Bilkent University

Department of Computer Engineering

Senior Design Project

Project short-name: Here!

Project Specifications Report

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This report is submitted to the Department of Computer Engineering of Bilkent University in partial fulfillment of the requirements of the Senior Design Project course CS491.

1. Introduction

The COVID-19 pandemic that struck the world in early 2020 led humanity to search for alternate solutions to everyday tasks. It affected people to the point that these tasks which would have been quite trivial in the past, now require immense care to complete. Along with these safety measures came the exercise of social distancing, which led to a complete overhaul of human to human interaction. We now communicate mostly online, with little to none face to face interaction. Video conferencing applications, such as Zoom, Google Meet or Microsoft Teams are much more prevalent than ever, due to this unprecedented circumstance. Even though this new type of communication is necessary to prevent the spread of the disease, it certainly has its drawbacks.

As students, during our time being educated remotely, we have experienced some problems that affected both the instructors and the students. It is evident that an online education setting has much less room for student-instructor interaction compared to a classroom setting. This mainly has to do with the fact that video conferencing applications such as Zoom or Google Meet are not specialized to be used as an education medium. Many valuable information, such as the attention of the students to the lectures, that were constantly gathered by instructors in classrooms are lost in online education due to the fact that these conferencing mediums are simply not specialized enough to gather such information. Our experiences show that the loss of such information leads to a complete detachment between the instructors and students, which overall diminishes the effectiveness of online education. Our application aims to overcome this problem, by providing a solution using machine learning and computer vision algorithms that would increase the amount of knowledge the instructors receive about their students both in real time and right after lectures.

Students also lose their ability to effectively follow the lessons, as these video conferencing mediums do not provide them any means to enhance their learning process. They are now essentially “participants” rather than “students” that do not have the essential tools they once had in their classrooms. This unfortunate situation distances them from the learning process itself. We also aim to solve this problem, by providing a platform specialized for the needs of the students in an online education environment.

This report consists of the brief description of the project, constraints that would be enforced on such an application, and both the functional and non-functional requirements of the application.

1.1. Project Description

Here! is a video conferencing service that is specifically designed for educational needs of both students and instructors. It will include the general characteristics of a video conferencing application with the inclusion of practical educational tools. These tools can be divided into two parts, an online TA that will use motion and eye tracking technologies in order to analyze videos of students to come up with informative data about the class session, and other complementary features that will make online education more reliable and easy for both students and instructors.

If an instructor chooses to do so, it can use the online TA feature to analyze and gather data from videos. Our online TA will print out attendance rates by analyzing how frequently a student participates or raises their hand. It will also notify the teacher simultaneously when a student raises their hand or gives a specific reaction, like a thumbs up. Another feature is to track eye movements in order to understand if a student is distracted and notify the teacher during the lecture.

Other than our online TA, we have multiple features that support online education. One feature will be a simultaneous note taking, where you can instantly screenshot the current slide or shared screen and add that into your notes, where you can view them later in your profile with added personal notes from you. Another main feature will be the slide sharing, where students can navigate freely through a slide that the teacher is actively sharing in order to better read and understand the content without hindering the rest of the class, and sync up with the instructor whenever they want. Additionally, instructors will be able to share their screens separately from the slide share.

1.2. Constraints

1.2.1. Implementation Constraints

The backend of the program will be implemented using Python to make use of TensorFlow [1]. The frontend will be implemented using Flutter [2]. To add real-time communication capabilities to the program, WebRTC framework will be used [3]. The underlying database will be MySQL [4]. GitHub will be used for the collaborative work.

1.2.2. Economic Constraints

The economic constraints on this project will be imposed by the cost associated with the server costing, libraries and APIs. Datasets that we will use for training are free. Since our application will be a web application, we will need domain and hosting which will cost approximately $5 per month.

1.2.3. Social Constraints

Students and instructors are expected to maintain mutual respect in an online class environment.

