INDIAN INSTITUTE OF TECHNOLOGY, JODHPUR

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Engineering Design II

Group 3

Project: Cardi 3

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Motivation

- Old people face higher risk of having Cardiac issues. Many of them are the ones, who live alone unattended and have only themselves to rely on. Moreover, many of them are not comfortable with using technology. If by any chance of the occurrence of chest pain, they are away from their mobile phones, there might not be any possible way for them to call for help which might lead to something even worse than what we expect. So, Our major motivation is to make a device simple to use and can help to contact the helpline in case of emergency.

- Doctors, in general, have to go through an NGO-graphic and bypass surgery in cases of cardiac arrest. This results in the waste of a golden hour of surgery which might cost another life. Our device will make it easier for the doctor to monitor and operate on the patient's condition.

Ideation and project planning (as done in 1st semester)

To make a device similar to a watch that helps us detect the pulse of the user and in case of any abnormal behaviour, the user can directly send a message to the emergency helpline number.

We plan to use to use :

- Pulse rate sensor: keeps track of changes
- Circuitry: acting as an indicator, and is responsible for taking and sending signals
- GSM Shield: that handles the communication process.
- Codes: For making hardware parts work and to calibrate the output of the sensor.
- Sim card: A sim card compatible with GSM shield.
- Online platforms like arduino ide for coding and connecting to our embedded hardware.

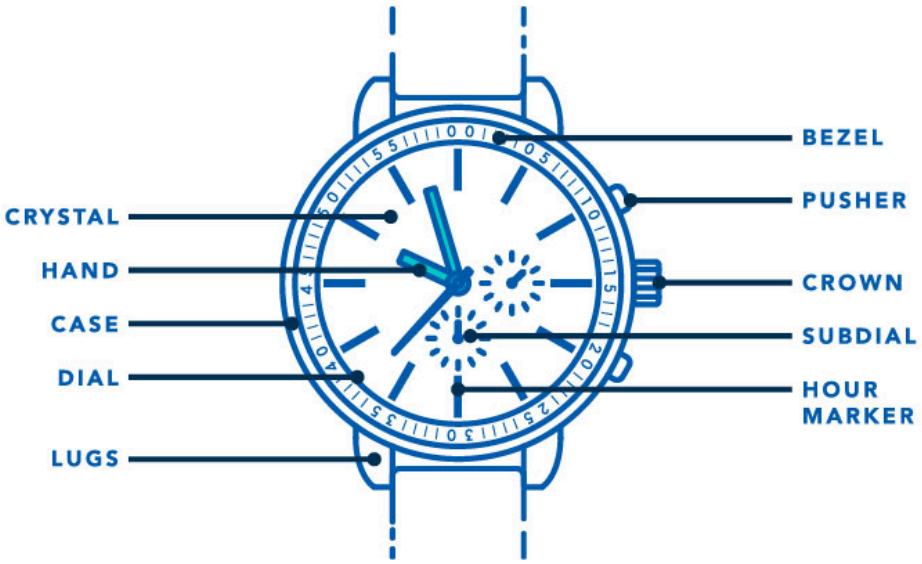
Work Description of ED2

1. Plan the design of the watch (so that it becomes a user-friendly model).
2. Modify the code to replace arduino with IC (possibly Photonic Integrated Circuit (PIC) or ATmega328) for appropriate size.
3. Work with the ESP8266 Download Tool.
4. Debug the code, and add fluctuations conditions.

Design Analysis

For the designing of our Cardi-3, general clock requirements and working were studied. It was noted that,

1. A battery, two pins, closing case, segment converter would be required.
2. The LED circuit needs to be powered similar to the light mechanism in digital watches.
3. The OLED display needs to be working similar to the display of a digital watch.



