**Infrared Thermal Temp. Sens.**

Senior Design

Project Planning Paper

Group: Shocking Engineers

9/24/2021

**Sections 1:**

Our team consists of two electrical engineers, one computer engineer, and one computer science engineer. With this in mind, our team skills analysis is very well rounded. Based off the excel sheet, we are mainly in the “basic/ want to learn categories”. For the software section our team is about 50% basic and 50% wants to learn. Moving on to the electrical section, all members of our group have a basic understanding of the devices and some have intermediate knowledge about them. For the computing section our team is split up 50-50. The two computer engineers have a basic knowledge and the two electrical engineers want to learn. For the rest of the sections (general, engr. Develop., conduct research, and project mgmt.) our team ranges from “basic” to “advanced”, except for a few “want to learn” in the general section.  Moving onto the physical devices, our group has a good spread and at least one person has used them, except for a logic analyzer, point-to-point, PCB design, and PCB manufacture.

For our infrared thermal door frame, our team is the perfect fit. For the programming of the infrared thermal camera and Raspberry Pi we have Peter who can code in python and C++ and Shaima who has experience working with infrared cameras. For the electrical side we have Adrian and Lexi who have experience with electrical components, I/O’s, wiring, and power sources.

We can all help contribute to the mechanical side of building the project around a door frame or a prototype. Overall, we work good with each other, are eager to learn from each other, and learn new skillsets that this project requires to get it up and running.

**Section 2: Legal and Ethical Analysis**

        Infrared thermal camera (ITC) can be very helpful if they are properly used. Similar to other engineering developments, the infrared thermal camera can be misused if the users are unfamiliar with the product. Due to the COVID-19 global pandemic the improper use of thermal imaging systems may lead to inaccurate body temperature measurements which can present potentially serious public health risks. Such risks may include, but are not limited to, the device incorrectly detecting a normal human body temperature when a person has an elevated temperature and incorrectly assessing a person to have an elevated body temperature when they do not. With COVID-19, one of the first signs of being infected with the virus is having an elevated temperature. If the infrared thermal camera doesn’t detect a high temperature when it needs to, it could potentially let an infected person into an area with people who are uninfected. Therefore, causing the virus to spread and getting more people sick. The possibilities of misreading’s increase if the infrared thermal camera is used to scans multiple individuals simultaneously.

        Some easy ways the infrared thermal camera misread and be misused is if the distance away from the forehead is too close or too far away. Environmental factors like the wind and sun can come into play as well. There are some reports of the ITC not being at a proper angle causing the system to have incorrect readings. Some of the infrared thermal cameras come with warnings of using it is relative humidity that’s higher than 85%. They also advise to try and wait 30 minutes after exercising, bathing, or spending time outside before get temperature read. Some even say to recalibrate when using on individuals with different skin tones.

        To help mitigate the risks, the FDA is providing important recommendations in the safety communication to consumers, health care providers and other users about the proper and improper use of these systems. The biggest recommendation is to measure only one person’s temperature at a time. To date, these systems have not been shown to be effective or accurate when used to take the temperature of multiple people at the same time. Other recommendations from the FDA include allowing a person’s skin to have enough time to adjust back to normal from being affected by the environmental factors, the person should not be wearing a hat or glasses and their hair should be pulled back away from their face. Thermal imaging should not be used near strong light sources, such as sunlight or bright electric lightning. They should also be kept in an area that status between 68-76° F. The FDA also recommends to not have it facing anything that can reflect lights such as windows, mirrors, or shiny surfaces.

        LETA, Law Enforcement Thermographers’ association, states that if a thermal camera system is being used in law enforcement that you must have it certified. There are currently two levels of certification; Basic and Instructor. The purpose of training is to standardize law enforcement thermography in accordance with current federal, state, and local laws.  There are twelve standards and protocols in law enforcement application. For general surveillance there is search and rescue, fugitive searches, vehicle pursuits, flight safety, marine and ground surveillance, perimeter surveillance, and officer safety. For specialized surveillance there is structure profiles, disturbed surface scenario, environmental law enforcement, vehicle compartments/profiles, and accident investigations/skid marks. As long as we do not try and use the infrared thermal camera in a law enforcement environment we should not have to worry about breaking a law.

**SECTION 3:**

The focus of section three is to identify major milestones and deliverables necessary for the completion of this project. The project milestones for the first semester of work will mainly consist of important planning and management. Project planning will consist of knowing the necessary tasks needed to be completed each week/s to move forward. Management will consist of keeping the project on task and spending available time to work on the project as a team correctly.

**Individual Contribution**

This consists of team members completing their class and team project objectives/assignments prior to each due date in order for the team to function fluidly.

**Research**

Research will consist of identifying and understanding necessary components to complete the project. Research ethical and moral issues, situations, and problems that might arise from the completion of this project.

* Rasberry Pi
* Thermal Camera
* Power Source
* Ethical Problems
* Legal Issues
* LED’s
* Programable Digital Display

**Technical Feasibility and Applications**

Research and work must be done to produce a viable reason for this project. What is different than other products? Cheaper, easy to install, widely available, etc. Functionable? Research and testing will need to be conducted to determine the feasibility of the product.

**Service Learning**

Group members will need to decide the best applicant for possible approval of service learning. First step after that is to produce a project proposal for that applicant.

**Project Presentation**

Group members will need to clearly identify their goals and roles for this project. The group will need to produce a precise presentation of the research and documentation already completed and each group member will need to know their roles during presentation time.

