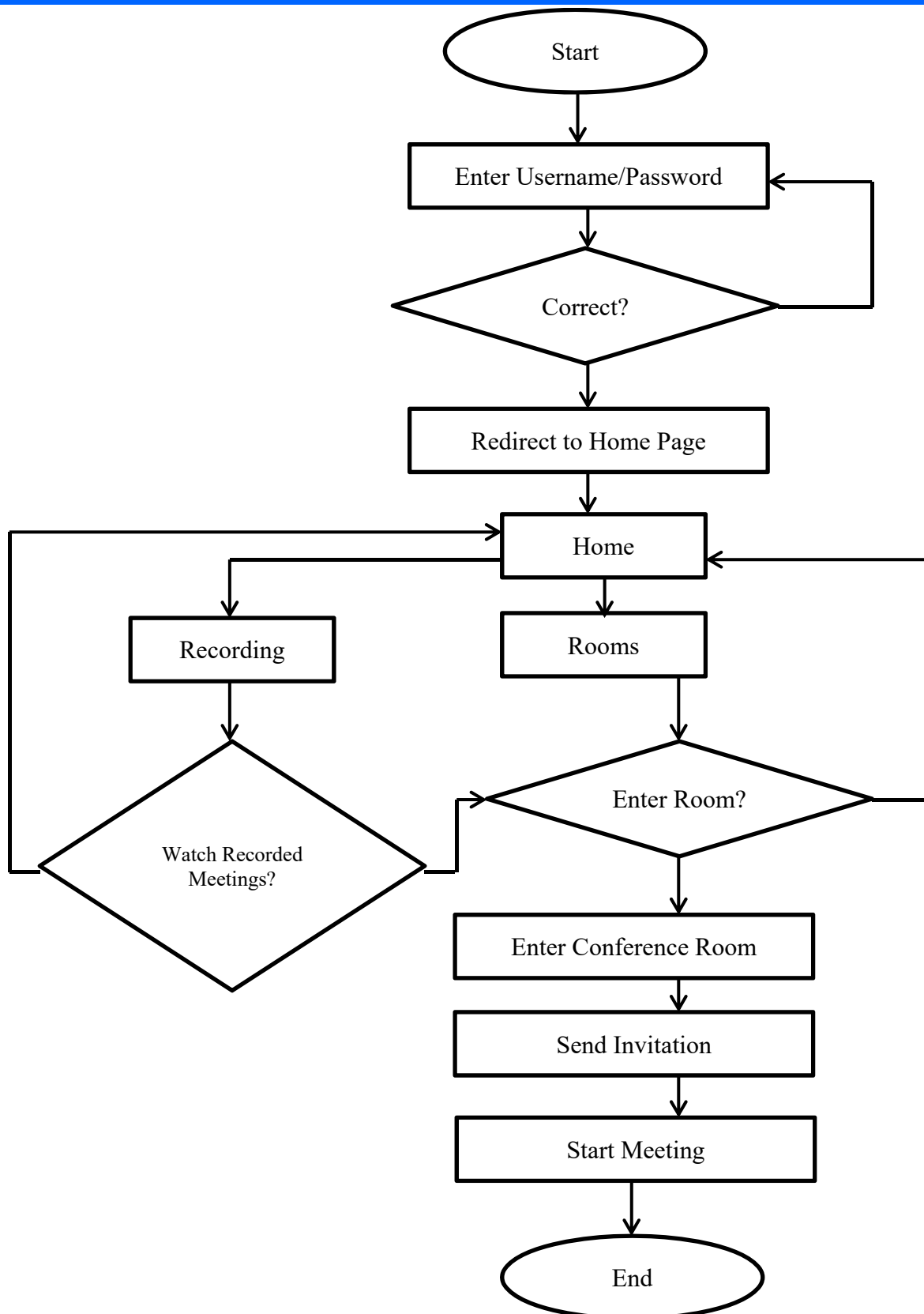Figure 8: Class Diagrams for Conference Room Management Submodule