Clock components

The assembly of a wrist watch was studied to be

1. The entire set of crystal and microchips is set onto a circuit board. The board incorporates a space to hold the battery that supplies electricity to the quartz crystal and supplies the power for the led display.
2. The space on the battery is outside of the circuit facing the back of the case. The battery can be replaced by removing the back of the watch, shaking out the old one and dropping in the new battery.
3. The mechanism used for setting the watch involves two pins that extend beyond the case of the watch. One pin lets the counter circuit know which reading to reset - seconds, minutes, or hours. The second pin is pushed a number of times to bring the display of the desired reading.
4. The entire circuit board is placed along with the battery and closed into a case, and a wrist watch is attached.

The working of the hands of the clock need not be studied as per the requirement.

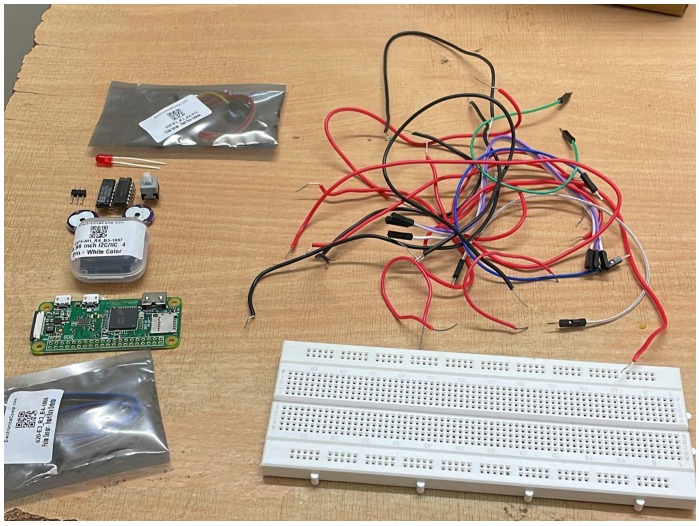
Conclusion was made to have the pulse sensor at the bottom, so that it is in direct physical contact to our wrist. The display needs to be at the top, covered by a glass case. And the cell and beetle can be placed in the middle. The push button and led can be placed towards the top to have input and output signals while the gsm and sim shall be connected towards the sides. Efforts were to be able to replace gsm with wireless connections but no suitable solution could be found.

The database connection was to be secured with the help of ESP 8266 and WifiClient libraries, to store the inputs on a regular basis so that they could be accessed later by the doctor, to check the general state of the patient. This extra feature was later discarded due to problems in the inbuilt required libraries.

The size of the product had to be at max of 30 mm width and powerable by a lithium ion cell. The important phone numbers (to contact) should already be stored in the code.

Modelling and simulation

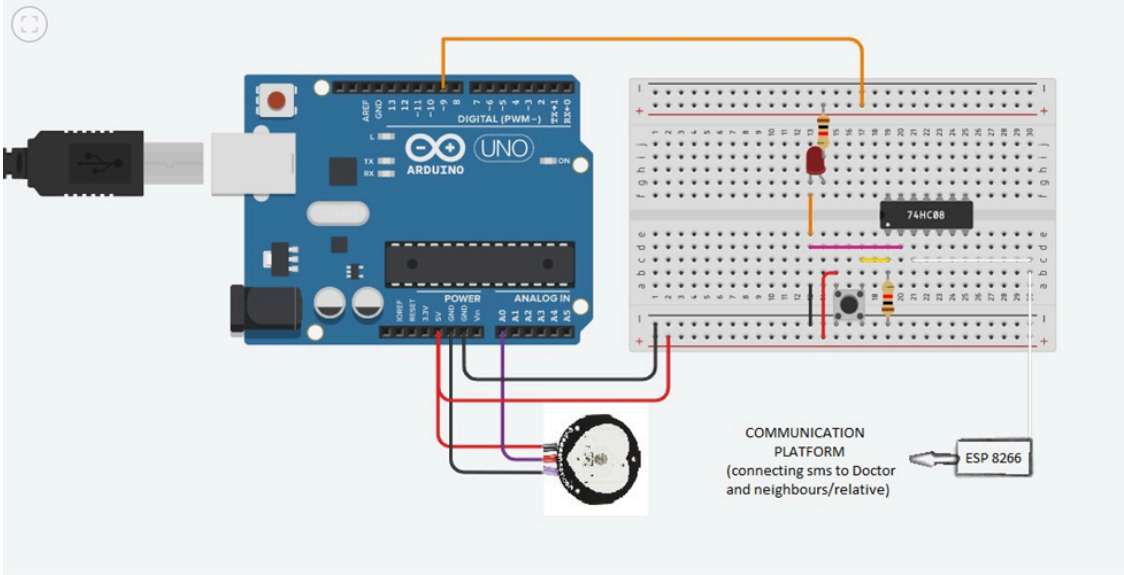
- For the hardware, first the required components were listed and ordered .



