Sardar Vallabhbhai National Institute of Technology

Surat -395007, Gujarat, INDIA

ELECTRONICS & COMMUNICATIONS ENGINEERING DEPARTMENT

CERTIFICATE

This is to certify that **SUMMER INTERNSHIP PROJECT** entitled "ADAPTIVE FACE VERIFICATION OF CHILD FOR HEIGHT AND WEIGHT MEASUREMENT" is presented & submitted by Parthav Patel, Deep Jariwala, Rushi Bhatt & Sudhanshu Sinh bearing Roll No. **U16EC016**, **U16EC027**, **U16EC031** & **U16EC032** respectively of B. Tech III, 5th Semester studying in Electronics & Communications Engineering.

They have successfully & satisfactorily completed the project. We, certify that the work is comprehensive, complete and fit for evaluation.

Prof. Anand D. Darji
Assistant professor
Project Guide

Seal of the Department
MAY-JULY 2018

AKNOWLEDGEMENT

We take this opportunity to express our profound gratitude and deep regards to our guide Professor Anand Darji (Assistant Professor, ECED, SVNIT) for their exemplary guidance, monitoring and constant encouragement throughout the Summer Internship. The blessing, help and guidance given by him time to time shall carry us a long way in the journey of life on which we are about to embark.

We also take this opportunity to express a deep sense of gratitude to the ECED of our college SVNIT for allowing us to use laboratories and various electronic and electrical components, which helped us a lot to complete our project.

We are obliged to staff members of ECED for the valuable information provided by them in their respective fields. We are grateful for their cooperation during the period of our assignment.

Parthav Patel (U16EC016)

Deep Jariwala (U16EC027)

Rushi Bhatt (U16EC031)

Sudhanshu Sinh (U16EC032)

ABSTRACT

System and method for verifying a child by facial recognition from a mobile application. Several challenges pertaining to child's authentication have been overcome by the present invention. The palm vein sensor is not suitable because the palms of the child are not well developed, to be used as an authentication entity. Similar problem happens if retina scan technology would have been implemented.

All these challenges were overcome by authenticating a child by facial recognition. The facial recognition is done through the mobile application developed in the course of the project, with minimalistic number of training data set for each child. It validates each child, and publishes their corresponding height and body weight into their record of the database, which can be visualized as graphs in the mobile application to check annual growth of the child.

The hardware embodiment comprises of an ultrasonic sensor and load cell to measure the height and weight of the child. These are the standard techniques for measuring height and weight automatically without any human intervention. The microcontroller (Arduino Nano) processes all this data and establishes the communication with the mobile application via Bluetooth Low Energy.

The authentication is done on a server and token passed on to mobile application, only after which can the hardware measures data. Also, a novel approach of training the model after every successful verification has also been incorporated. In addition, the present disclosure also enables each centre to monitor the data recorded.

INDEX

Chapter 1: Introduction

The existing method of maintaining a child's height and weight record is a lot tedious and requires a lot of paperwork to be maintained. Another major issue is in face verification of the child is that the child's face is recorded annually and huge variations are present in the captured image as compared to the previous year's. Not only does the verification application works for developing face child, but also for minimalistic number of training set of each child.

It is therefore a feature of the system is to provide an automatic apparatus and method for measuring the height and weight of a child along with facial recognition which substantially overcome all of the traditional alike system and also measurement for child more efficient and faster with very less human intervention, the issues with organize records of child on papers and analysing them have been resolved with present invention.

The present system consists of two aspects; the hardware embodiment and the mobile application. The hardware embodiment consisting of the entire framework, along with the sensors used for weight and height measurement of a child. An ultrasonic sensor positioned stationary at predetermined distance above, from which ultrasonic sensor data is subtracted, in order to get the height of the child. The weight of the child is measured using a load cell. The present invention uses 40kg load cell, for demonstration purpose but can be implemented according to the requirement.

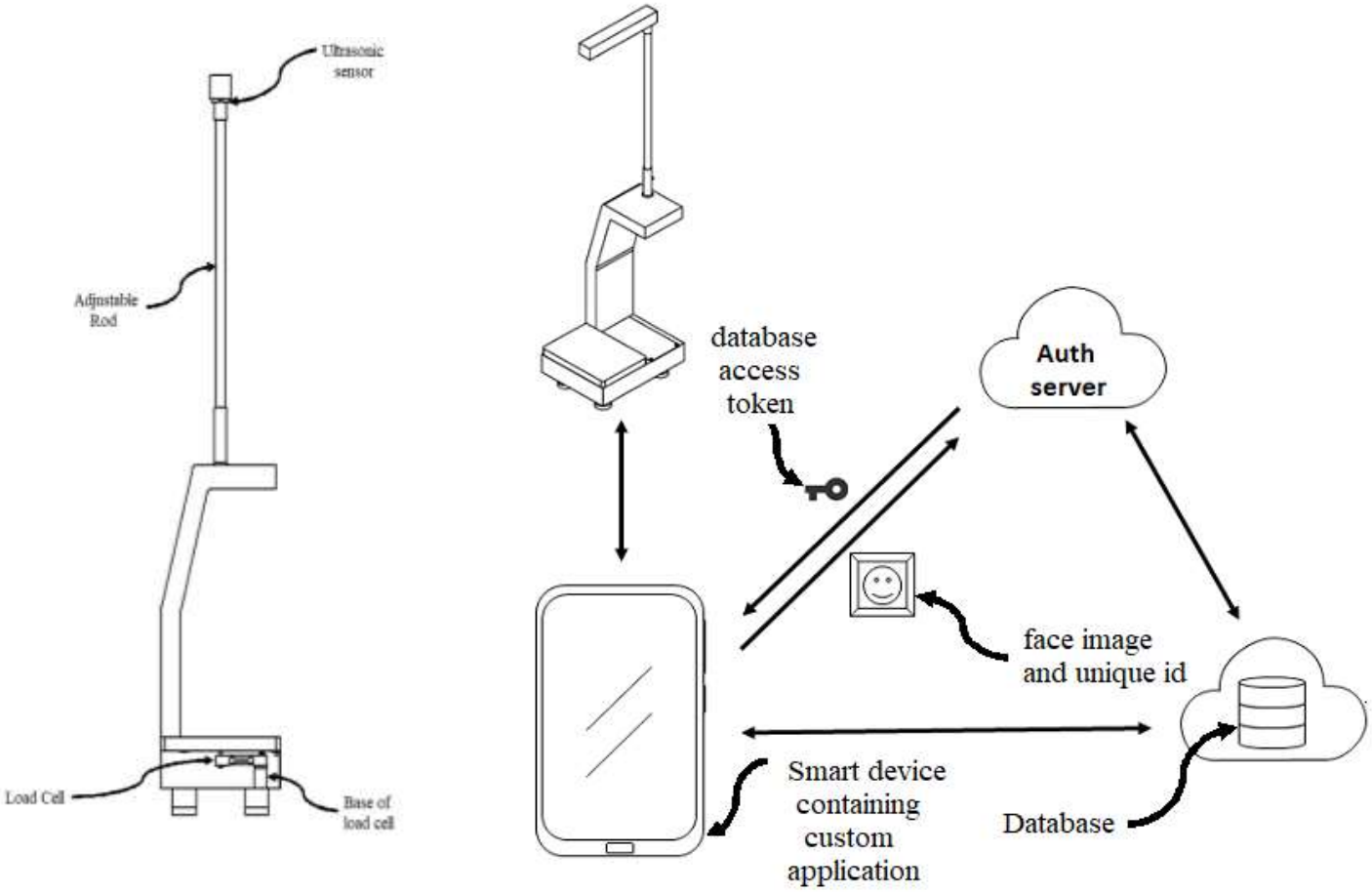
An automatic measuring apparatus consists of Arduino Nano, analog to digital converter along with amplification IC HX711 and Bluetooth protocols is used to communicate with hardware embodiment and mobile Application. the mobile application on contrary, consists of face verification, child data reception and graphical visualization of the child's and centre's data. The application proceeds by enabling the supervisor to select the particular centre. In the background, the Bluetooth pairing of the application with the hardware takes place.

