

**2nd Semester Work Statement**

**Team Name:**

Shocking Engineers

**Members:**

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**Introduction/Purpose/Objective:**

Infrared Thermal Temperature Sensor is infrared body temperature scanning device that is used for fast screening of people one person at a time, and it is designed to check the temperatures of human body without human interaction. The unit can be installed in schools, educational institutions, court houses, government buildings, hospital, building entry checks and other areas where people go through body temperature check. This device will be utilized to measure and detect human body temperature. This device will consist of two parts. First, infrared temperature screening device that will be used detect and check the human body temperature and time of flight distance sensor to measure the distance of the body. Second, an indicator such as LED lights that will turn red, green, or yellow based on temperature measured from the scanner and LCD screen to give instruction to the user. The thermal camera will be used to scan and check the bodies temperature. It will be connected to a microcontroller such as a Raspberry pi. That will then be programmed to get the result back from the thermal camera. The same type of connection will be used for LED lights and time of flight distance sensor. The main goal out of this project is to develop an affordable device that could help in measuring body temperature without the need of any expensive thermal cameras or human interaction.

This work statement will outline the scope, location of work, tasks/requirements/deliverables, period of performance/schedule, and acceptance criteria of our Infrared Thermal Temperature Sensor project. The team members listed above are responsible for the design, development and testing of the project

**Scope:**

To complete this work statement, our team will be responsible for all planning, implementation, and testing for the device. Continuing from our first semester prototype, our team will focus on achieving the goals defined in the Tasks/Requirements/Deliverables section.

**Location of Work**

Majority of work done for this project will be dispersed to individuals and small teams based on skills, knowledge, and assets. The collaboration for the project is mainly done virtually unless necessary to meet in person at a location at WSU.

For majority of testing, data collection, and studies, we will be putting our project into action at EmberHope Youthville’s staffing facility. We will test our product on their staff and commence surveys of how our product did once they are done.

**Tasks & Requirements**

The following table displays the major second semester tasks and requirements necessary for the completion of the project.

|  |  |  |
| --- | --- | --- |
| **Task/Requirement** | **Description** | **Expected/Tentative Completion Dates** |
| Update Housing | Design of a new enclosure for our product. Will need to be modular, portable, and adaptable to many different situations. | ~~02/15/2022~~ |
| Partner Meeting | This will be the first meeting held without partners/sponsors to discuss first location and time for testing. | ~~02/21/2022 – 02/25/2022~~ |
| Survey | A survey will need to be completed for our partners to fill out after the end of the first testing period. | ~~03/06/2022~~ |
| ~~Testing Period 1~~ | ~~This will be the first testing period for the product~~ | ~~02/25/2022 – 03/13/2022~~ |
| Software Update | This will include any software/logic updates necessary to improve our product based off our partners surveys. | ~~03/13/2022~~ |
| Hardware Update | This will include any hardware updates/replacements necessary for the improvement of our product based off the first testing period.  Battery will not need to be 100% decided. Partners have expressed they would like to plug it in. One of our goals is to still power off a portable battery. Another added Hardware goal: Save power and protect components using a power switch/relay to turn off components when not being used. | ~~03/13/2022~~ |
| Housing Update 2.0 | An enclosure update will need to be completed for the liking of our partner and any other mechanical needs for the system.  Enclosure will need to be completed because of the necessary hardware changes.  (Switched to SolidWorks) | ~~03/13/2022~~ |
| ~~Partner Meeting 2.0~~ | ~~This meeting will commence to talk about the recent testing period and further discuss future testing periods~~ | ~~03/14/2022 – 03/18/2022~~ |
| ~~Testing Period 2~~ | ~~This will be the first testing period after an update has taken place to improve the field performance of the product~~ | ~~03/21/2022 – 03/25/2022~~ |
| Update Period  First Period Finished | ~~This period is the second update period for software and hardware. This includes the third redesign of product housing. The goal of this period is to prepare for final product testing based off the recent testing period survey.~~  All previous goals will need to be achieved before the beginning of April.  Test Period 1.0 will begin. | 03/28/2022 – 04/01/2022 |
| ~~Testing Period 3.0~~  Testing Period 2.0 | The final testing period for our device with our partners/sponsors EmberHope Youthville. | 04/04/2022 – 04/15/2022 |
| Update Period | Final update period before end of the semester. This period should include considering all pervious testing periods to tackle the weak links of our product in terms of software, hardware, and mechanics. | 04/16/2022 – 04/22/2022 |
| Final Sponsor Meeting | This meeting we will report the progress of our product to our sponsors and their usefulness. We will also discuss the need of our product with them and if they would consider our product. | 04/25/2022 |
| End of Semester Goal | This time will act a stopping point and time by which all previous goals should be accomplished if necessary.  A goal of having a working product in which our partners can use is desired by this time. All updated hardware and software goals need to be finalized. If necessary, a second testing period can occur if time permits. | 05/01/2022 |
| Report out | The final period of our semester will focus on the finalization of our product based on its acceptance criteria and needs of implantation in the field. All documents necessary for the completion of the project will be discussed, drafted, and turned in. | ~~04/23/2022 – 05/06/2022~~  04/23/2022 – Final Due Dates |