- The needs of our project were listed which included:
    - A screen for display ,
    - A sensor to sense pulse,
    - An embedded hardware
    - A way to communicate with.

- Other extra depends were also encountered like
    - The sim should be 2-G only
    - The connection of wires were not easy in the beginning
    - The setting up of correct board and port on editor
    - Direct libraries were not available and had to be added from git-hub repositories of the contributors.

- Then the components were joined as per the circuit designed in the 1st semester.
  Circuit Involved:
  https://www.tinkercad.com/things/9K7tsgsn1ZM-incredible-uusam/editel?sharecode=XB1TKroC984KufYs2sehQp7t02z9x5GlsqC5YFDlP0A



INPUT: Pulse rate: It depends on the age gap (we have taken it for the old people i.e. 50-100bpm as they are our main target customers) and the starting value as the ones predicted.
OUTPUT: The LED glow, and transfer of data to the GSM module.

- Various libraries were worked out on the arduino.cc editor. They include :
    - PulsesensorPlayground.h
    - WiFiClientSecureBearSSL.h
    - TRIGGER_WIFI.h
    - TRIGGER_GOOGLESHEETS.h
    - DHT_Sensor
    - AdaFruit_sensor

- Reference were taken from https://circuitdigest.com/microcontroller-projects/programming-esp8266-using-arduino-ide
  For MCU installation.

- Charger was needed for the gsm and the arduino had to be connected to the laptop for constant power supply.

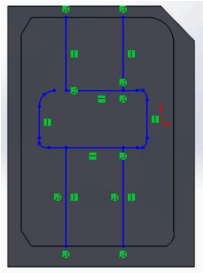
Dimensioning and Material Selection

Requirement:

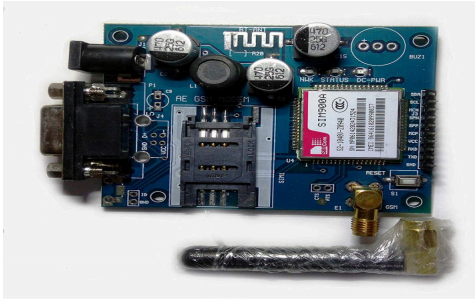
The model is expected to be of size around 25x25mm^2.
The cost price needs to be reasonable since the final product needs to be at an affordable price for old people. (current aim to be within Rs1000)
The hardwares should be easy to work with and widely available for mass production.

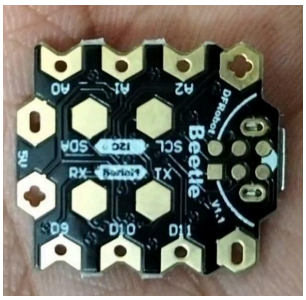
Components Selected:

1. OLED DISPLAY:
    a. Size-> 1x1.3 inch
    b. Power requirement: 5V
2. PULSE RATE SENSOR:
    a. Size: 15x8 mm^2
    b. Power Requirements: 3 to 5 V
3. BEETLE :
    a. Size : 20x22 mm^2
    b. Language : C++
    c. Pins: 10 digital, 5 analog, 4pwn