The system also consists of mobile application on which, child is biometrically verified by face verification through the verification server. The server, provided with the identification information called as unique id of the child and face image of the same child from the application. When the similarity of face of the child with the model face stored for verification is above a threshold value, the server provides the application with an authentication token which further provides the application access to add or view the child's data.

According to the above features, after the completion of the face verification, the face image is stored in the storage, which is used to train the model for future verification processes. By updating the model using latest face, reduces the chance of the rejection due to the aging effect of child's face.

A novel approach has been implemented where, the trained face model verifies the face of the child. For the successful verification, the model is trained with the new captured data, which construct the model for future utilization. Also, the facility of graphic visualization is provided for monitoring the personal growth of a child along with the average statistics of each centre.

Chapter 2: System



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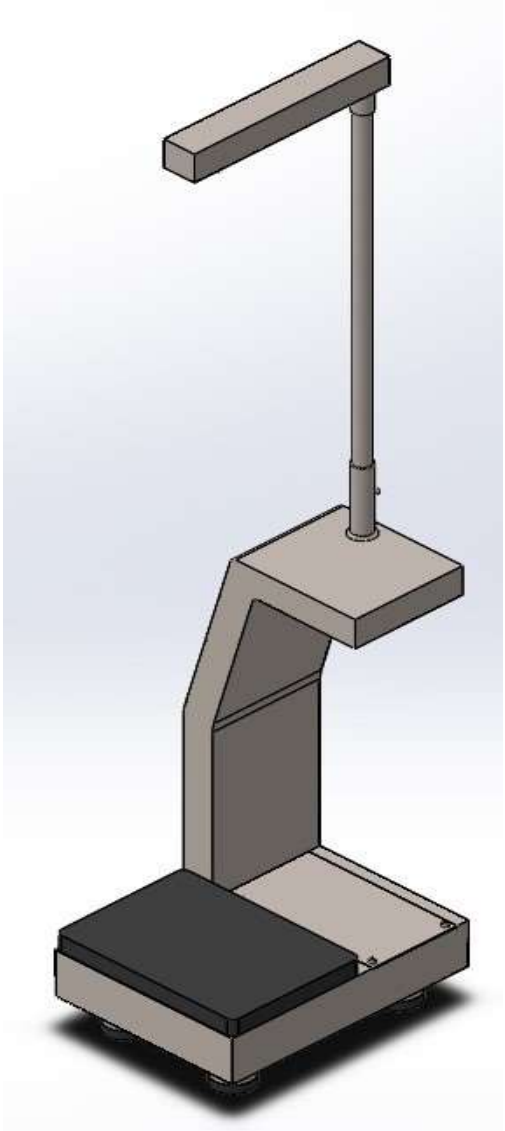
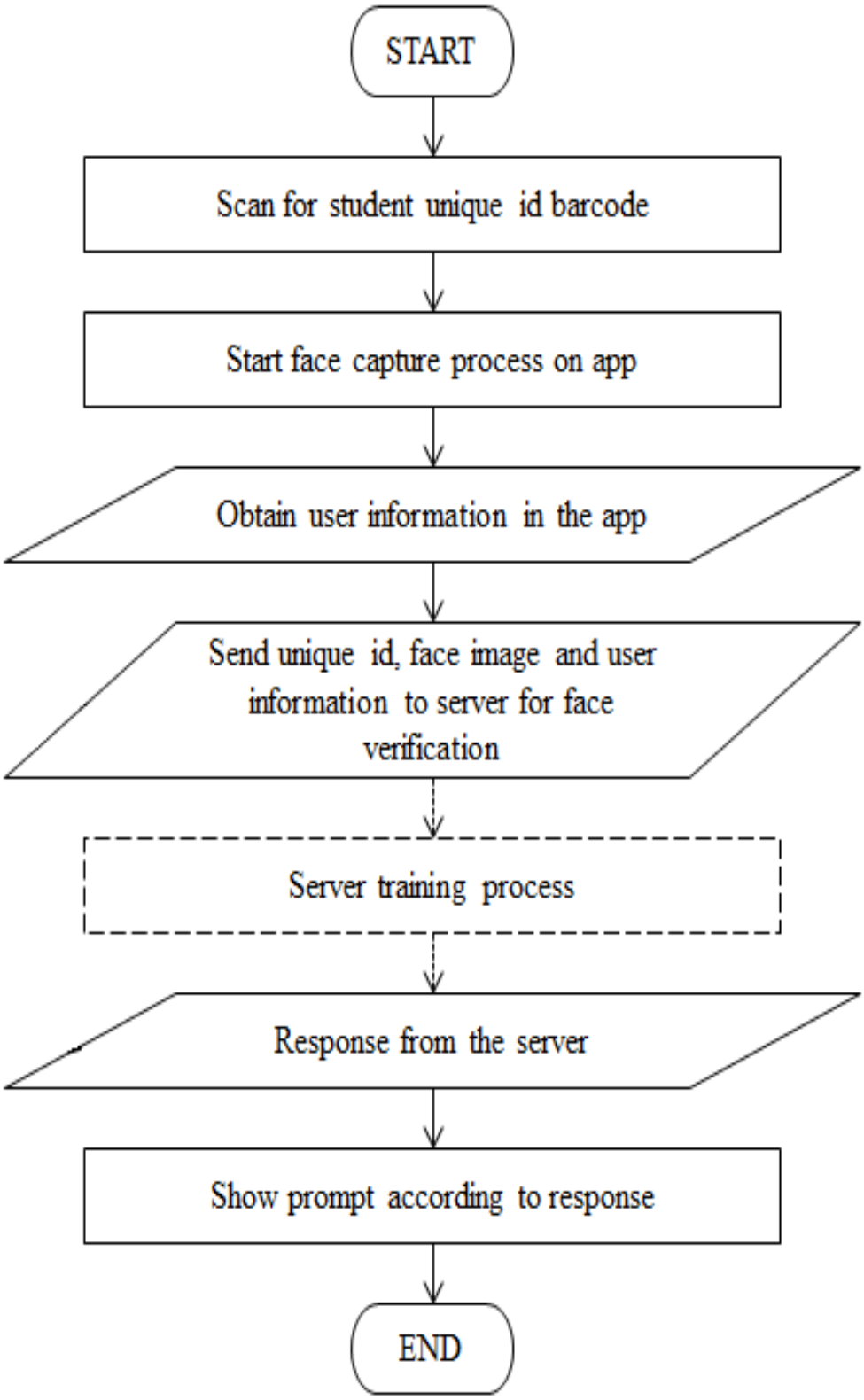
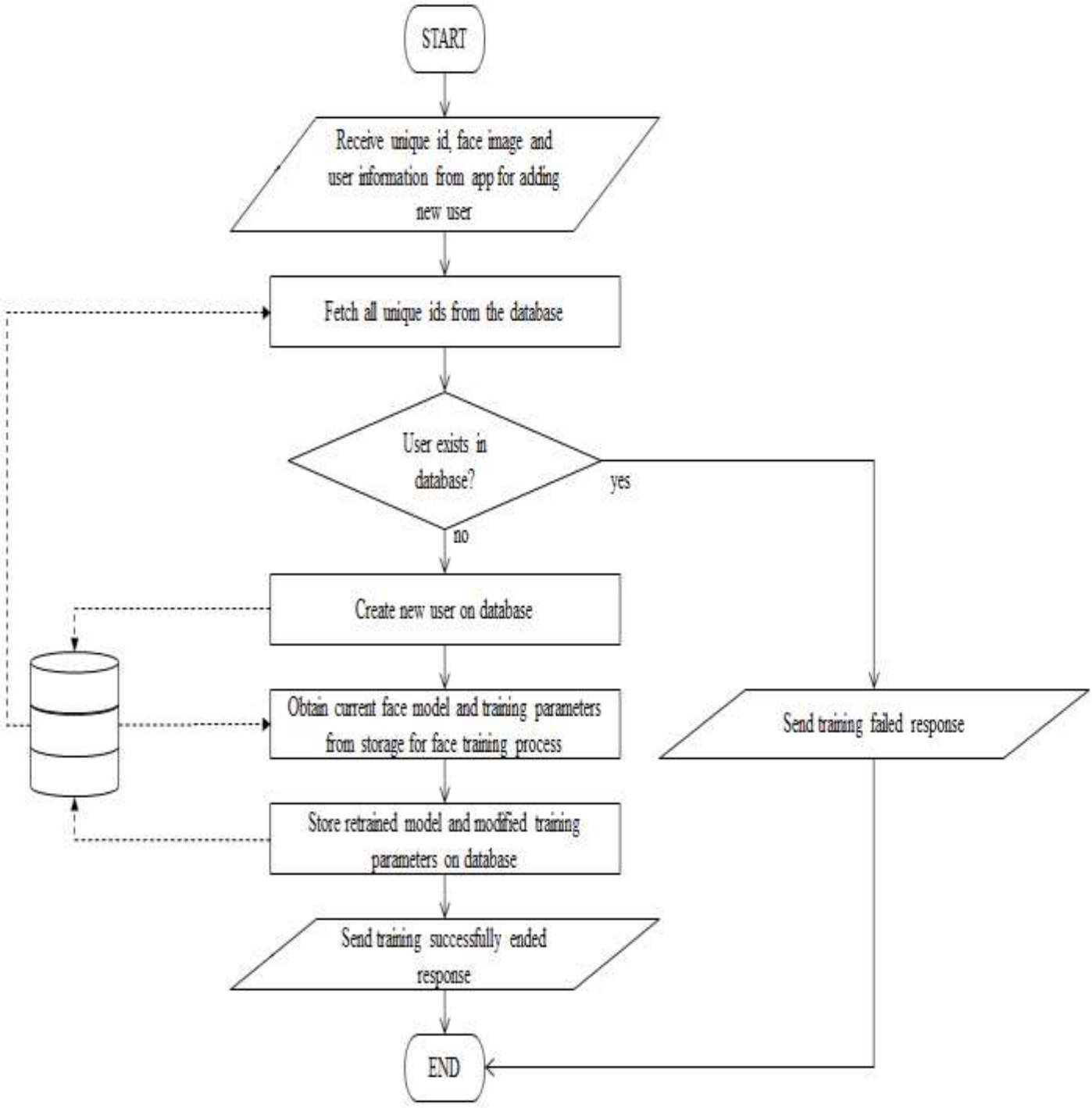