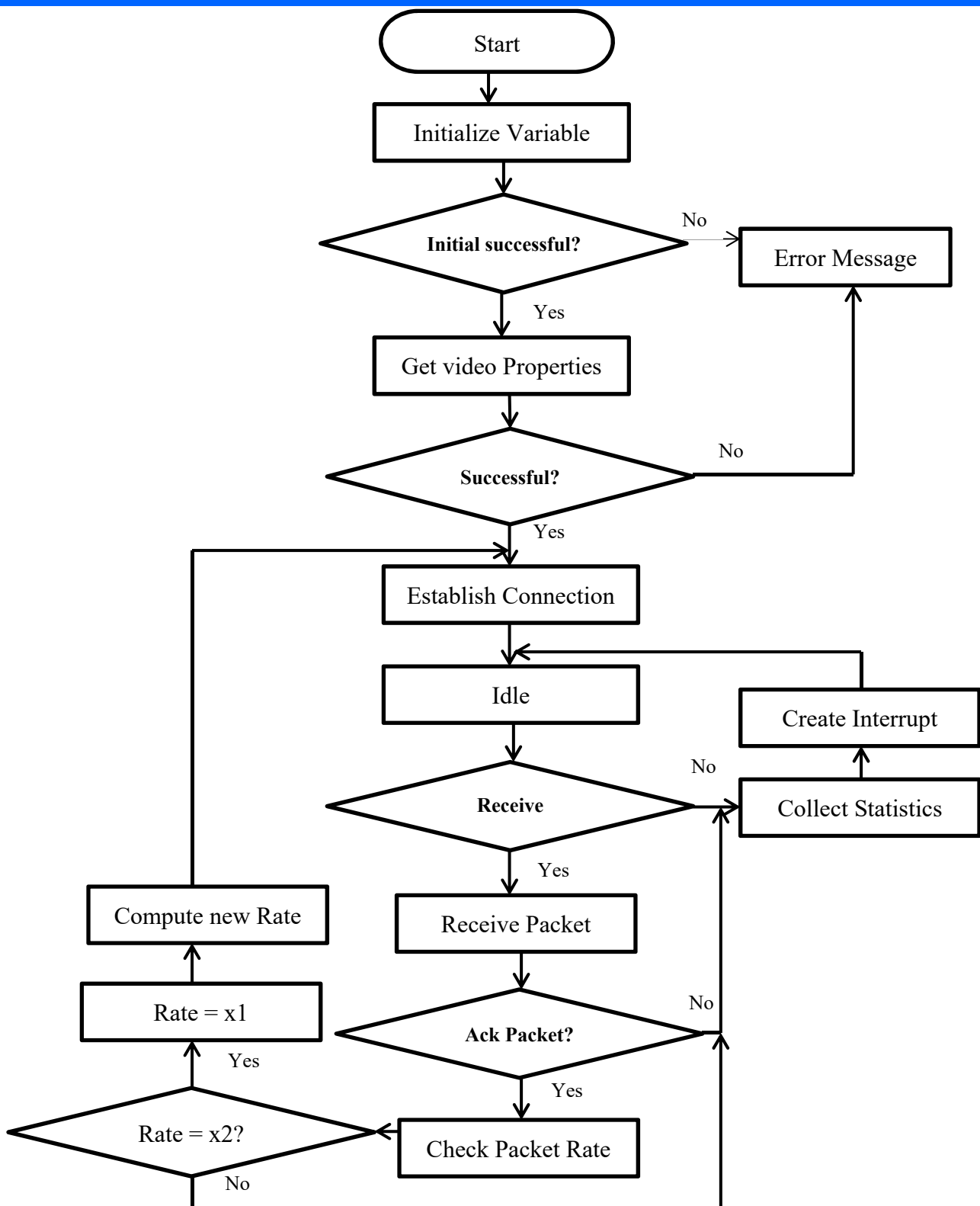Figure 9: Flow Chart Diagram for Open Meeting Management Module

Figure 10: Video Calling Party Flow Diagram with Traffic Controller Implementation

Notably, the system was implemented using ASP.NET along with C# language. Hence, the Internet Information Services (IIS) web server was used along with SQL-based relational database. Also, the client-server web app architecture is employed in the implementation of the system. A focused group system test was conducted to ascertain the use acceptance of the enhanced features.

