ECE 492

Senior Design Project: Foot Doctor

Team Members:

1. Sawera Ashfaq
2. Edward Fleming
3. Yulieth Larobardiere
4. Zekarias Belachew
5. William Fields
6. Joseph Arthur

Faculty Supervisor:

- Dr. Nathaila Peixoto

Introduction

The Foot Health Scan aims to provide an advanced, sensor-based system that monitors and evaluates foot health by measuring key parameters such as pulse rate, oxygen saturation, humidity/moisture levels on the foot, fungal infection risk, and toenail length. The system integrates various sensors and image processing techniques to collect and analyze data, transmitting results to a web application for real-time monitoring. This project seeks to offer a non-invasive, efficient, and practical tool for users to maintain foot hygiene and detect potential health risks early.

Project Timeline

January 24 - Project and Team Introduction

The project was introduced, outlining the objective of designing a foot health monitoring system. The team was assembled, and brainstorming sessions on potential product designs were held

January 31 - Project Finalization

The key components of the project, including functionalities, sensor requirements, and data processing methods, were discussed. The team members were assigned roles, and initial brainstorming sessions began.

Project development phases were reviewed, and responsibilities were officially assigned. The project signup form was submitted.

February 7 - February 21 - Research and Sensor Selection

Team members finalized the required functionalities and started researching suitable sensors and microcontrollers for implementation.

During this period, the team conducted research on:

- **Pulse Rate Measurement (Yulieth)**: Selection of the PulseSensor (Brand) sensor for detecting Pulse rate.
- **Oxygen Saturation (William)**: Use of the MAX30102 ppg sensor for monitoring oxygen saturation levels.
- **Humidity Monitoring (Zaka)**: HDC2010 humidity and temperature sensor for tracking foot moisture/humidity levels, that will also be used to predict fungal risk
- **Fungal Risk Detection (Joe)**: Development of an AI model for fungal infection prediction using data from Humidity and temperature sensors
- **Toenail Length Measurement (Edward)**: Nail length will be monitored using the pictures from the camera
- **Image Processing (Edward)**: Photos of the foot will be captured from both the top and bottom to assess overall condition. If feasible, Convolutional Neural Networks (CNNs) will be trained and utilized to detect fungal infections.

Team members selected the Raspberry Pi, ESP32, and Arduino Nano 33 BLE for data processing and wireless communication. A Web application was proposed to display real-time data and provide user feedback.

February 28 - Presentation & Reporting Development

The team began preparing documentation and compiling research findings. A framework for the final system was outlined, covering hardware conne ctions, data processing, and communication between the sensors and the Web application.

March 7 - Hardware & Software Integration

Prototyping efforts focused on:

- Connecting sensors to the microcontroller and testing their accuracy.
- Developing Python scripts for individual functionality, data collection and analysis.
- Designing/developing the Web app interface to display user results.

March 14 - Spring Break

No progress was scheduled during this time.

March 21 - Dry Run Presentation

A trial presentation will be conducted in class to demonstrate the project's progress. The team will present:

- **System Overview**: Explanation of how the project functions.
- **Sensor Functionality**: Explain the sensors chosen for the functionality.
- **Data Processing & AI Implementation**: Discussion on the integration of machine learning for fungal risk assessment.
- **Web Application Interface**: Introduce a possible website (if possible)

Final System Functionality

1. **Foot Placement**: The user places their foot in a sensor-equipped box.
2. **Sensor Activation**: A pressure or motion sensor detects the foot and starts data collection.
3. **Voice Prompt**: The system announces, “Scan in progress.”
4. **Data Collection**:
    - **Pulse Rate & Oxygen Saturation**: Recorded via a pulse oximeter sensor.
    - **Humidity & Temperature**: Monitored using moisture and temperature sensors.
    - **Fungal Risk Assessment**: AI model analyzes humidity and environmental factors.
    - **Toenail Length Analysis**: Camera captures images for length detection and overall foot condition.
5. **Data Transmission**: Results are processed and sent to the Web app.
6. **User Feedback**: The Web application displays foot health data and provides recommendations.