1.2.4. Ethical Constraints

The data that will be obtained by the users will not be shared with any third party application. “Code of Ethics” by the National Society of Professional Engineers is going to form the ethical boundaries of the application [5].

1.2.5. Health and Safety Constraints

Our program supports remote education, thus helping people to handle their businesses while staying at home and prevent spreading of coronavirus.

1.2.6. Manufacturability Constraints

The necessary libraries and APIs for the implementation should be available for the project.

1.2.7. Sustainability Constraints

Our program relies on real time image recognition and its maintainability. Continuous data from the user's camera and a real time motion tracking is required.

1.3. Professional and Ethical Issues

Privacy of the user is important. Since the program will use the user's camera, permission from the user will be taken before accessing any data. The user data will not be utilized other than the intended purpose of Here!. In addition, our program will inform the users how the private data is protected and processed for the benefit of the community while not violating any of the users' rights.

2. Requirements

2.1. Functional Requirements

- Users will be able to give video input to the application using any webcam.
- Users will be able to give audio input to the application using any microphone.
- Users will be able to register to the application as an instructor or a student.
- Instructors will be able to register a course to the system.
- Instructors will be able to set a weekly schedule for a course.
- Students will be able to see their weekly schedules.
- Users will be able to receive notifications for upcoming lectures.
- Instructors will be able to start a lecture.
- Students will be able to join a lecture.
- Users will be able to open/close their cameras and microphones during the lecture.
- Students will be able to view the instructor's video and their shared screen in a lecture.
- Students will be able to navigate in the shared slides (if any) independent from the instructor and synchronize back with the instructor when they want.
- Students will be able to open a notepad on the side while listening to the lecture and view their notes after the lecture.
- Users will be able to access the chat panel during the lecture.
- Users will be able to view the participants list during the lecture.
- Instructors will be able to mute/unmute students.

- Students will be able to raise their hands physically to begin to speak.
- Instructors will be able to receive notifications when students raise their hands.
- Students will be able to express that they agree on an idea by making a “thumbs up” sign with their hands.
- Instructors will be able to know how many students have given a “thumbs up” to a question.
- Students will be able to receive statistics about their performance in the class after the lecture.
- Instructors will be able to receive statistics regarding the attention of the students to the lecture both in real time and after lecture.

2.2. Non-functional Requirements

2.2.1. Security

The program must ensure that video recordings of users will not be shared with any other 3rd party application. Users must accept the terms of service and privacy policy to use the program.

2.2.2. Usability

The program must be suitable for webcams with different resolutions. The program must be supported by different browsers.

2.2.3. Performance

The program must be working fast such that it can process all frames of a video captured in real time from 1 second to no delay.

2.2.4. Extensibility

The program will be developed as a web application at first but it must be extensible for desktop, Android and iOS environments.

2.2.5. Scalability

Since the focus area of our program is education it must be scalable to handle a large number of users from various institutions.The database and the server must be able to handle large numbers of concurrent video calls.

2.2.6. Reliability

The program must detect motions accurately since mistakenly detecting a hand raise can interrupt the flow of the class. Similarly, missing a single one will affect satisfaction of the student.

References

[1] “Introduction to TensorFlow, [Online] Available: https://www.tensorflow.org/learn [Accessed Oct 10, 2020]

[2] “Flutter Documentation”, [Online] Available: https://flutter.dev/docs [Accessed Oct 10, 2020]

[3] “WebRTC”, [Online] Available: https://webrtc.org/getting-started/peer-connections [Accessed Oct 10, 2020]

[4] “MySQL Documentation”, [Online] Available: https://dev.mysql.com/doc/ [Accessed Oct 10, 2020]

[5] “Code of Ethics | National Society of Professional Engineers” Nspe.org, 2019, [Online] Available: Available: https://www.nspe.org/resources/ethics/code-ethics [Accessed Oct 10, 2020]