3. Results and Discussion

The Home page is given in Figure 11. It provides links to register and Login. The 'REGISTER' link is meant to be used by users who do not have

account on this platform. When the registration link is clicked, it opens to the 'REGISTER' page which is shown in Figure 12. Users who do not have account on the platform are redirected to the 'REGISTER' page on attempt to login. In the registration page, user data collected are: Name, Email Address, Password and Confirm Password. The system ensures that the Email Address

provided is unique since it is basically used for authentication during login. This is to ensure that no two users have the same identity. When the 'LOGIN' link is clicked, it opens the Login page where the user can enter his/her login details to access the application dashboard. The Login page for this application is shown in Figure 13.
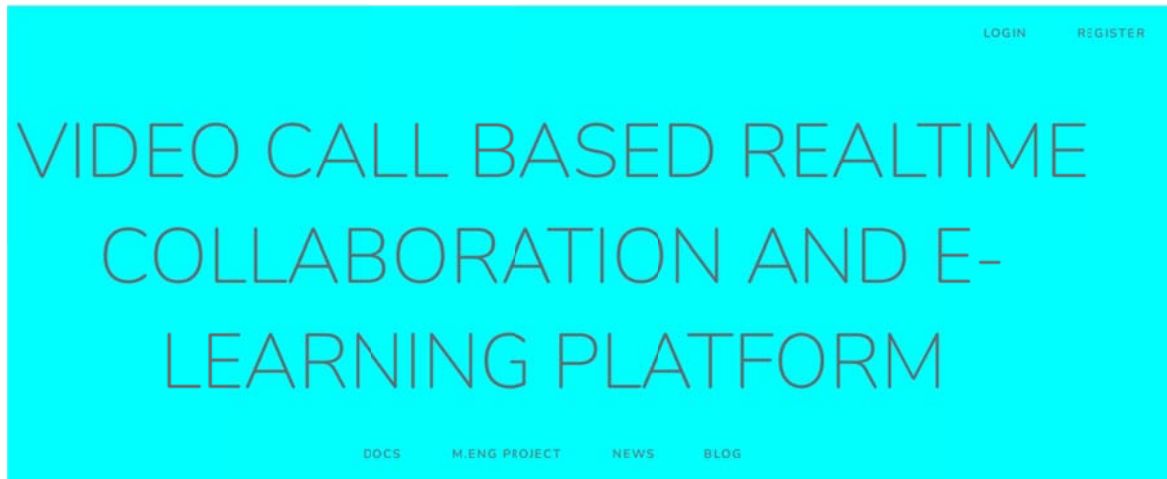

Figure 11: Home Page

Figure 12: Registration Page

Figure 13: Login Page

When a user successfully logs in to the system, the landing page is the user's dashboard where the user has access to other pages on the application. The Dashboard view is as shown in figure 14. The dashboard as seen in Figure 14 contains many views and useful tools for the user. There are four major tools on the user's dashboard, these are: "My Courses", "Assignments", "My Library", and "Lecturer's Resources". Figure 15 shows the view for user's courses page.

The user's courses page enumerates all the courses registered by the user. User can register new course by clicking the Register course button on which will lead to the view in Figure 16.

The assignment page shows the list of assignments given to the user by the instructor. This page is shown in Figure 17. This is published on the students' repository where every student that belongs to that class can see.

Video Conference can be made on the application by navigating to the video conference window which is shown in Figure 18. The application is designed to host multiple participants who can listen to tutorials, make contributions, and ask questions. There is a microphone symbol which is used to toggle between loudspeaker and headphone or any other external audio device. On this window too, there is an option for users to mute their audio. The audio muting was implemented on two categories. Either the host mutes any or all participants or a participant chooses to do so. The user can join the conference room, and access public video conference; can share screen, vote and create poll; can also upload files.

