A Wearable Wireless Video/Audio Recording System for Live Streaming Undergraduate Engineering Labs

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***Abstract*—The current challenges our institutions are facing during the COVID-19 pandemic have required instructors and students alike to approach learning in ways we never have had too before. Some courses are built from the ground up with an online learning environment as the goal, but for the majority of courses that is not the case. They have had to adapt in major ways, and this has severely impacted instruction. That is where this affordable, wearable, wireless audio-visual streaming device comes in. The target application for this device is the laboratory, but any sort of remote learning can really benefit for it. It will be built to incorporate all the capabilities of its competitors on the market currently but manufactured for a fraction of the cost.**

I. INTRODUCTION

This project is about developing a wearable technology with its central purpose aiming to make teaching labs to students easy and efficient in a remote setting (device seen in Figure 1). This device will help record different kinds of presentations regardless of their time duration. This device will be worn by the TA or the lab instructor. It will include a lightweight camera which will make it easier for the user to carry it around. The camera will have tactile zoom functionality. Also, it is easy to integrate the camera to the microcontroller. The camera will be attached to a comfortable strap that will be worn on the user's forehead. The device will be specially built to be able to focus on the experimental apparatus. It will record the experiment with a sufficient video/audio output quality which will also help the students virtually present in labs. A wireless lapel microphone will be utilized in conjunction with the other components to offer increased audio quality and flexibility for the user. The students will be clearly able to see the experiment while it is in progress due to its sharp video quality feature. Furthermore, the audio capturing device will feature efficient noise cancellation technology that will help minimize any unwanted background noises. The device will be built so that it consumes minimal energy so that typical two-hour labs can be performed without any obstacles. This will make the device even more effective by not having to recharge it in the middle of a presentation. This device will also be able to zoom in/out and focus where the user wants it to. Using this feature, lab instructors will be able to aim attention on what they want to show the students. Also, this device is not going to be limited to lab purposes. Our budget goal was under $200 and it will cost just over $120.

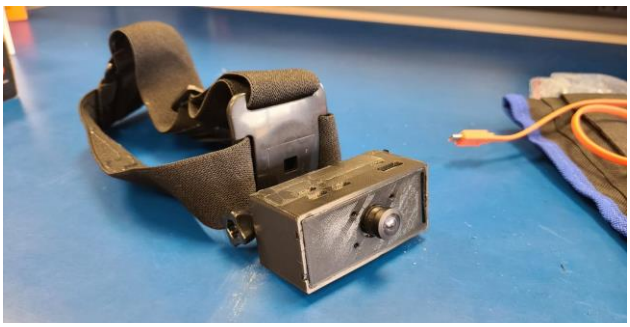

Figure 1: Completed Prototype

II. BACKGROUND

The current global pandemic has led to many challenges for today's society. People have been forced to isolate, unable to go to work and even being laid off. Schools have been forced to close leaving students unable to learn in a traditional fashion. Many schools have resorted to online learning to try and keep students engaged. This has led to the rise of live-streaming platforms such as Microsoft Teams, Zoom, and many others. With these platforms, teachers can engage with students and teach them to live. While this can be good for traditional lectures, problems arise with classes that rely on a more hands-on approach. With live-streaming platforms, students may not have the means to perform a project or lab at home, so they are forced to observe a professor. However, some classroom or lab settings lack the equipment to properly Livestream projects to students. That is, cameras are positioned so that students will be able to see exactly what the professor is doing.

III. PURPOSE

The purpose of this project is to provide professors an easier way to livestream their labs. This project will provide an inexpensive camera setup that can be worn or mounted by a professor to provide optimal viewing angles for students. With a worn camera, students will be able to see exactly what the professor sees, eliminating confusion about what is being

worked on. Block diagram of interconnected components can be viewed in Figure 2.

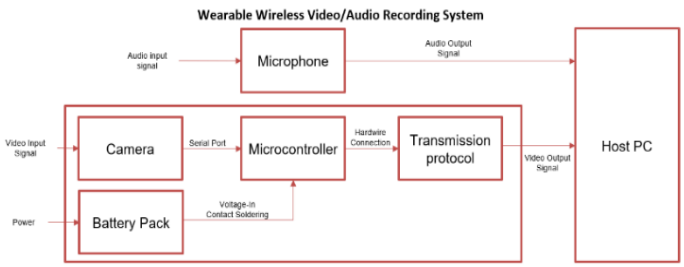

Figure 2: Level 1 Block Diagram

IV. DESIGN

A. MICROCONTROLLER: RASPBERRY PI ZERO W [1]

This MC (microcontroller) fits all the requirements of the device. It can interface with a camera through a dedicated serial port. The selected battery along with the integrated Wi-Fi and Bluetooth capability allows the device to operate completely wirelessly between charging sessions.

B. CAMERA: RASPBERRY PI CAMERA MODULE (G) W/ FISHEYE LENS [2]

This camera provides the desired quality for viewing streamed video through the internet, as well as a tactile zoom capability to allow the operator to manually change the zoom to improve the lab experience.

C. BATTERY: PI SUGAR [3]

The PiSugar was designed as a 3rd party accessory to the Pi Zero W to give the MC wireless operation capability through seamless integration. The matched form factor also allows for improved case design.

D. MICROPHONE: WIRELESS LAPEL MIC [4]

A simple wireless lapel mic offers flexibility and ease of use to the operator. The device has plug and play capability with any device that uses an audio microphone jack, but specifically for this design it will be connected to the same host PC as the camera.

V. CAPABILITIES

A. VIDEO

Device is able to comfortably achieve 720p at 30 frames per second. This video has been tested in the NIU lab setting and is clear enough to make out details in circuits as well as introductions by the lab professor.

B. AUDIO

Microphone provides 360° coverage within 160ft of open space. Operates in the 2.4 GHz band providing high stability, low interference, fast transmission, and short delay (20ms). Easy to use plug in play with any host PC equipped with an audio jack and USB port to supply power to the transmitter.

C. BATTERY

Rated at 1200mAH / 4.4Whr. Measured power draw of the device was 2.2W with WiFi connected and camera stream running. This equates to a 2hr operation time of the device due to battery capacity.

D. CONNECTIVITY

The device can either operate in a fully wireless state utilizing the integrated WiFi and battery pack, or in USB mode which offers higher quality audio in areas where network quality is not as reliable. These modes can easily switch by utilizing the interchangeable SD cards labeled for each build.

Conclusion

In the current pandemic, in person lectures and labs needed to be moved to fully remote just as most of the industry experienced. This project will provide a device that will solve this problem, designed by students within the department. This device is designed with the internet of live streaming labs so students can still receive a lab experience while attending virtually.

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