**Section 4:**

Project success is accomplished if these following goals are accomplished and held true.

1. Stick to Timeline
2. Maintain Budget
3. Maintain Quality
4. Effective Delivery

Following an effective timeline for the project in terms of, research, development, assignments, meetings, etc. is extremely vital to a project. A major our team has is to produce a product within an affordable price range. Sticking to strict project important but can affect quality and delivery. These things must be considered.

An important goal in terms of the product is to maintain quality. The product may work but not affectively. Quality may be good, but value is high and user friendliness lacks. All things must be balanced. The last goal is to perform and affect final delivery of the product. This can only be accomplished if all other goals are met.

**Section 5:**

**The Project Architecture: Build and Construction/Implementation/Testing**

|  |  |
| --- | --- |
| **project architecture** | **Description of project architecture** |
| Infrared Thermal Camera  Adafruit MLX90640 | * This camera will be used to measure body temperature it ccontains24x32 array of IR thermal sensor and it * It will return an array of 768 individual infrared temperature readings over 12C * It has 2 versions, a narrow 55°x35° field of view and have a version with a wider 110°x70° field of view, based on the test result the team will pick the version with the better accuracy readings. * This part will measure temperatures ranging from -40°C to 300°C with an accuracy of +- 2°C (in the 0-100°C range) and after testing the team will check the accuracy of readings. |
| **STEMMA QT** connectors **STEMMA QT** connectors | Used for easy to plug-n-play various sensors and devices without a lot of wiring. |
| QT Raspberry Pi | Raspberry pi will be programmed to get the result back from the thermal camera and control the LED lights to inform the user about the temperature. it is engaged with graphical user interface library. |
| LED lights | * LED lights will be in three colors. Red light will inform the user if the temperature is within the normal range which is between 97 F (36.1C) and 99 F (37.2 C) * Green light will inform the user that the temperature is in the normal body temperature range. * Red light will inform the user that the temperature is not in the normal body temperature range. * Yellow light will be on in other cases such as if the thermal camera cannot measure a because of foreign object covers the body. |
| Alarm | Integration thermal camera with an alarm. Alarm sound will be used if the thermal camera detected high body temperature, it would continue to sound until the thermal camera detects normal temperature. |

**Bill Of Material**

|  |  |  |  |
| --- | --- | --- | --- |
| product | Quantity | Unit Cost | Total Cost |
| Infrared Thermal Camera  Adafruit MLX90640 | 1 | 65$ | 65$ |
| QT Raspberry Pi  3 B+ Motherboard | 1 | 69$ | 69$ |
| LED array | 1 | 29.95$ | 29.95$ |
| QT connectors | 2 | 0.95$ | $1.90 |
| FT232H USB C to QT PCB | 1 | $14.95 | $14.95 |

**Section 6:**

The inspiration of this project came with the global situation that we all are currently in. A number of places are tacking temperatures of population with non-contact thermometer before the person enters a premises. This project give cheap reliable way to measure temperature without human interaction to the public. This device will be an integration between hardware and software. Hardware of this device is infrared temperature screening that will be built in the door frame to detect and check the human body temperature. It will be connected to an indicator, such as LED lights, that will turn red, green, or yellow based on temperature measured from the scanner and alarm sound will be produced when a high body temperature is detected. Software is the programming of the Raspberry Pi, which is a powerful Single Board Computer (SBC). It can be used to do many sophisticated tasks.

**Section 7:**

The software development of the Infrared Thermal Doorframe will require knowledge of specific python libraries, Linux commands on the Raspberry Pi platform, and possibly knowledge of GIO pins and the Raspberry Pi as well. The team discussed that integration of all these technologies may require research, testing and redesign to ensure an effective prototype.

More specifically, the team has a member with python experience but will require time to learn the necessary Python library, CircuitPY. This learning is necessary for any testing with the MLX90640 infrared camera. This likely represents the most significant hurdle to software implementation. The same member also has experience with Linux operating system and should not pose a problem to product completion.

As such, the iterative development model will be the most appropriate for the software portion of this project. We have chosen this model as rapid software design, coding and prototyping can be done quickly and allows for learning for the design team with each iterative step.

**Section 8: Speculative Semester Schedule**

The planning project phase (Semester 1) will consist of multiple small software steps with the end goal of integration of all components.

First it will be necessary to establish a way of communicating between a Linux based operating system and the MLX90640 thermal camera (will be referred to as IR camera from now on) via the F232H USBC to STEMMA chip.

Second, research of the Adafruit Circuit Python library to perform basic commands and data extraction with the IR camera.

Third, before further implementation is completed, ensure fidelity and quantity of information from IR camera is sufficient to determine if a person’s forehead skin temperature is greater than 37.2 Celsius. Failure at this step will require redesign or project abandonment.

Fourth, migration of software from Linux PC to Linux running on Raspberry Pi with same IR camera functionality.

Fifth, software integration of Passive Infrared Sensor (PI) to detect when a person is standing in front of IR camera, or discussion if this step is unnecessary (could be completed by IR camera).

Sixth, discussion of end user signaling system. It will likely be necessary at times to remeasure the end user’s temperature if the data from the IR camera was insufficient. This must be indicated to the end user in some fashion. (The current discussion includes an array of different colored LED lights and/or display panel giving explicit instructions)

Seven, using programming from step 3, to design prototype, and test a program that outputs a simple ‘greater than’, ‘in range’, or below range(remeasure) signal depending on IR camera output.

Eight, implement software portion of signaling system based on the outputs discussed in step seven. (This should finish the prototype of the device)