The e-learning part of the application was not left out. The instructor's module was designed to help the instructor manage and present resources to the students or audience. The module comprises of students' exams which contains the exams questions (if available) which the students will take; students' resources which contains students' work such as tests, assignments, and classwork; registered student which contains list of students who have enrolled for the course; and finally students' results. Figure 19 features the instructor's dashboard.
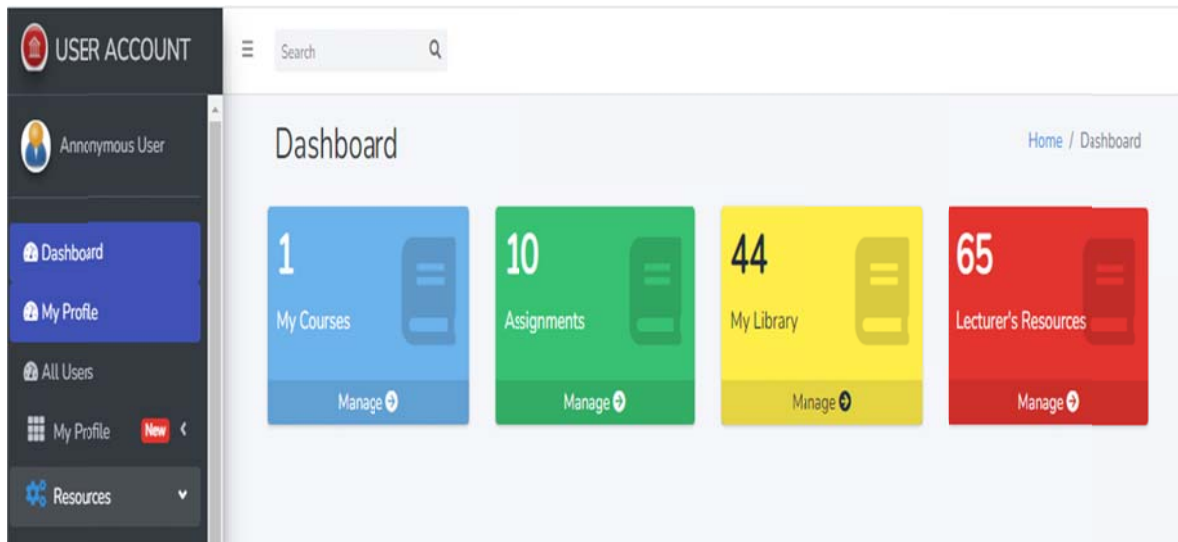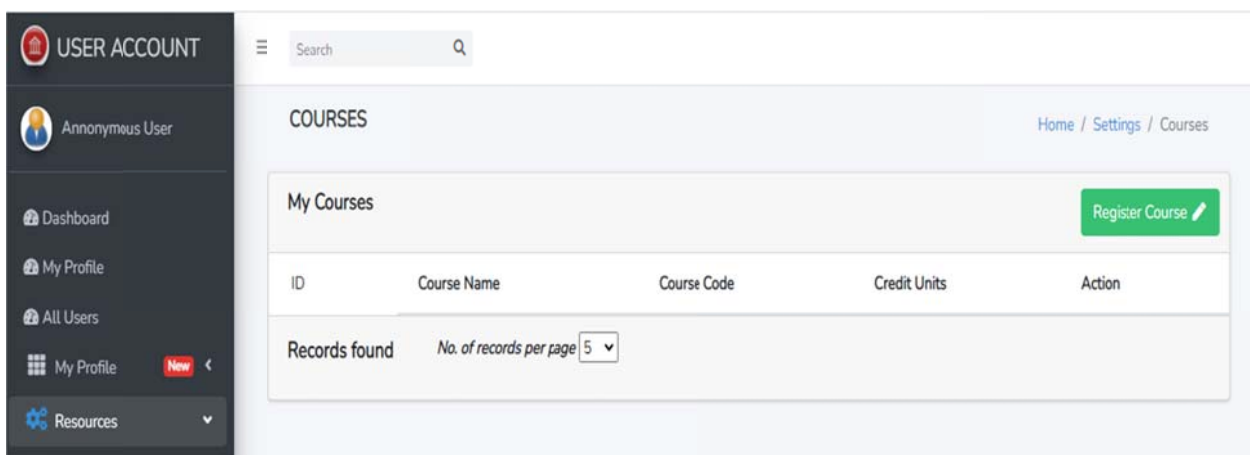
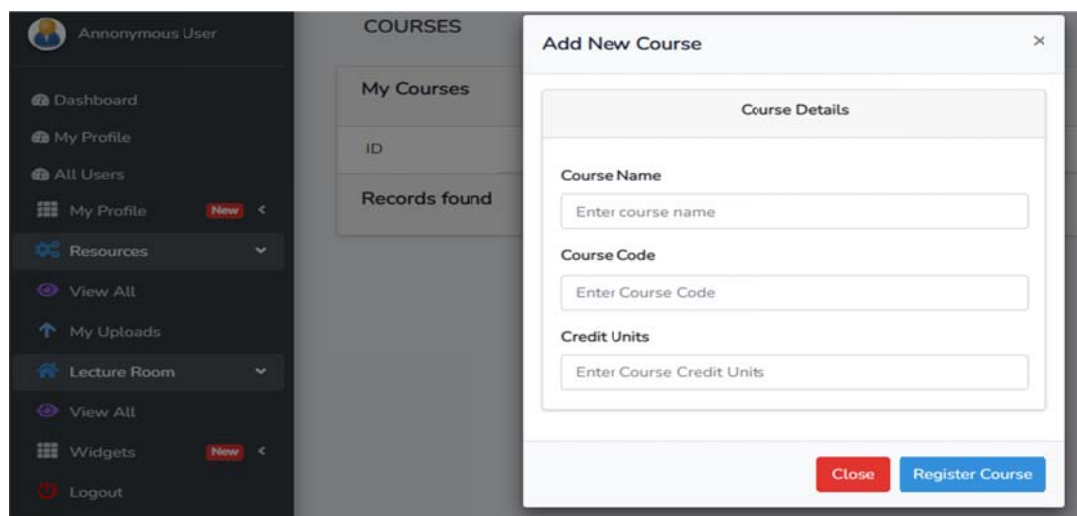Figure 14: User's Dashboard