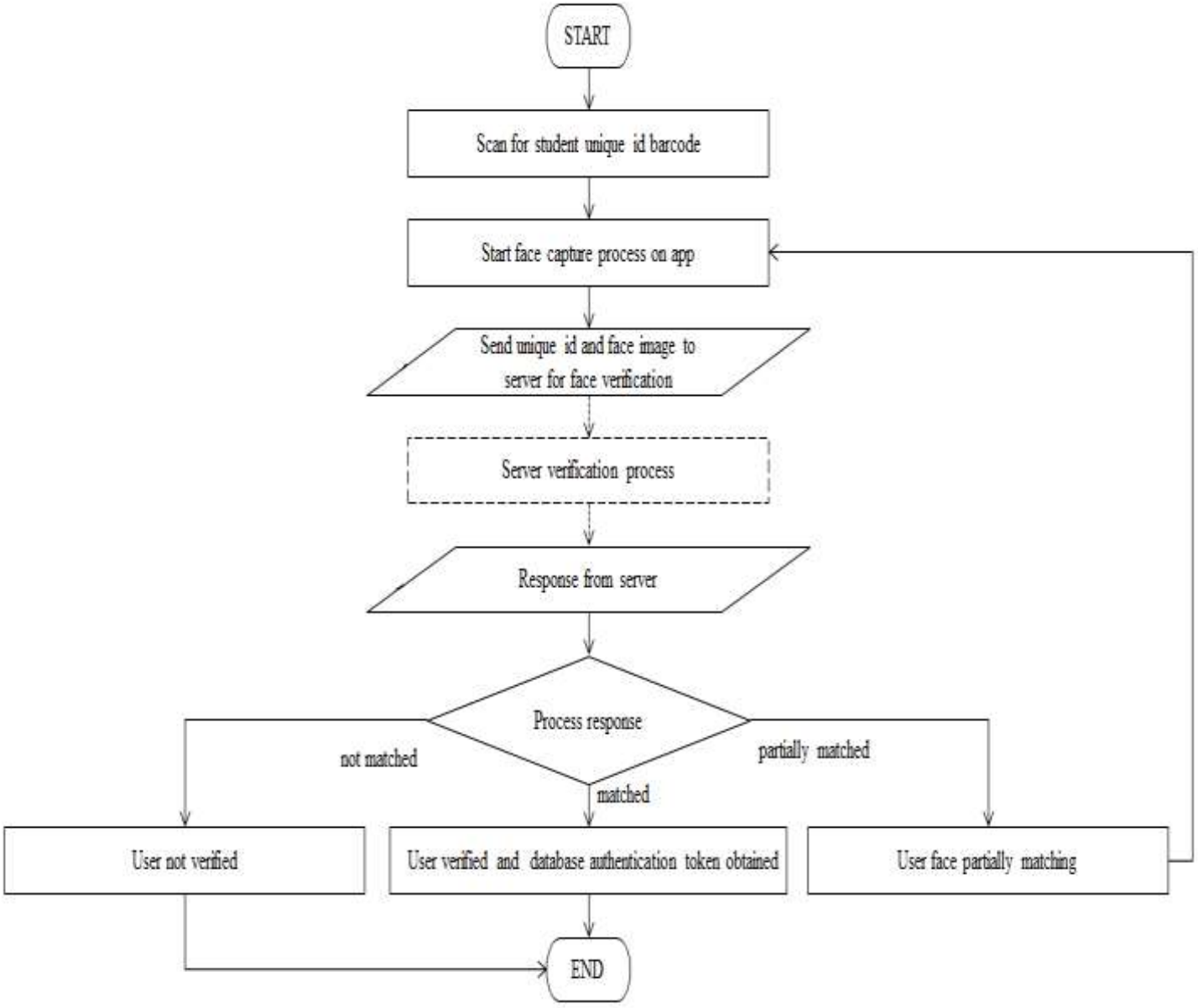
Flow diagram to add new child on custom mobile application