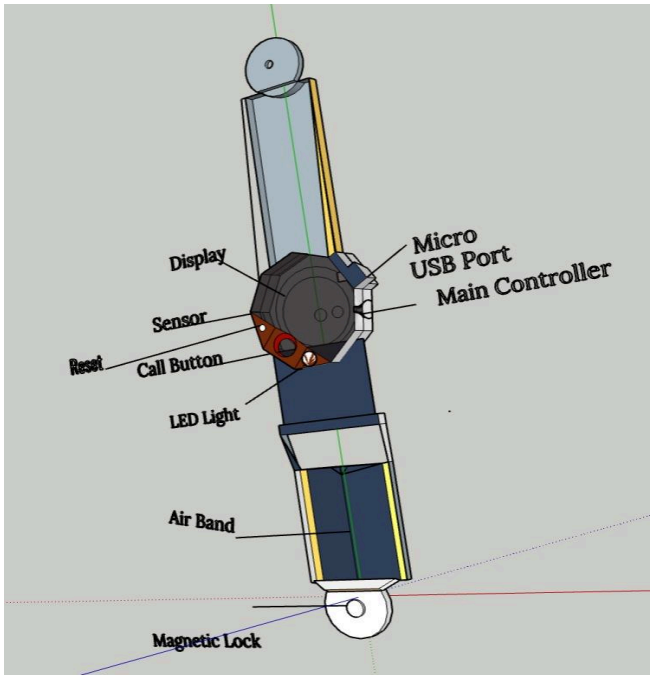
4. GSM SHIELD :
    a. Size : 10.16 x 2.54 x 7.62 cm;
    b. Power required: 1 amp to 2 amp max
5. SIM900 GSM Shield and sim card
6. LED, and gate, jumper wires, breadboard, push button,
7. Glass case, hand band and soldering material for the final designing process





Prototyping and Refinement

Prototype:



The model is expected to be of size around 25x25mm^2 , with a circular display on the top and sensor at the bottom, placed safely in the case. This prototype is powered with the help of a lithium polymer battery.
The information regarding our heartbeat is updated once every 30 seconds. The LED light is used to indicate the abnormality and waits for the call button signal to send a message to the phone. The Main controller or the crown button is being used for accessing the basic functions of the watch just like the other watches. Micro USB port is the space for GSM and the sim card. The magnetic locks are being used to ensure a comfortable locking system.

However the physical implementation had certain problems that included:

- Size of the GSM was larger than the normal size of a clock. A wireless system connected with the help of IOT, was thought of as an alternative.
- The removal of wires for integration to the clock case would require soldering work that was not possible to be done in the campus.
- The database storage was left out due to library issues (same reason for which the wireless system could not be adopted.)
- A 2-G sim was difficult to find, which also came out as a limitation to our model.
- Powering of microcontroller from cell instead and working of setup without constant connection to laptop.

Refinement:

- We tried using a Raspberry Pi in the initial stages for the circuit, but since the size of the watch was becoming larger than expected, we switched to Beetle and Arduino UNO. Arduino uno was used for the initial trail purpose and later replaced by beetle once the code was working fine.

- The outputs which were received were continuous values from the instances of some time delay and signals received could be modified as an average value from those instances.

- The device was working efficiently with an initial error percentage of 20%. This was later reduced to about 15%. However the accuracy of the code can be improved towards adding conditions on the glow of LED. (Original reading, which is the reference reading used in this project, is the heart beat measured by an MI watch 3).