Figure 15: User's Courses Page
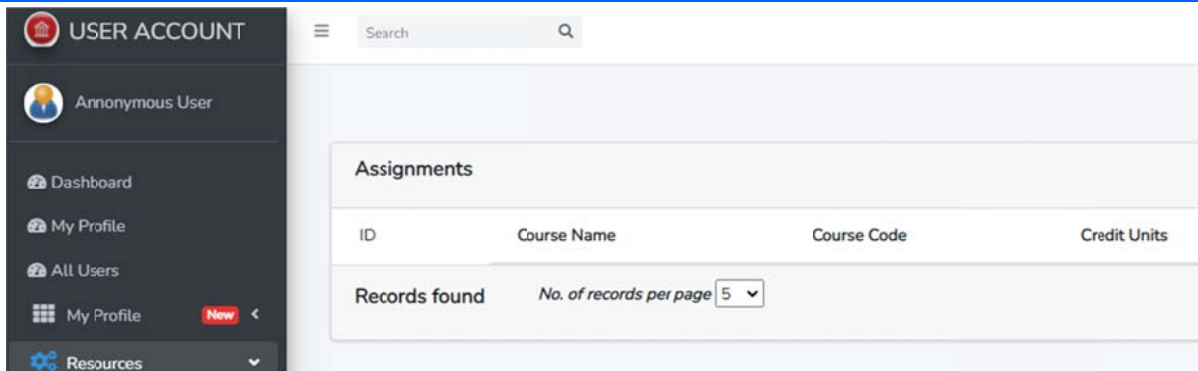

Figure 16: User's Course Registration Page
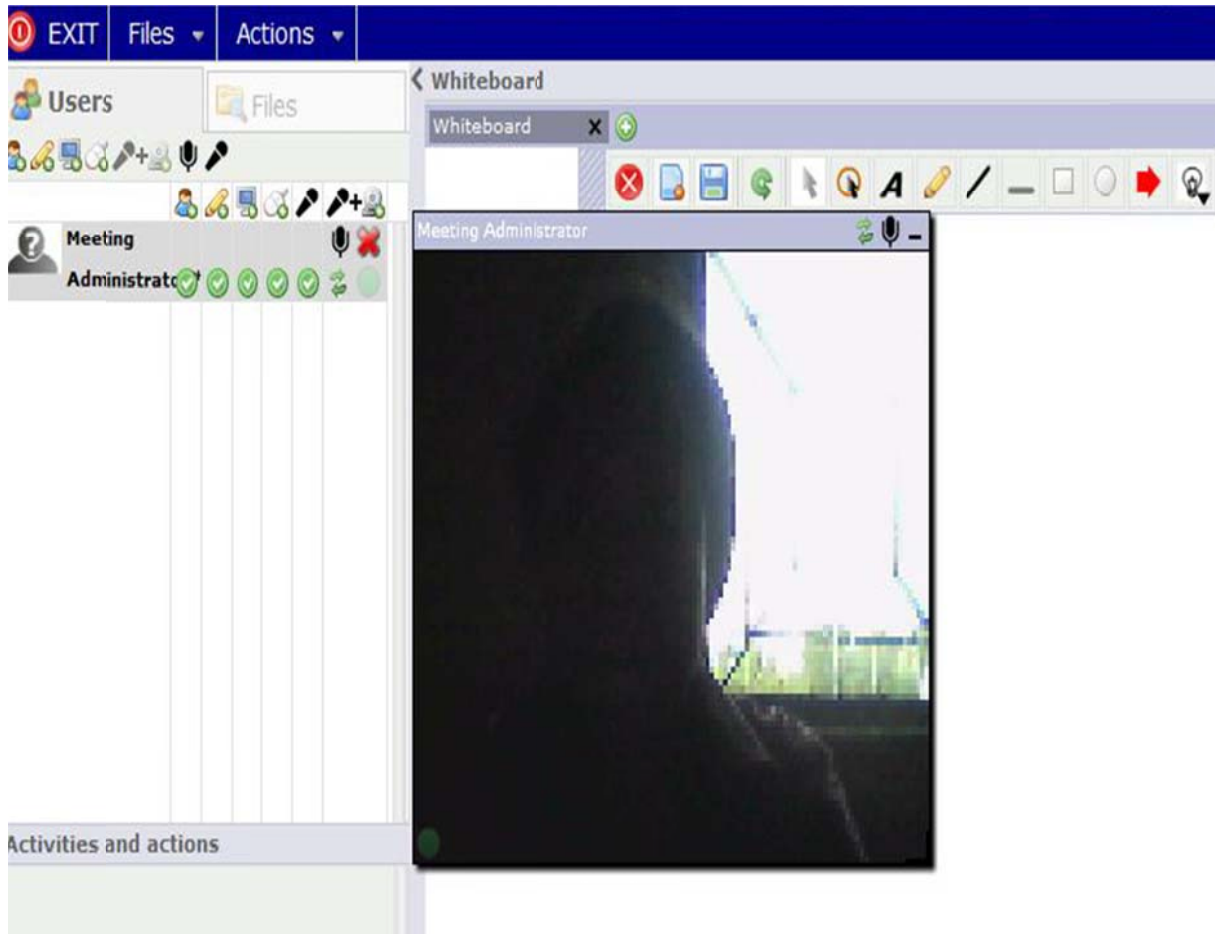
Figure 17: User's Assignment Page