**Work Performance**

Our groups work schedule can be seen listed above in the previous section. Our plan as a group is to meet once or twice a week and discuss the weekly assignments. As well as inform each other on our progress and improvements that we completed during the times we were not together. Our main concern for this upcoming semester is being able to get lots of testing done with our service learning partners. As listed above, we will also have to make some minor changes to the program on the raspberry pi and some physical components for the products housing. From the testing we can make the necessary changes to make our product the best with our combined abilities.

**Acceptance Criteria**

Validation of our product will occur in 3 steps. First, we must validate that the device can accurately measure core temperatures from 0.25 meters to 0.75 meters.

Next, we must verify that the device can work reliably, without intervention, in the work environment it is intended to be used in. More specifically, we need to show that the device can function on a battery in a climate-controlled environment for at least 6 hours.

Second, we must make sure and that the person having their temperature measured understands that they have had their temperature taken and if they have a fever or not. They also need to know if the device is unable to take their temperature for any reason or if they need to move closer to the device for a temperature to be taken. (Fever is defined as a temperature of > 37.2 degrees Celsius.)

**Step 1: Temperature measurement validation**

The device will need to be tested on real human volunteers. We will accomplish this by first utilizing our own group members. First, we will verify our own temperature with an FDA approved contactless thermal monitor. Then we will measure our temperature with our device. If both our device and the FDA approved device are within a tolerance +-0.5 Celsius the mean of each respective data set should approach each other. Specifically after 25 measurements the variation between the mean of both data sets should be +-0.05 as it relates to the standard error = 0.25/(sqrt (25)). This will require multiple measurement sets from different ranges from the device.

**Step 2: Environment validation**

This will be tested by our group members by mounting the device in our respective homes and allowing the device to operate 6 hours continuously with intermittent temperature checks dispersed during its continuous operation. Given the nature of where the device will be placed in our sponsor’s work environment, we feel our climate-controlled houses will provide an adequate analog of the final placement environment.

**Step 3: User Interface validation**

The device will display messages on the 4-inch LCD screen. The messages will indicate one of 4 items: Person has a fever, Person does not have a fever, Person is to far away from sensor and needs to move forward and face camera, and finally, if the device is unable to take temperature. We will first test our messaging system among our own group members for basic validation. Then we hope to deploy our device at our sponsor Emberhope Youthville for further feedback on the messaging system. We will obtain feedback on the device by creating a voluntary, anonymous survey form with questions regarding the user experience. We will not collect any electronic data. We will then use this feedback to make appropriate changes to the messages or software.

**Environment Testing**

* Verify that the camera is in calibration. This can be done by standing a specific known distance (a distance you know captures a person’s forehead easily) and seeing what it captures. From looking at your results you should be able to determine if the camera is in or out of calibration. If it is out of calibration you will need to reference a heat source from a fixed distance to start the calibration process. Recalibration should also be done if it is dropped or if extreme temperatures are measured, like boiling or freezing. It is also recommended that you calibrate your device every time you feel it’s a bit off.
* As of spring semester 2022, we have added facial recognition to improve this process and make our product much more capable, user friendly, and powerful.
* Verify that the camera will work after being exposed to extreme temperatures. You can verify this by first having your camera measure a known heat source, like a human’s forehead. You will then need to record that temperature that way you can compare it after exposing it to the extreme temperatures. Then take your camera and measure something extremely cold, like an ice pack or the inside of a deep freeze. Once again have your camera measure your known heat source and compare the tow values to see if the camera is still properly working. You can then do this same process with an extreme heat source like boiling water.
* To ensure that the camera works to the best of its ability, you must keep it away from strong light sources. This can be considered direct sunlight, mirrors, glass, or other shiny surfaces. To avoid doing this you will need to place your camera in a room that has no shiny surfaces to minimize reflected infrared radiation. It is also recommended that you avoid incandescent, halogen and quartz tungsten halogen light bulbs.
* The room temperature your camera is placed in will also affect its performance. To achieve peak performance the room temperature should be 68-76 °F and relative humidity 10-50%. The room should also have no draft (movement of air) and away from radiant heat. For example, portable heaters, fans, or open windows. If temperatures outside are cold or hot this can affect a person’s forehead temperature. Exercise can also affect their temperature. Therefore, the room that the camera is placed should not be an entrance if you want the most accurate results.