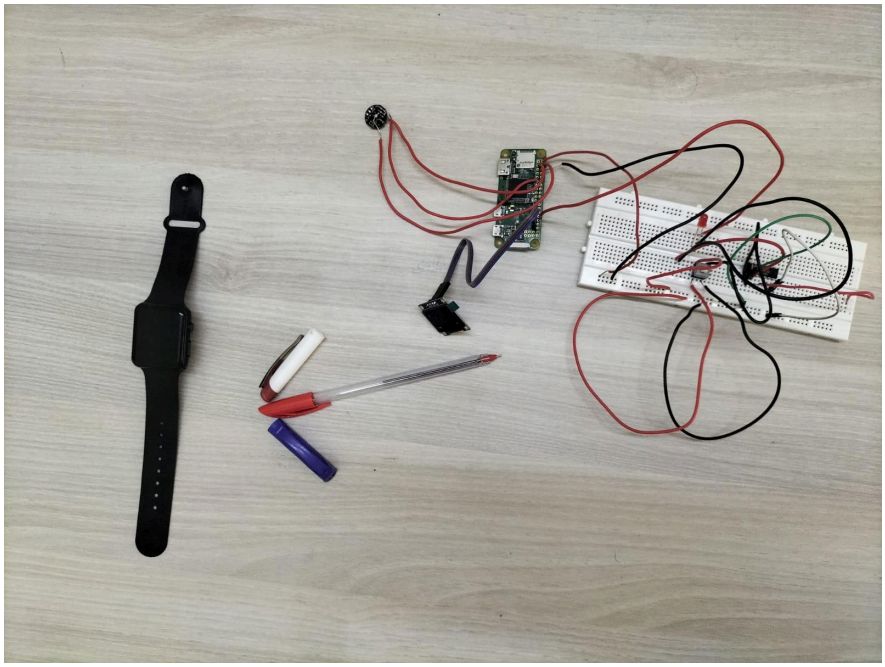
- It was concluded that it was better for the watch to have a wireless system rather than having too many connections with the help of IOT. This would help reduce the size of GSM can, making the size similar to that of an average watch. The data storage could also be possible once it could be implemented.

- Delay of the message received by the user's phone must be ruled out and must be made to have a time gap of 1-2 seconds. In this watch, we have a delay of almost 7-8 seconds.

- There was no guarantee on how long the sensor would last in the watch i.e, The durability of the sensor. So, once the sensor gets damaged, the watch would start showing outputs which were not regular. The user might not recognize this and also might receive repeated warnings from the watch if there's an abrupt rise in the reading of the watch even when his/her heartbeat is regular.

Integration

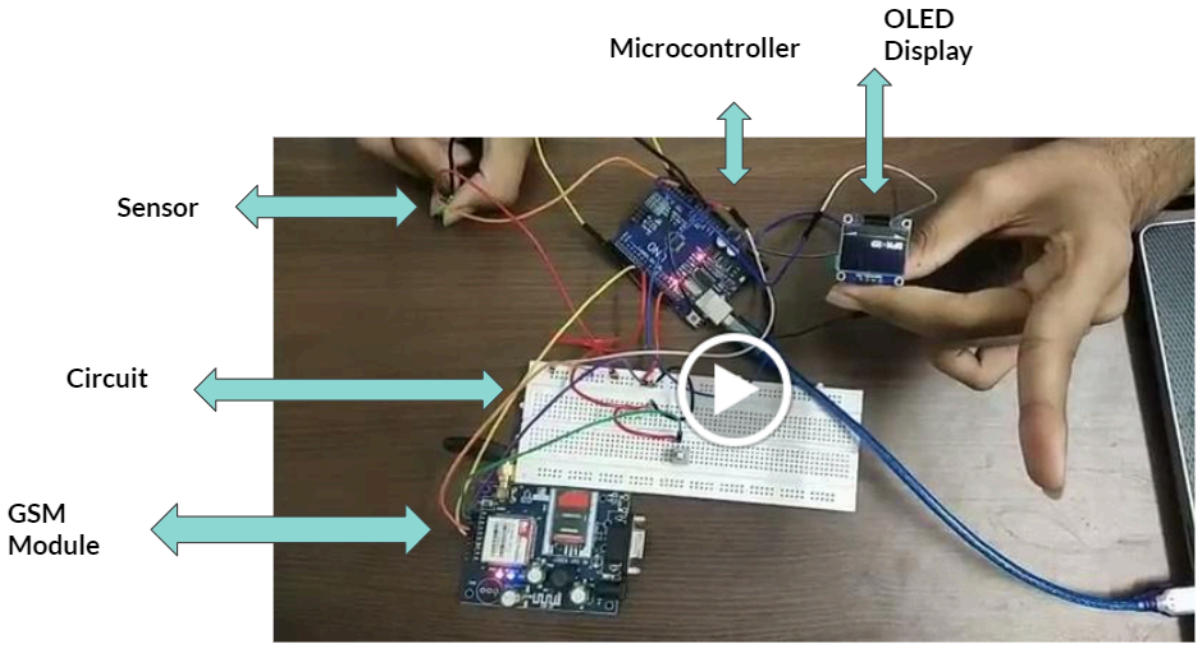
- Electrical : circuitry
  https://www.tinkercad.com/things/9K7tsgsn1ZM-incredible-uusam/editel?sharecode=XB1TKroC984KufYs2sehQp7t02z9x5GlsqC5YFDlP0A
- Hardware : materials