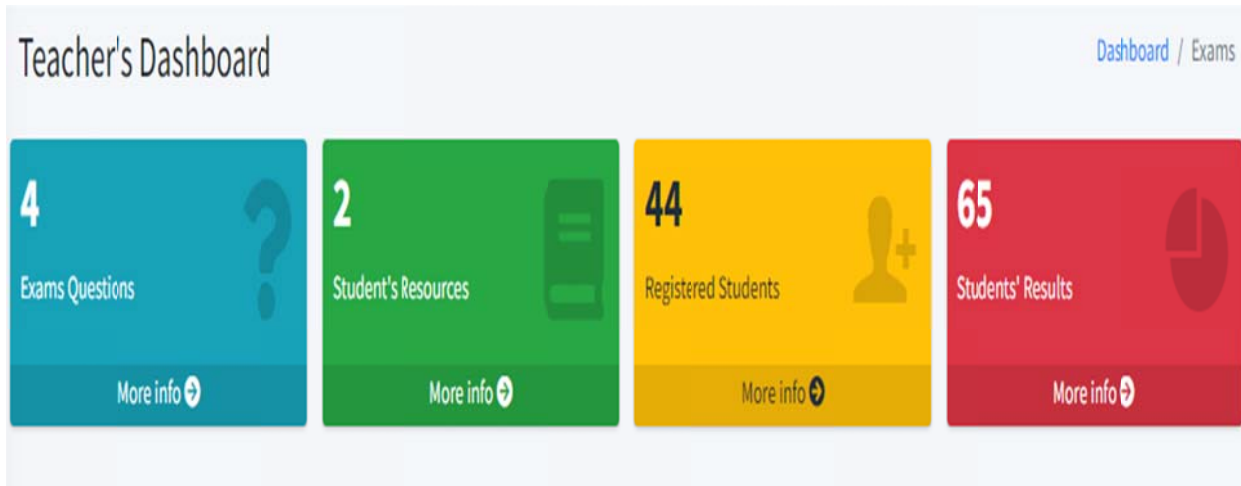Figure 18: Video Conference Meeting Window
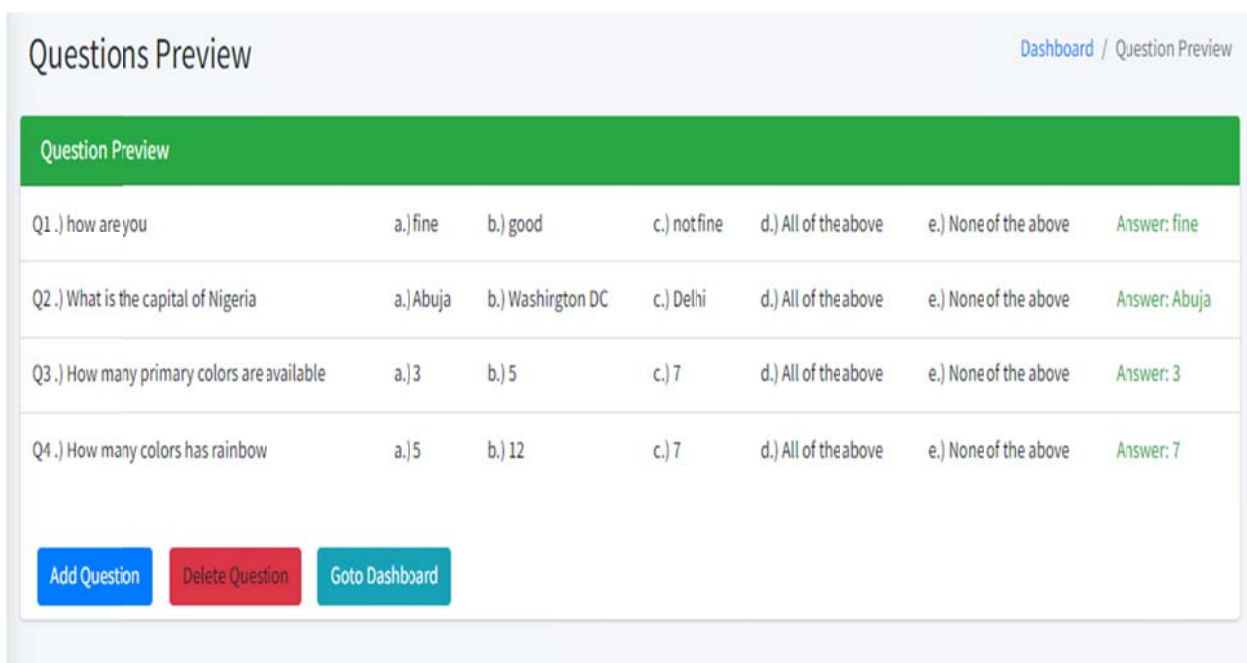
Figure 19: Instructor's dashboard