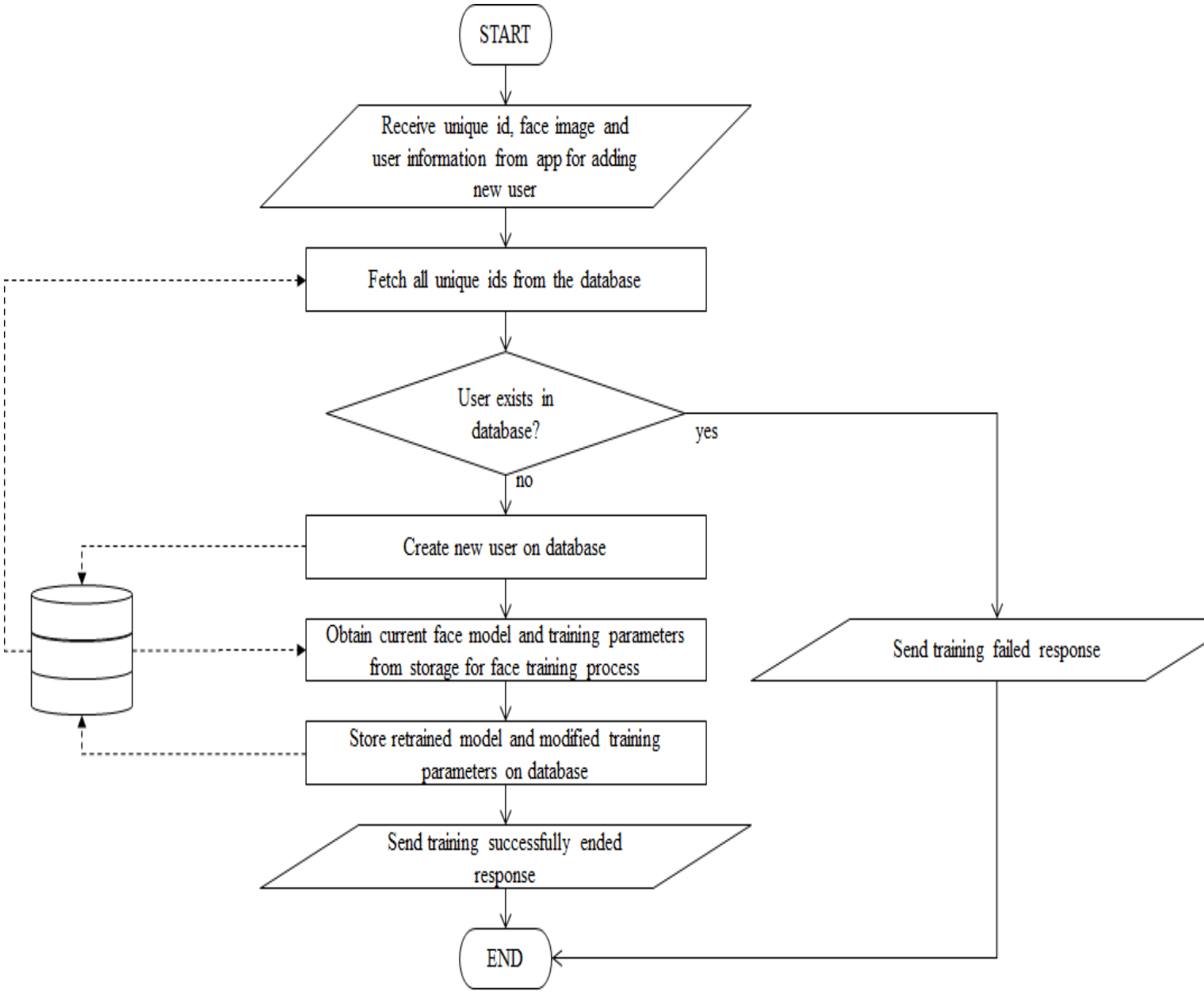
Flow diagram to add new child on server

According to the above features, after the completion of the face verification, the face image is stored in the storage, which is used to train the model for future verification processes. By updating the model using latest face, reduces the chance of the rejection due to the aging effect of child's face.

A novel approach has been implemented where, the trained face model verifies the face of the child. For the successful verification, the model is trained with the new captured data, which construct the model for future utilization. Also, the facility of graphic visualization is provided for monitoring the personal growth of a child along with the average statistics of each centre.



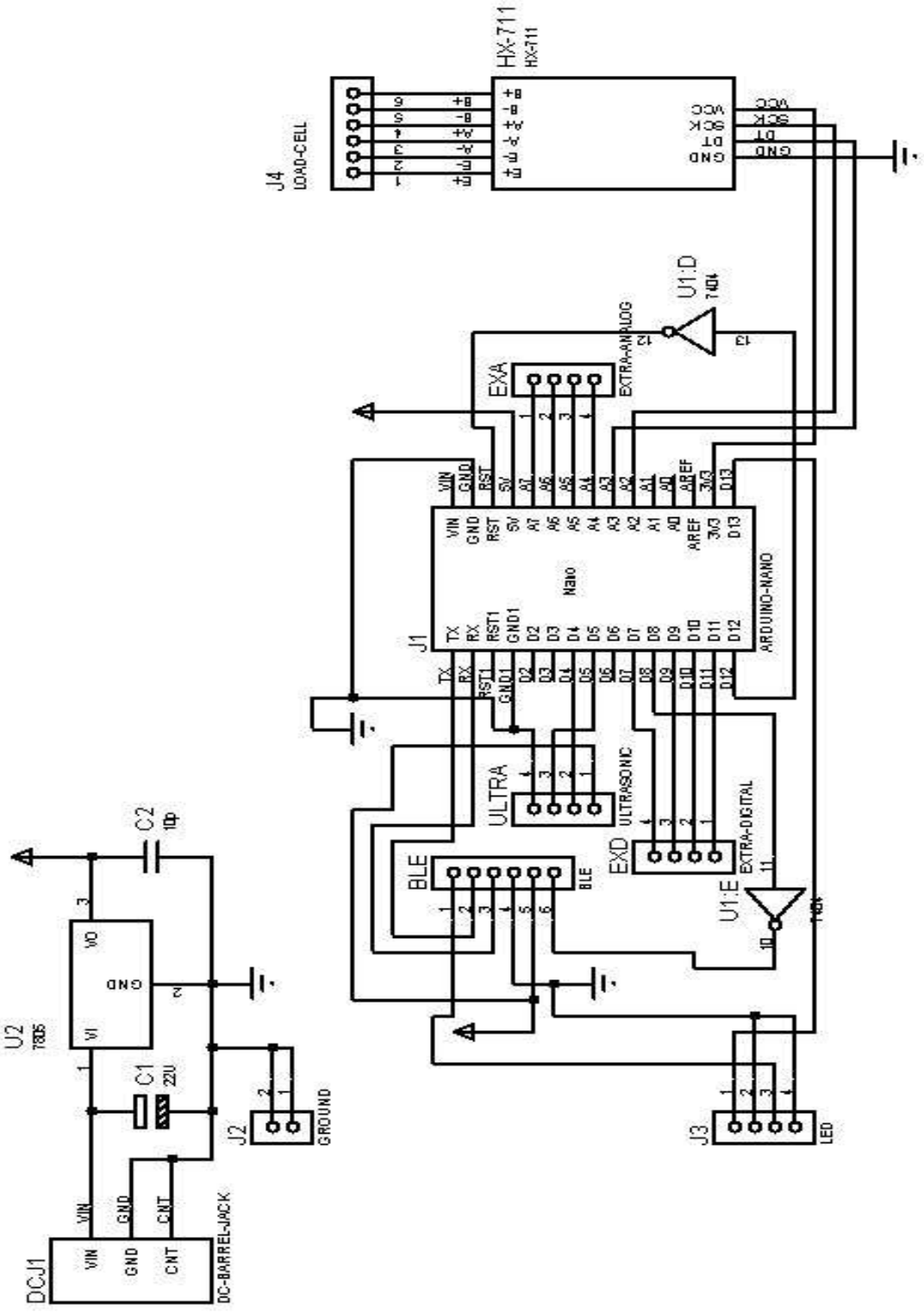
Flow chart of the custom mobile application verification process



