Embedded Software Development Project - SWE4740

Report on

Smart Health Tracker

Prepared By

Team - 12

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Introduction:

A smart health tracker for real time observation of human health that provides human health vitals.

Our health is the most important aspect of our life. Unfortunately, most of the time we ignore it pretending to be engaged in daily jobs throughout the months and years. This leads us to critical illnesses. It is often not feasible to remain continuously under basic checkups. A health tracker is a handy tool that provides information on the basic body metrics and keeps us informed about our health.

Motivation:

With the busy and hectic schedule that modern-day people have today, health is easily overlooked. And this reluctance may result in various short and long term health issues. It’s very important to always be reminded to exercise and to keep track of everything to avoid regretting at the end for not taking care of your health. By tracking our health, we will increase awareness about our current health status.

Getting regular checkups such as blood pressure, oxygen saturation, and body temperature can often serve as early signs of major diseases, yet we don't have them examined on a regular basis. If there’s something wrong with our heart rate or other vital signs, that can be easily monitored by health tracking. Heart rate monitoring nowadays has also become an essential feature because tracking our heart rate reflects cardiovascular endurance. Also, this feature measures our overall health over time.

Tracking our health regularly reduces the risks of developing chronic diseases in the long-term, such as arthritis, heart disease, and degenerative diseases, such as Alzheimer’s and Parkinson’s Disease.

During COVID pandemic, one of the fatal vital conditions one faces is the sudden drop in oxygen saturation. For a healthy individual, the normal SpO2 should be between 96% to 99%. We took this situation into consideration when we planned the health tracker. We're attempting to incorporate the important parts of one's health and to help them take necessary steps to take care of themselves. We wanted to make the process a little easier, so we didn't have to make a doctor's appointment to go through the basic checks, and some of our bad habits could at the very least be kept in check, if not completely avoided.

Social Impact:

A healthier lifestyle: We often desire to incorporate positive habits into our lifestyle but are unable to do so since it is difficult to break free from our busy lives. The health tracker contains a number of features that help us stop bad habits and start living a better lifestyle. Our system has the potential to play a key part in ensuring that we can maintain our health despite our hectic schedules.

Early Detection of Diseases: Health disorders generally begin as mild irregularities. Our health monitoring system can keep an eye out for these irregularities and send you early warnings, allowing you to intervene before things get out of hand.

Automatic measurement of Health readings: In case of any emergency the health readings need not to be measured manually rather the digital system will be providing the basic data.

Project Features:

We want to build a smart health tracker which will monitor the user's basic health condition. The ***key features*** of our project are:

- Measure **Heart rate** of user.
- Measure **Body temperature** of the user.
- Measure **Blood Pressure** of the user.
- Collect **Footstep and calorie burn** of the user.
- Provides the current state of the **humidity** of the environment.
- Provides the current state of the **temperature** of the environment.
- Measure SpO2, also known as **oxygen saturation** of body
  (Oxygen saturation (SpO2) is a measurement of how much oxygen your blood is carrying as a percentage of the maximum it could carry)

Using the temperature sensor, we can detect drastic changes in the body temperature, detect anomalies. Accelerometer can keep track of the amount of calories burnt in a specific time. The Pulse Oximeter and Heart rate sensor will keep track of the Heart rate and Oxygen saturation of the user’s body, which is very important during the COVID 19 pandemic. We can immediately be alerted in cases where a patient’s oxygen rate is decreasing and take steps accordingly. The DHT11 sensor to measure environment temperature & humidity will give us real time data on the weather so that the user can be conscious about water consumption and take necessary steps for preventing himself/herself from heat stroke, dehydration etc.

Apparatus and Sensors we proposed but couldn't use:

- **MAX30205**: MAX30205 is a temperature sensor to measure body temperature of a user. Unfortunately, we could not find the sensor in tinkercad or proteus.
    - **Alternative:** Instead of MAX30205, we used **LM35** which is also a sensor for measuring body temperature.
- **ADXL 335 accelerometer**: For measuring acceleration that will be used in footsteps/ calorie burn calculation. We could not find the accelerometer in tinkercad or proteus.
    - **Alternative:** We implemented the exact functionality of the accelerometer. For this, we had to rigorously study about the sensor and noted the working process of it and accordingly implemented it using **3 potentiometers** representing acceleration in x, y and z axis respectively. 100 values of each direction is gathered from the sensor from which the average value is taken as acceleration in each direction. The resultant acceleration of 3 axes is calculated which is considered as the ultimate acceleration.
- **MAX30102**: High Sensitivity Pulse Oximeter and heart rate sensor to measure the SpO2 and heart rate.
    - **Alternative:** Because we could not find any oximeter sensor, we ended up using a **potentiometer** as a MAX30102**.**

- **Arduino UNO**: microcontroller board.