Figure 20: Instructor's Exams/Test Questions

As seen from Figure 20, the instructor can have list of questions to publish to the registered students. The list can grow by using the "Add Question" button or reduced by using the "Delete Question" button. Figure 21 and Figure 22 shows the "Add Question" module.

Figure 22 features students' resource module from the instructor's end. These resources are retrieved from the students' repositories onto the instructor's dashboard. Here is where the instructor can access the assignments, tests, and exams given to the students. As seen in the Figure, the instructor can only read the resources but cannot comment on them. When the "Read" button is clicked, it opens a .PDF file which is the accepted format apart from excel documents for all submitted resources.

Figure 23 shows the result summary for each student who participate in the exam for the specified course. Figure 24 shows the students' dashboard. This dashboard is only accessed by those who registered on the platform as student. Once enrollment is complete, the application will present the available courses for the prospective student to select those ones to register. After course registration, the registered students can then access or share activities that belong to that course. Figure 25 features a typical student exams module. Students who registered for a particular course sees the questions set by the instructor when the exams date and time sets. Once an option is selected, and submitted, another question pops up and the cycle continues until the student finish answering the questions.

Figure 21: Add Question Module

Figure 22: Students Resource Module (Instructor's End)

Figure 23: Students' Results Summary

Figure 24: Student's dashboard.

Figure 25: A typical Student's Exam Page

4. Conclusion

Development of a video call based real-time collaboration and e-learning platform (VCBRCEP) is presented. The key mechanisms developed in this application are: video call real-time collaboration mechanism, virtual background mechanism, learning resources repositories, screen sharing and recording mechanisms. The application is also enhanced with features such as e-classroom where students meet their instructor via video conferencing. The activities carried out during the conference meeting can be optionally recorded by the student or instructor. Instructors can share the soft copy of their resource material to the students who can as well submit any task given to them by their instructor by sending it to the instructor's private repository. The application is designed such that students can only access courses or lectures which they registered for. The system was implemented using ASP.NET along with C# language, SQL-based relational database and then hosted using the Internet Information Services (IIS) web server.

References

1. Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. *Education and information technologies*, *25*(6), 5261-5280.

2. Oyediran, W. O., Omoare, A. M., Owoyemi, M. A., Adejobi, A. O., & Fasasi, R. B. (2020). Prospects and limitations of e-learning application in private tertiary institutions amidst COVID-19 lockdown in Nigeria. *Heliyon*, *6*(11), e05457.

3. Farid, S., Ahmad, R., Alam, M., Akbar, A., & Chang, V. (2018). A sustainable quality assessment model for the information delivery in E-learning systems. *Information Discovery and Delivery*.