Project Design

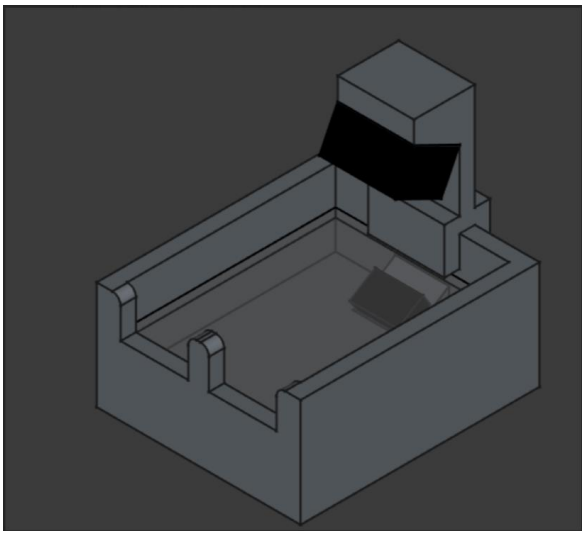

Figure 1- Foot Scanner – with two cameras

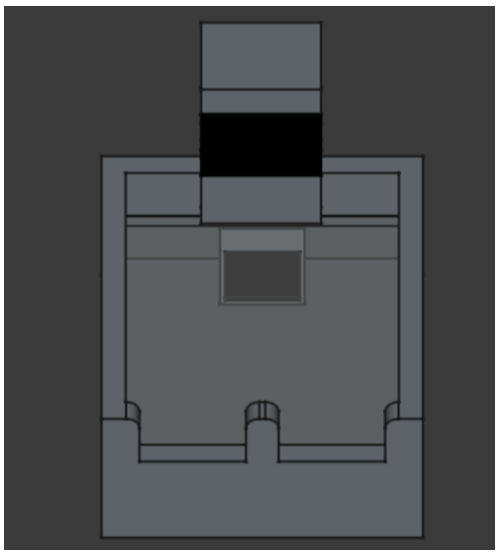

Figure 2- Foot Scanner (Top View)

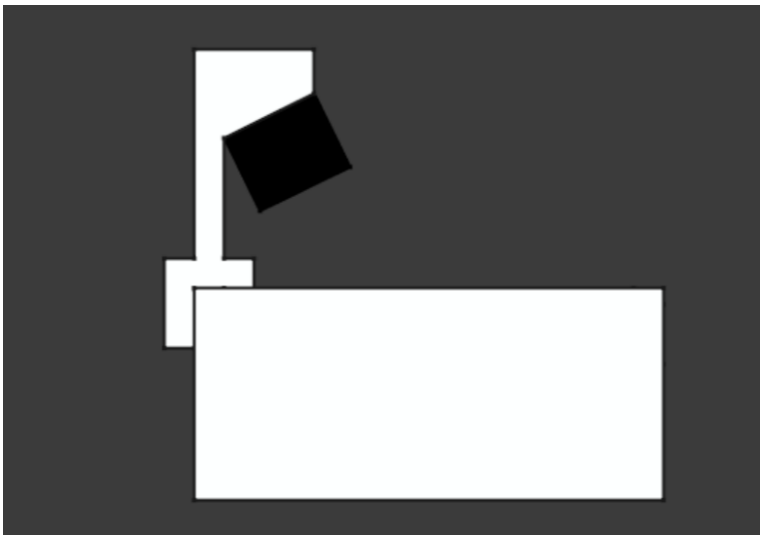

Figure 3- Foot Scanner (Side View)

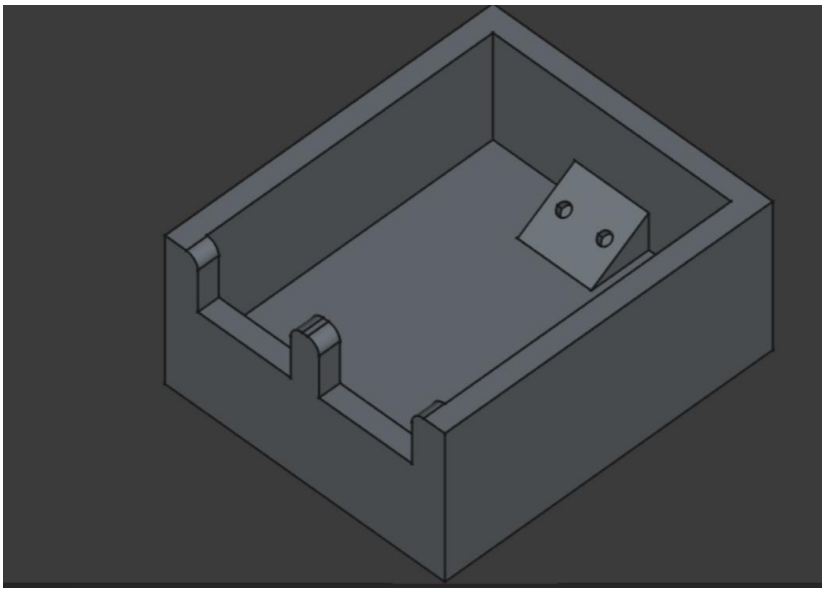

Figure 4- Bottom Panel without the Transparent plate