    - **Alternative:** Because the number of pins of arduino uno is very limited, we had to shift to **Arduino Mega**.

Apparatus and Sensors we used:

- **Heart Beat Sensor 2:** This **heart beat sensor** consists of 4 pins. GND indicates ground connection. VCC is for power connection. Out pin sends the sensor value to the arduino. Test pin connects with a potentiometer so that we can modify the heart beat value accordingly.

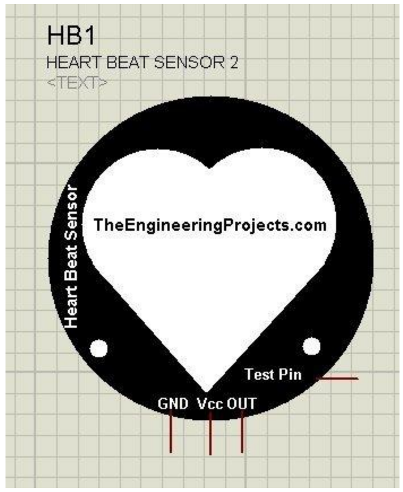


Fig: Heart Beat Sensor 2

- **LM35:** The LM35 sensor is a **body temperature** measuring sensor which has 3 pins. One VCC pin that connects to power, one GND pin that connects with ground and the output pin that sends sensor data to the arduino.

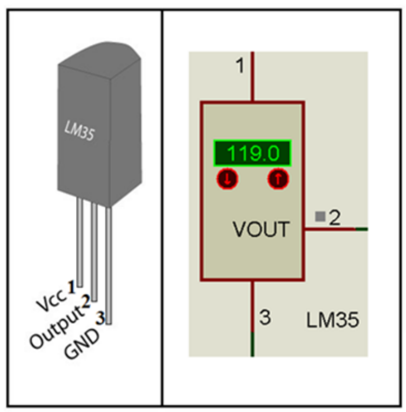


Fig: LM35

- **DHT11:** DHT11 is a sensor to measure **temperature and humidity of the environment**. The sensor contains 3 pins including GND as ground, VDD as power and Data as the pins for sending value to the arduino. The upper value is the humidity and temperature is just below the humidity value.

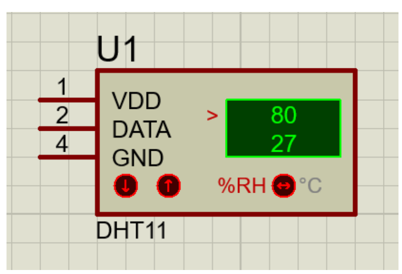


Fig: DHT11

- **MPX4115:** MPX4115 is a pressure measuring sensor consisting of 6 pins. We used it as a **blood pressure** measuring sensor. We have used the first pin for data transmission to arduino, the second one for ground connection and third one for power supply. The rest three pins are kept connectionless.

  The obtained pressure value is considered as diastolic pressure after converting it to pascal unit from atmospheric data. From the diastolic pressure we calculated the systolic pressure based on the research work “Blood Pressure Profiles Among Makerere University Undergraduate Students”.

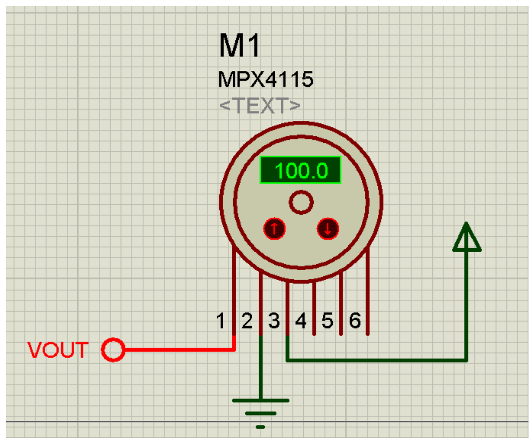


Fig: MPX4115

- **Arduino Mega:** Arduino mega contains 54 digital pins and 16 analog pins apart from a reset pin, power pin (GCC) and ground pin (GND).

