Abstract—We developed a lightweight, easy-to-use and smart unit to be attached to military combat helmets and provide comprehensive information about the battlefield for military personnel in real time. The device takes advantage of 3 MEMs microphones placed in specific spots to maximize operations of the system. When detection of a shot is registered the system locates the angle relative to the soldier position. An LED in the array will light up the section where the shot originated from, this provides vital information to our troops in combat situations and is the key to their success. A battlespace 360-degree image is taken with four CMOS cameras located around the housing; these images will be available for intelligence review for further operations. All information is routed to the Raspberry-Pi with a Graphical User Interface for information. This device is meant to assist in combat operations in many climates and situations for our Military.

I. INTRODUCTION

In the modern environment, there is no telling where dangers can come from. This can affect the modern soldier in numerous ways while on deployment. There are many stresses and conditions that harm the efficiency and morale of our soldiers. The Smart Combat Helmets’ goal is to reduce mortality rates and increase the effectiveness of our forces when deployed.

This device will be thin, lightweight, and meant to attach easily over existing helmets currently used in the military. One key characteristic of this device is to keep it simple so it can effectively operate in multiple environments. Keeping the unit simple allows ease of production and minimal implications that can arise in combat situations. This is meant to assist troops in combat while being unobtrusive enough that they will never be bothered by the unit. This has led to the design shown in Fig 1. The high profile allows the soldier a full view of the battlespace and provides assistance when needed.

The frame allows the cables to run through to the back of the unit. This is where the Raspberry-Pi is stored and protected. The inside portion of the frame is curved to sit properly on the helmet. The unit opens by pulling the pin seen on Fig 1. and Fig 2. Once it’s pulled, the helmet has a hinge that allows the cables to pass through while being protected from the outside elements. This also allows the user to take off the unit without damaging anything.

The key feature is sound localization, the entire system works based on the frequency of the sound a travelling bullet makes. Enemy shots can be identified by their frequency and their location will be shown by a single LED in the general direction of the shot’s origin. The system relays the analog signal output to the Raspberry-Pi to evaluate the frequency response between each MEMs microphone. Using this information, an angle is determined followed by an LED that points to the shot’s origin.

The unit has four cameras around the device, each placed in a certain position to provide a 360 degree view. Each is stored inside the housing with open ports as seen in Fig 1. and Fig 2. Having a wide field of view camera system allows documentation of positions and locations for future advancements in zones of operations. The system operates when a shot is detected, the camera array will start. Each camera will take a photo of the battlespace. As shots are detected the cameras will activate while storing all the data.

With more knowledge of combat situations, the Smart Combat Helmet will be modified and changed over time. This device will also change with the evolving military forces’ needs as well as adhere to all regulations provided by the Department of Defense.
II. METHOD AND MATERIALS

A. Prototype Design

The Prototype design can be determined from the above Fig. 4. The sound is an impulse response which the MEMS microphones will pick up and send to the Raspberry Pi. The Raspberry Pi will convert the digital signal to an analog output and determine which microphones have the best two impulse responses. This analog information will be submitted to the noise localization coding and used to calculate the last angle of the triangulation theorem. With this computed, the program modules will split into two functions. The cameras will activate and capture the surrounding area and store the images into a folder that can later be extracted by the user to further examine the battlefield scenario. The other part of the program module will relay the localization coding into the Degree of Freedom program which will designate a specific LED to light up corresponding to the calculated angle.

B. Raspberry-Pi Interface

The Raspberry-Pi is the main component of this system. This device is used as a Graphical User Interface that allows for many applications to be used simultaneously. For this interface, it is used to store images that the CMOS cameras have taken into a specific file that can be extracted for further investigation. The program that is used to save all coding aspects of this system is called “Thonny”, a Python Integrated Development Environment. This IDE allows the user to create the coding required to translate the digital signal for the rest of the program to understand the syntax.

III. Results

Using recordings of various bullets passing, frequencies corresponding to different bullet calibers were found by running the recordings through a spectrum analyzer.

IV. RESULTS

The resulting graphs are shown below in Fig 5:

![Fig 5. Passing Bullet Spectrographs](image)

From these graphs, it is shown that each caliber has distinct acoustic behavior and a maximum frequency. These differences can be used to identify specific bullet calibers and types of weapons. Using this information, friendly and hostile elements can be distinguished, and an estimate of armed hostiles present can be found.

Using an IVMech multiplexer board, it was possible to run 4 cameras using the Raspberry-Pi. Shown in Fig 6. are images taken using the 4 cameras. Images saved by the device can be used to get more detailed information when reviewing battle data that can be helpful in the future.

![Fig 6. Multiplexed Camera Images](image)

V. DISCUSSION

As this system is currently completed for phase one, it can be further improved by implementing more technological devices to increase the capability of this system. Such implementations can include: an LED Screen displaying the information of the position, a geographical coordinate system and design of a custom PCB board to accommodate all components necessary.

VI. CONCLUSION

Upon completion of the system, this device will help soldiers in combat to increase survivability ratings and better evaluation of the battlespace after image extraction. Ultimately, this device should be used as an assist and is meant to be out of the way when not needed.

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VII. REFERENCES