4. Ananga, P. (2020). Pedagogical Considerations of E-Learning in Education for Development in the Face of COVID-19. *International Journal of Technology in Education and Science*, *4*(4), 310-321.

5. Cheok, M. L., Wong, S. L., Ayub, A. F., & Mahmud, R. (2017). Teachers' Perceptions of E-Learning in Malaysian Secondary Schools. *Malaysian Online Journal of Educational Technology*, *5*(2), 20-33.

6. Salloum, S. A., Al-Emran, M., Shaalan, K., & Tarhini, A. (2019). Factors affecting the E-learning acceptance: A case study from UAE. *Education and Information Technologies*, *24*(1), 509-530.

7. Kalpokaite, N., & Radivojevic, I. (2020). Teaching qualitative data analysis software online: a comparison of face-to-face and e-learning ATLAS. ti courses. *International Journal of Research & Method in Education*, *43*(3), 296-310.

8. Dhir, S. K., Verma, D., Batta, M., & Mishra, D. (2017). E-learning in medical education in India. *Indian pediatrics*, *54*(10), 871-877.

9. Rasouli, J. J., Shin, J. H., Than, K. D., Gibbs, W. N., Baum, G. R., & Baaj, A. A. (2020). Virtual spine: a novel, international teleconferencing program developed to increase the accessibility of spine education during the COVID-19 pandemic. *World neurosurgery*, *140*, e367-e372.

10. Wallis, C. J., Catto, J. W., Finelli, A., Glaser, A. W., Gore, J. L., Loeb, S., ... & Spratt, D. E. (2020). The impact of the COVID-19 pandemic on genitourinary cancer care: re-envisioning the future. *European urology*, *78*(5), 731-742.

11. Mahaye, N. E. (2020). The impact of COVID-19 pandemic on education: navigating forward the pedagogy of blended learning. *Research online*.

12. Wu, P. E., Styra, R., & Gold, W. L. (2020). Mitigating the psychological effects of COVID-19 on health care workers. *Cmaj*, *192*(17), E459-E460.

13. Ifijeh, G., & Yusuf, F. (2020). Covid–19 pandemic and the future of Nigeria's university system: The quest for libraries' relevance. *The Journal of Academic Librarianship*, *46*(6), 102226.

14. Sweetman, D. S. (2021). Making virtual learning engaging and interactive. *FASEB BioAdvances*, *3*(1), 11-19.

15. Hilgefort, J. M., Arp, D., & Rieck, K. (2021, November). Spying through Virtual Backgrounds of Video Calls. In *Proceedings of the 14th ACM Workshop on Artificial Intelligence and Security* (pp. 135-144).

16. Palanica, A., & Fossat, Y. (2022). Effects of nature virtual backgrounds on creativity during videoconferencing. *Thinking Skills and Creativity*, *43*, 100976.

17. Russell, D. A. (2021, June). Positive aspects of teaching online during COVID-19: Zoom backgrounds, MannyCam, and increased student engagement. In *Proceedings of Meetings on Acoustics 180ASA* (Vol. 43, No. 1, p. 025001). Acoustical Society of America.

18. Barbosa, T. J., & Barbosa, M. J. (2019). Zoom: An innovative solution for the live-online virtual classroom. *HETS Online Journal*, *9*(2).

19. Kurzweil, D., Marcellas, K., Henry, B., & Meyer, E. (2020). Evidence-based guidelines for recording slide-based lectures. *Medical science educator*, *30*(4), 1611-1616.

20. Chandra, S. (2007). Lecture video capture for the masses. *ACM SIGCSE Bulletin*, *39*(3), 276-280.

21. Odhabi, H., & Nicks-McCaleb, L. (2011). Video recording lectures: Student and professor perspectives. *British Journal of Educational Technology*, *42*(2), 327-336.

22. Winzker, M., Kiessling, R., Schwandt, A., Paez, C. S., & Shanab, S. A. (2018, March). Teaching across the ocean with video lectures and remote-lab. In *2018 IEEE World Engineering Education Conference (EDUNINE)* (pp. 1-4). IEEE.

23. Nightingale, K. P., Anderson, V., Onens, S., Fazil, Q., & Davies, H. (2019). Developing the inclusive curriculum: Is supplementary lecture recording an effective approach in supporting students with Specific Learning Difficulties (SpLDs)?. *Computers & Education*, *130*, 13-25.