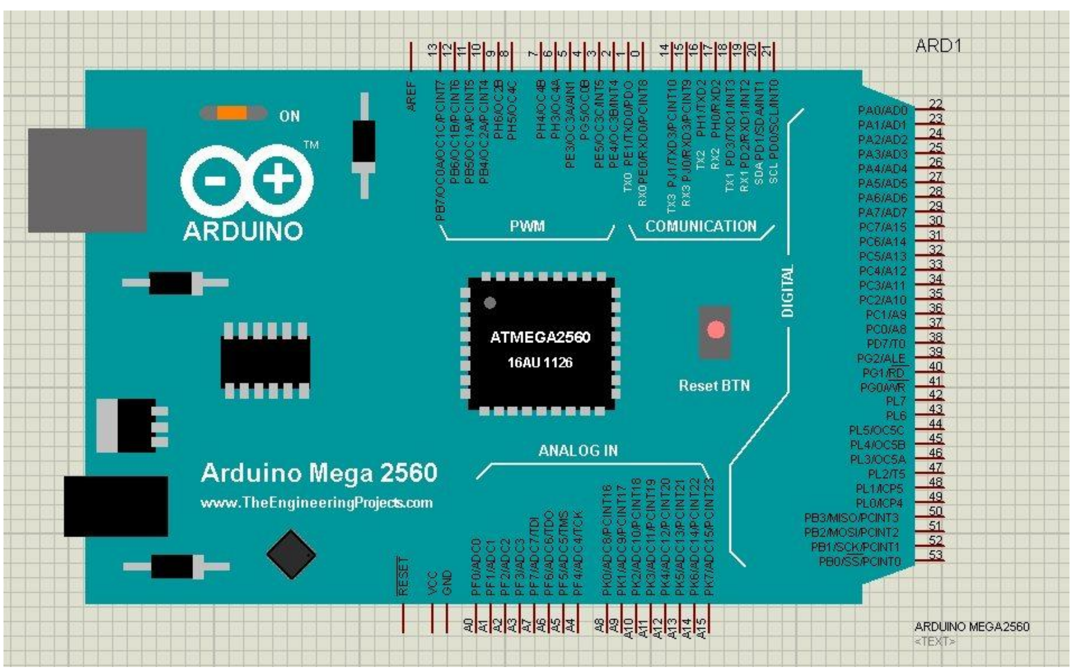


Fig: Arduino Mega

- **DC Voltmeter:** The voltmeter is used for **measuring potential difference** between two places. The voltmeter is mostly used for checking the appropriateness of our connections.

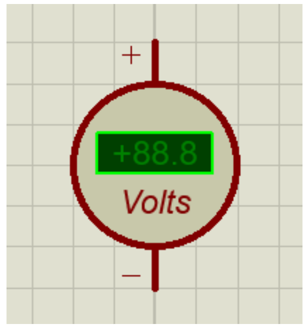


Fig: DC Voltmeter

- **POT-HG:** POT-HG is a **potentiometer** which we have used to regulate the value of the sensors. It has 3 pins: one is for ground connection, another for power supply and the last one to regulate the value.

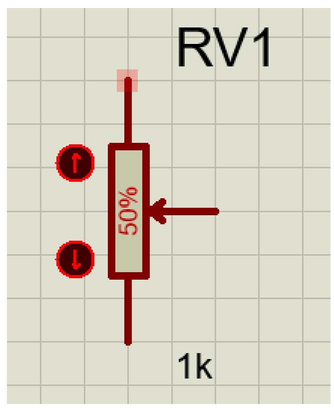


Fig: POT-HG

- **LM018L:** It is a **(40 X 2) alphanumeric LCD display** that is used to show the output to the user. It has a total of 14 pins.
    - Pin number1 is the Ground and will be connected with the Arduino's Ground.
    - Pin number 2 is the VDD and will be connected with the Arduino's 5 volts.
    - Pin number 3 the contrast pin, this pin will be connected with the potentiometer. The LCD contrast can be then controlled using a potentiometer.
    - Pin number 4 is the RS which stands for register select. It can be set to 0 or 1. 0 is equal to an instruction input. 1 is equal to data input.
    - Pin number 5 is the read or write pin of the LCD. It can be set to 0 or 1. 0 means Write to an LCD module and 1 means Read from the LCD module. Most commonly we use 0, as we print text and sensor values on the LCD. For this, we simply connect this pin with the ground, as ground means 0.

- Pin number 6 is the enable pin.
- Pin number 7 to 14 are the data pins which are also represented by D0 TO D7. SO Pin number 7 = D0, Pin number 8 = D1, Pin number 9 = D2 and so on up to pin number 14 which is D7. To reduce the wiring we will be using this LCD in a 4-bit configuration, so out of these 8 pins, we will be using only 4 pins D4 to D7.