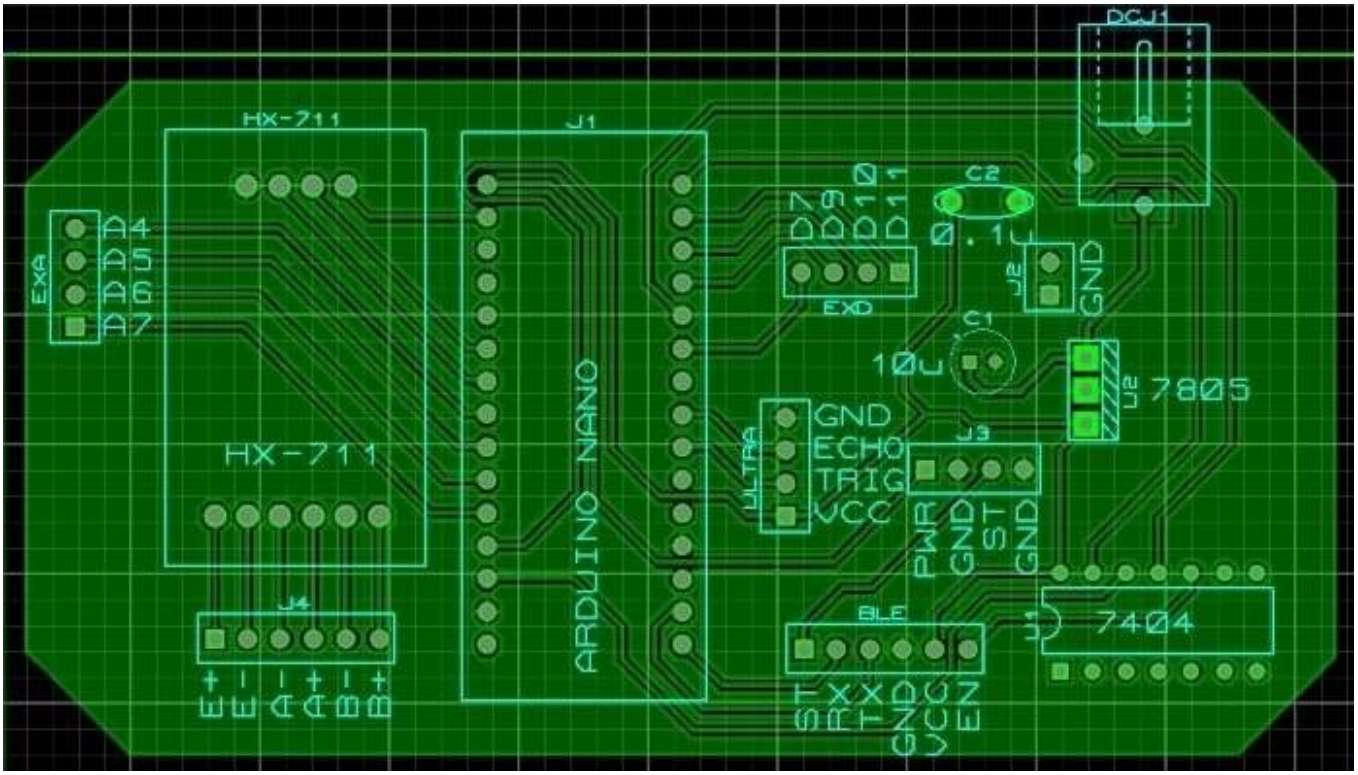
Flow chart of the server verification process

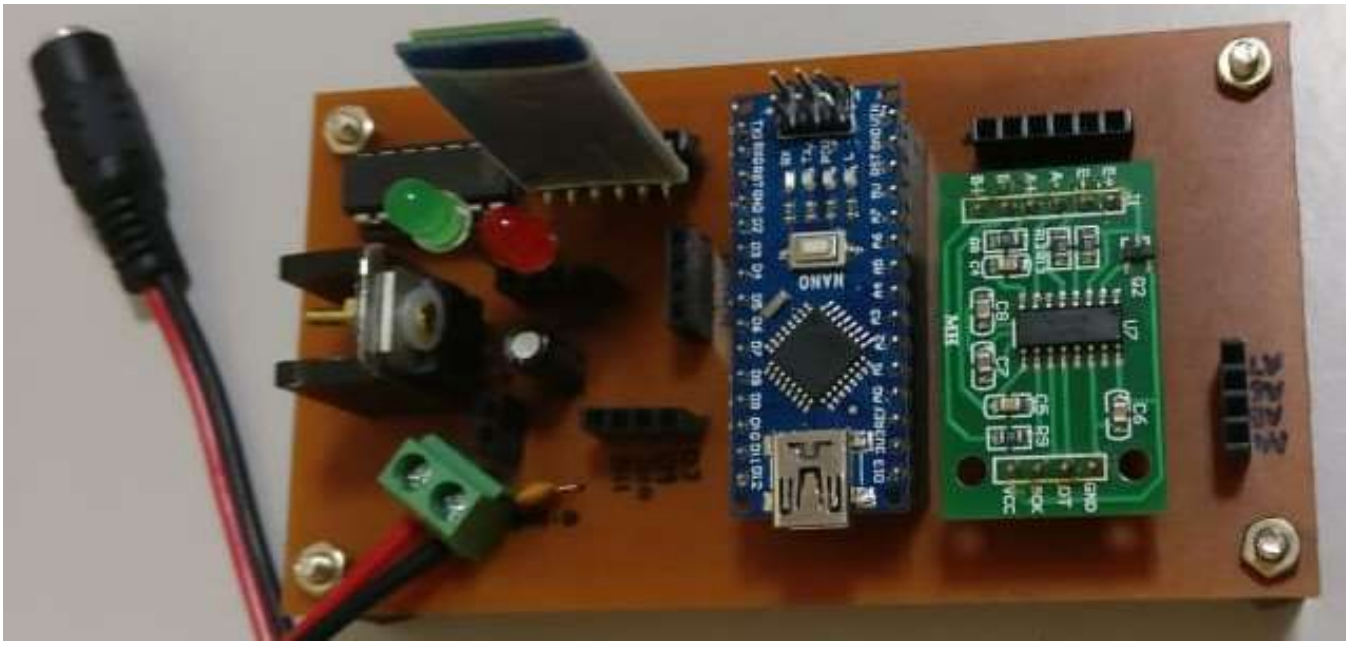
The portability and the adjustability feature of the following embodiment are also beneficial. The hardware embodiment consists of the facility to reset the Bluetooth channel and calibrate the height and body weight sensor from the mobile application itself.