- Software : code
  https://create.arduino.cc/editor/menigstar91/397de638-2ba6-40dd-89eb-1f27b0f79e5e/preview

The input (pulse rate) is taken as an analog signal. This value is normalized and stored according to the general pulse range. The OLED display is also connected to an analog pin and takes in the measured pulse rate, as a parameter. The led is connected to a digital pin that sets high when pulse rate takes extreme measurements (>100 or <50 in our case). This is sent as an input to an and gate with the other input being a direct current supply, with a push button to break the current flow. The output of this AND gate is then sent as an initiator for gsm to send a message to the already feeded telephone number. All this circutary is powered by a beetle board, and instruction of data flow is induced via the code. The validity of our circuit is checked by seeing if the pulse sensor is reading correctly (readings compared to that taken by a fit-bit watch) and checking if the msg is received whenever the led glows.

Demonstration of the final design



https://drive.google.com/file/d/19bbPvfU0aIvTIkvs7D-pR_2TuDeEjaua/view?resourcekey&usp=slides_web

The measurement, display and flow of data was successful as per requirement and the message was received successfully. But the size requirement had problems with gsm being bigger than the required size, and the storage of data was left due to wifi requirements. Over the project it was observed that the gsm requires a 2-G sim to be functional, which is a major limitation to our model.

The model had an error of about 20% (display value as per the sensor), But no measure has been added to detect in case the sensor goes faulty after a certain period of use.

The prototype of the circuitry was successful while the clock's design could only be finalized on a simulation basis. The powering of the beetle from a coin cell instead of the laptop connection and replacing the wires with soldered connection was left out, towards preparing the actual product.

Individual Contribution

For the Project:

1. Learning part of Machine Learning and Data Analysis.
2. Web search to know more how crucial the arduino code is for the project and trying to understand more about it from different sources.
3. Learned new theories about Arduino UNO which I couldn't during my Electrical Engineering course.
4. Creating the machine learning model with the help of Diksha.
5. Creating the prototype in the campus with the help of Priyanshi and Romit.
6. Learned a minor part of Numpy as it was required in the code writing part.
7. Contributed in the online simulation of the watch by researching on Arduino and learning Numpy to an extent.
8. Creating the Powerpoint presentations and played a role in assigning the parts which everyone has to explain and also asking everyone a few questions so that there wouldn't be any silence when any the professor asks a question.
9. Questioning Shetaanshu and Romit regarding the negative points of the project whenever they raise new ideas so as to prepare ourselves for all possible questions to be asked

For the course:

1. Discussing more questions than answers in the beginning stages which was helpful in the end.
2. All of the group members were helpful when in need and we never had any issues during the Project-discussions.
3. Taking help from others to make the prototype hereby improving teamwork skills.
4. Borrowed materials from the IITJ Electrical lab and ordered materials online which were necessary for the project. I, Priyanshi and Romit spent 2-3 night out together working on the model which made the project more interesting