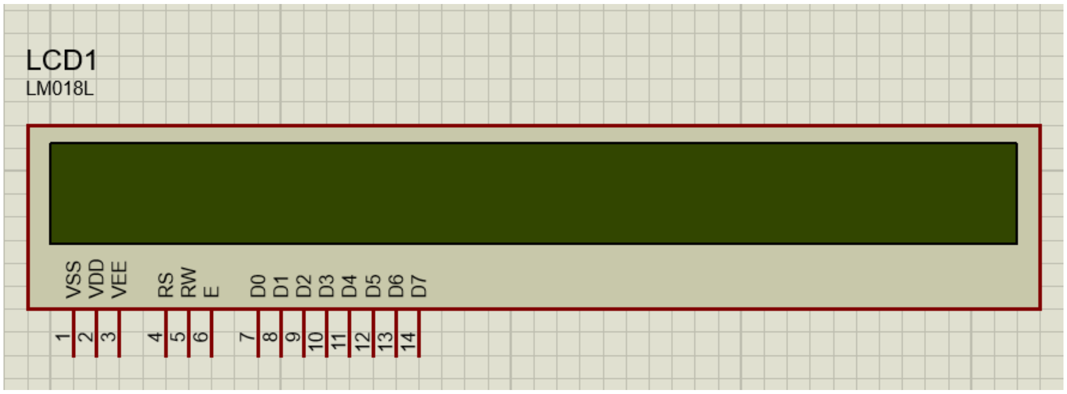


Fig: LM018L (40 X 2) Alphanumeric LCD Display

- **Switch:** A switch implementation is used to turn off and on the device.

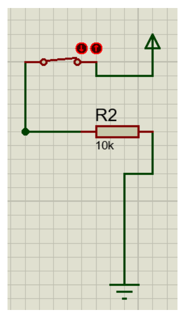


Fig: Switch

- **Resistors:** Necessary resistors are used in the project wherever we are required to increase resistance.

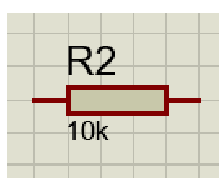
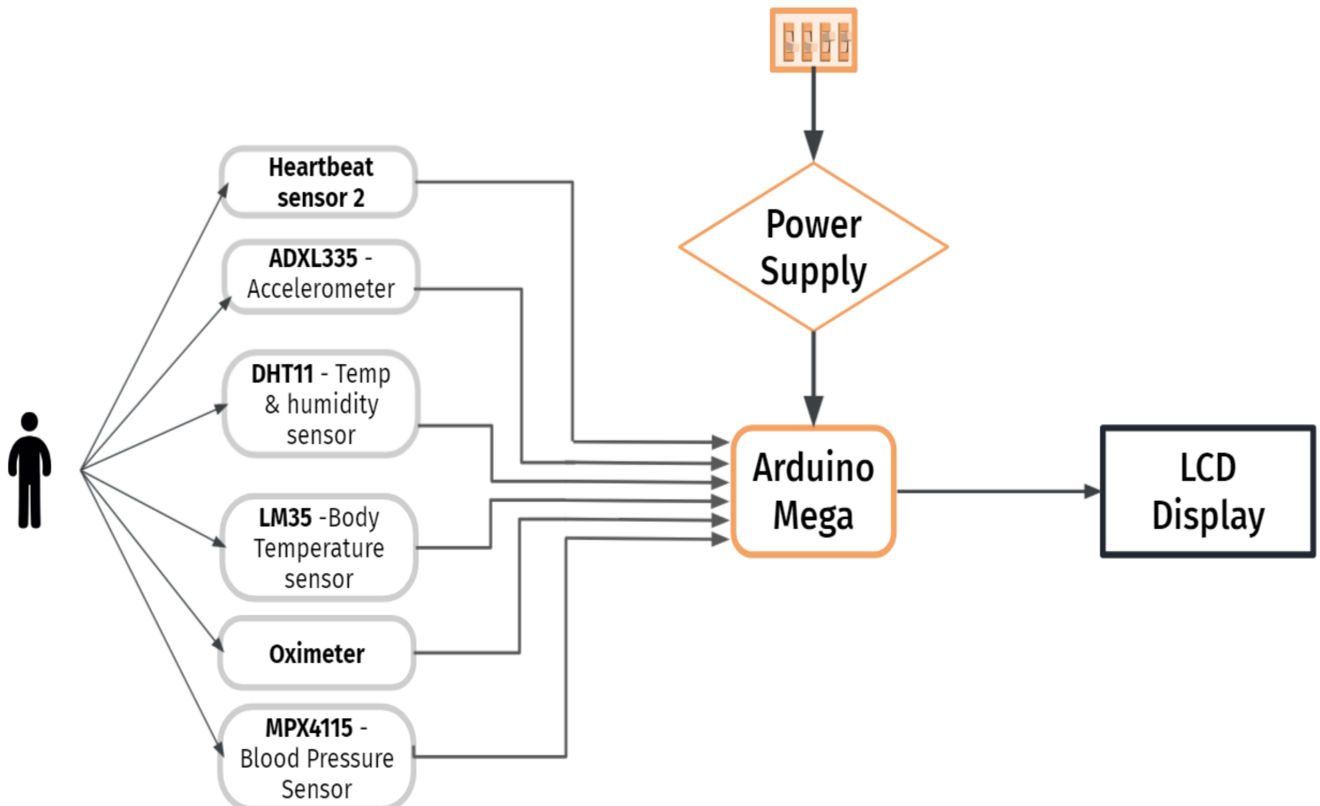