Chapter 3: Circuit Diagram



Chapter 4: PCB (Printed Circuit Board):

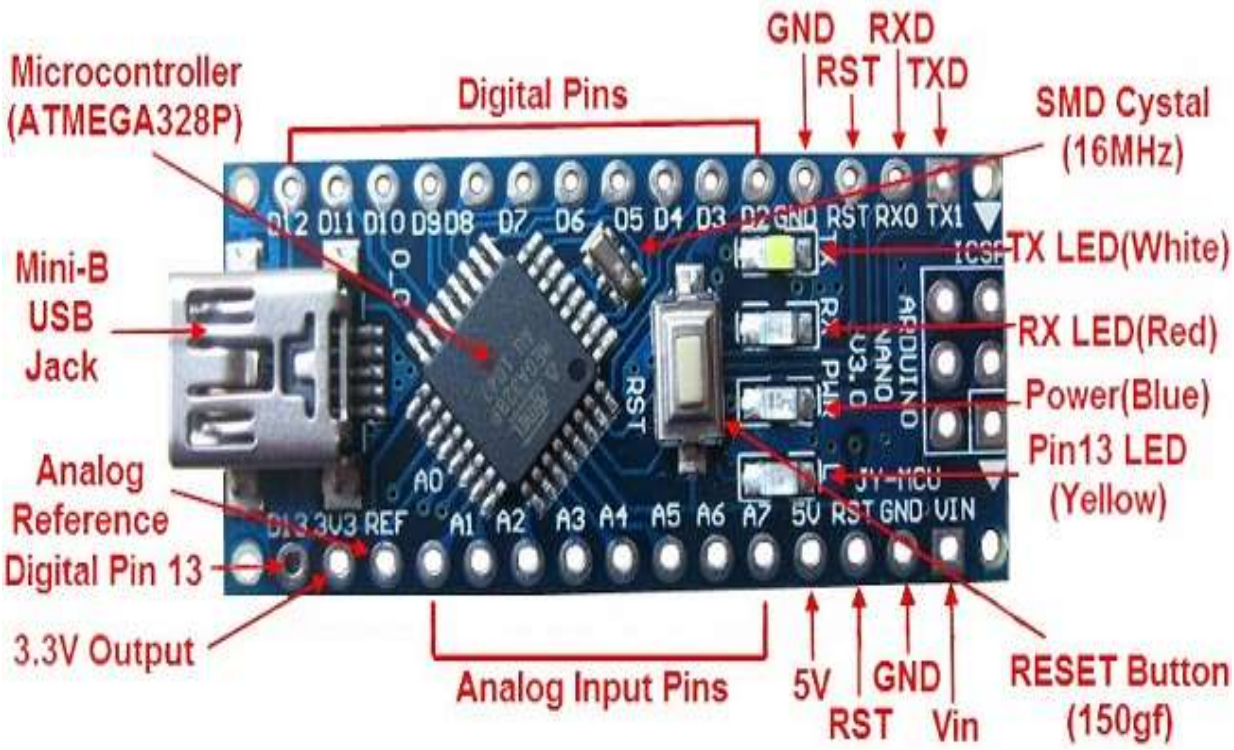




Chapter 5: Hardware Description

I. Arduino Nano:

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) or Atmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one. The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.



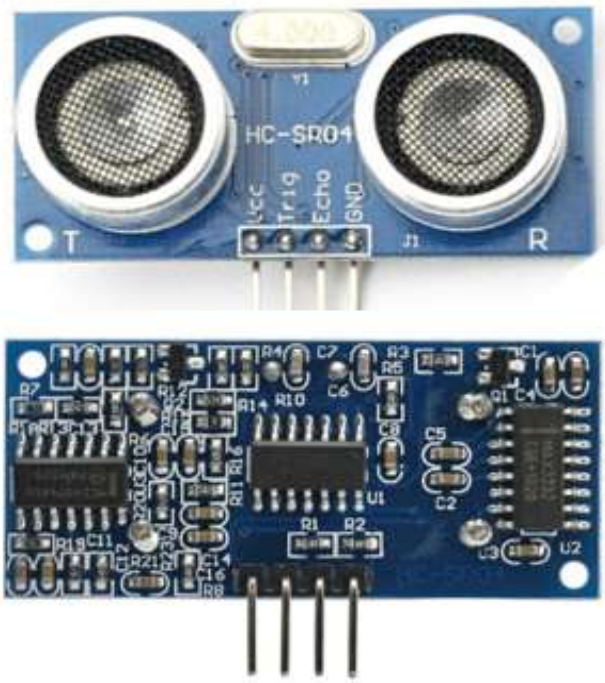
Input and Output of Arduino Nano:

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kΩ. In addition.