Fig: Resistor

Workflow with Observation:



- The users can turn on the on/off switch of the tracker based on their need. Switching on will result in activating the device by providing power supply and switching off will stop all its functionalities by removing power supply.
- After the power supply is provided, the Heart Beat Sensor (Heart Beat Sensor 2) will measure the heart beat value of the user. The value is then transmitted to arduino which makes the LCD display active to show the heart beat or pulse rate of the user.
- The accelerometer will count the steps of the user while walking and based on this step count it calculates the approximate calorie burnt by the user. A threshold value of 200 is considered. Acceleration above this value is a step otherwise the movement was a normal movement and thus no step is added. For each step generally 0.4 calorie is used on average. So multiplying step cunt with 0.4 will provide the total calorie used by the user.
- Temperature and humidity sensor (DHT11) will get the environment temperature and humidity and inform it to the user by presenting the value to the LCD.

- The body temperature of the user is monitored by the body temperature sensor (LM35). The value is shown in the display on a celsius scale.

- Blood pressure is a vital indicator as the drastic change of it often results in strokes. The pressure sensor (MPX4115) will measure the blood pressure and display it.

- Lastly, the oximeter sensor will compute the oxygen saturation of the body and show the value in percentage. This is a must-needed feature in this pandemic tenure.

- The sensors collect the data from the human body and send it to arduino. After required calculations the arduino presents the health metrics to the display.

Our Challenges:

- **Getting accustomed with proteus:** Proteus was new to us when we started our project. We were familiar with tinkercad but because of the absence of most of the sensors we had to shift to proteus. At the beginning it took a time to get used to proteus.
- **Finding appropriate sensors:** We could not find all our enlisted sensors in proteus as well. We have used some alternate sensors that work similarly. Finding all our necessary sensors was a challenge for us.
- **Study the possible alternatives for missing any sensor in proteus:** For some sensors we could find some alternate sensors that work similarly. But for some features we could not find any alternate sensors as well. We studied rigorously about the working process of those sensors and tried to implement them as appropriately as possible.
- **Learning sensors and components:** FInding the sensors is not everything, rather a huge effort is necessary to understand how the sensor works and the work of each pin of it. Additionally, the code of the sensor library needs to be studied for the implementation.
- **Learning arduino and sensor libraries:** For coding purposes, we had to go through the library codes and understand the functions the library has. Because of the difference of each library the coding functions also changed from library to library which made our work tougher.
- **Integration of the whole project:** Integration of all the features was a huge challenge. Maintaining the whole code base containing different libraries for different components to make the whole project work perfectly required a significant effort and time.

Our Limitations:

- **Missing sensors:** Because we could not find all our sensors, for some features we have used potentiometer. Although we have studied a lot regarding the working process of the sensor, it will obviously not be the same as that of the actual sensor.

- **Absence of hardware implementation:** In this pandemic period we were in different parts of the country and could not collect the necessary hardware as well. So, it was quite impossible for us to continue real hardware implementation of the project. The hardware implementation would have been more challenging and beneficial for real life usage.
- **Lacking some vital features:** We could have integrated more vital health features like ECG, blood sugar level, insulin level, cholesterol level etc. But because of our lack of knowledge and shortage of time we could not do so. Surely, integration of those features would have taken our project to the next level.

Future Work:

- In future we intend to work on hardware implementation of our project
- We plan to integrate as many features as we can in the future versions
- Discussing with the professionals of the medical sector we plan to set some alarms that will alert the individuals regarding any health issue.

Manual Link:

https://drive.google.com/file/d/1JVZXXu3EMoe7noSC8TpU9Q2mE1AYJXcb/view?usp=sharing