Specifications:

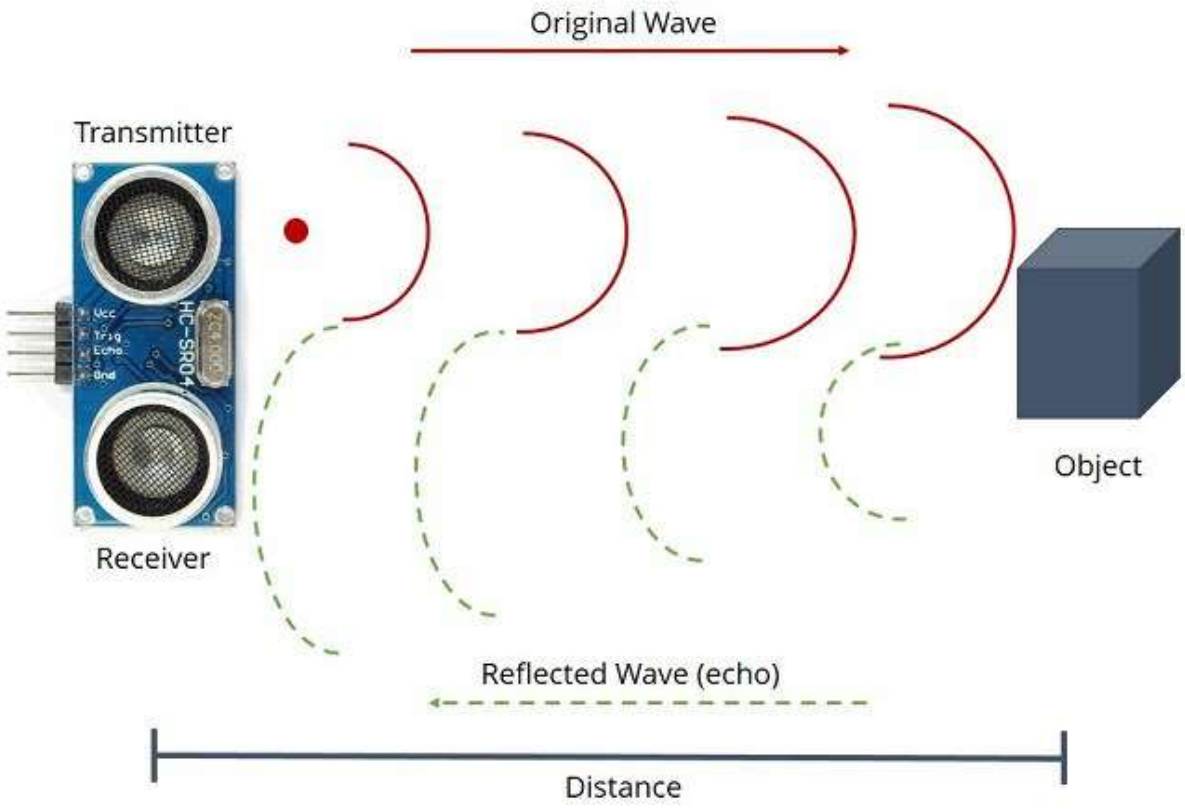
- **Microcontroller:** Atmel Atmega168 or Atmega328
- **Operating Voltage (logic level):** 5 V
- **Input Voltage(recommended):** 7-12 V
- **Input Voltage (limits):** 6-20 V
- **Digital I/O Pins:** 14 (of which 6 provide PWM output)
- **Analog Input Pins:** 8
- **DC Current per I/O Pin:** 40 mA
- **Flash Memory:** 16 KB (Atmega168) or 32 KB (Atmega328) of which 2 KB used by bootloader
- **SRAM:** 1 KB (Atmega168) or 2 KB (Atmega328)
- **EEPROM:** 512 bytes (Atmega168) or 1 KB (Atmega328)
- **Clock Speed:** 16 MHz

II. Ultrasonic Sensor (HC-SR04):



An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. Sonar uses the propagation of sound to detect object. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. Since it is known that sound travels through air at about 344 m/s (1129 ft/s), we can take the time for the sound wave to return and multiply it by 344 meters (or 1129 feet) to find the total round-trip distance of the sound wave. Round-trip means that the sound wave travelled 2 times the distance to the object before it was detected by the sensor; it includes the 'trip' from the sonar sensor to the object AND the 'trip' from the object to the Ultrasonic sensor (after the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half.

$$Distance = \frac{Speed\ of\ Sound\ \times Time\ taken}{2}$$



BASIC ULTRASONIC SENSOR OPERATION

But note that the accuracy of the ultrasonic sensor can be affected by temperature and humidity of the air it is being used. It is important to understand that some objects might not be detected by ultrasonic sensors. This is because some objects are shaped or positioned in such a way that the sound wave bounces off the object but are deflected away from the Ultrasonic sensor. It is also possible for the object to be too small to reflect enough of the sound wave back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately.

Specifications:

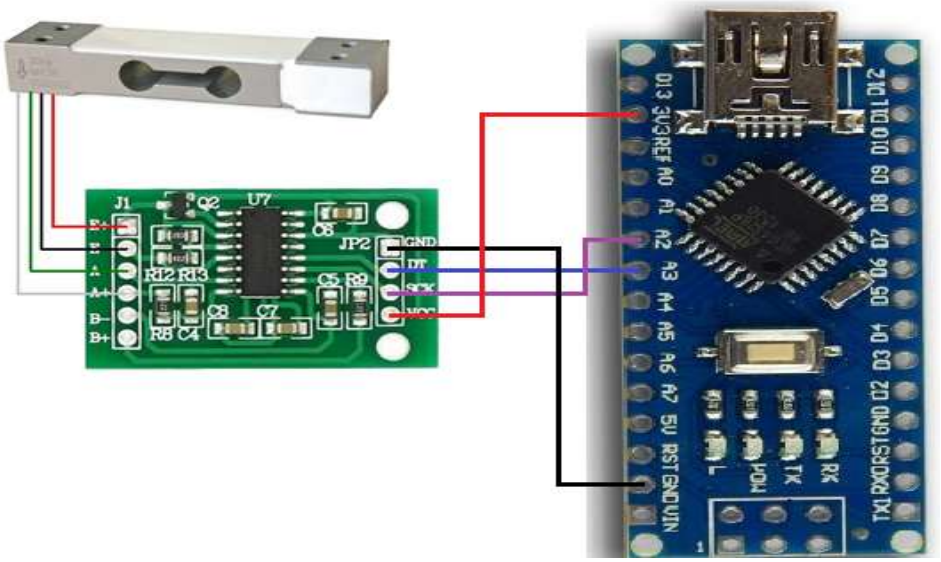
- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance: 2cm – 400 cm/1″ – 13ft
- Resolution: 0.3 cm
- Measuring Angle: 30 degrees
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

Pins:

- VCC: +5VDC
- Trig: Trigger (INPUT)
- Echo: Echo (OUTPUT)
- GND: GND

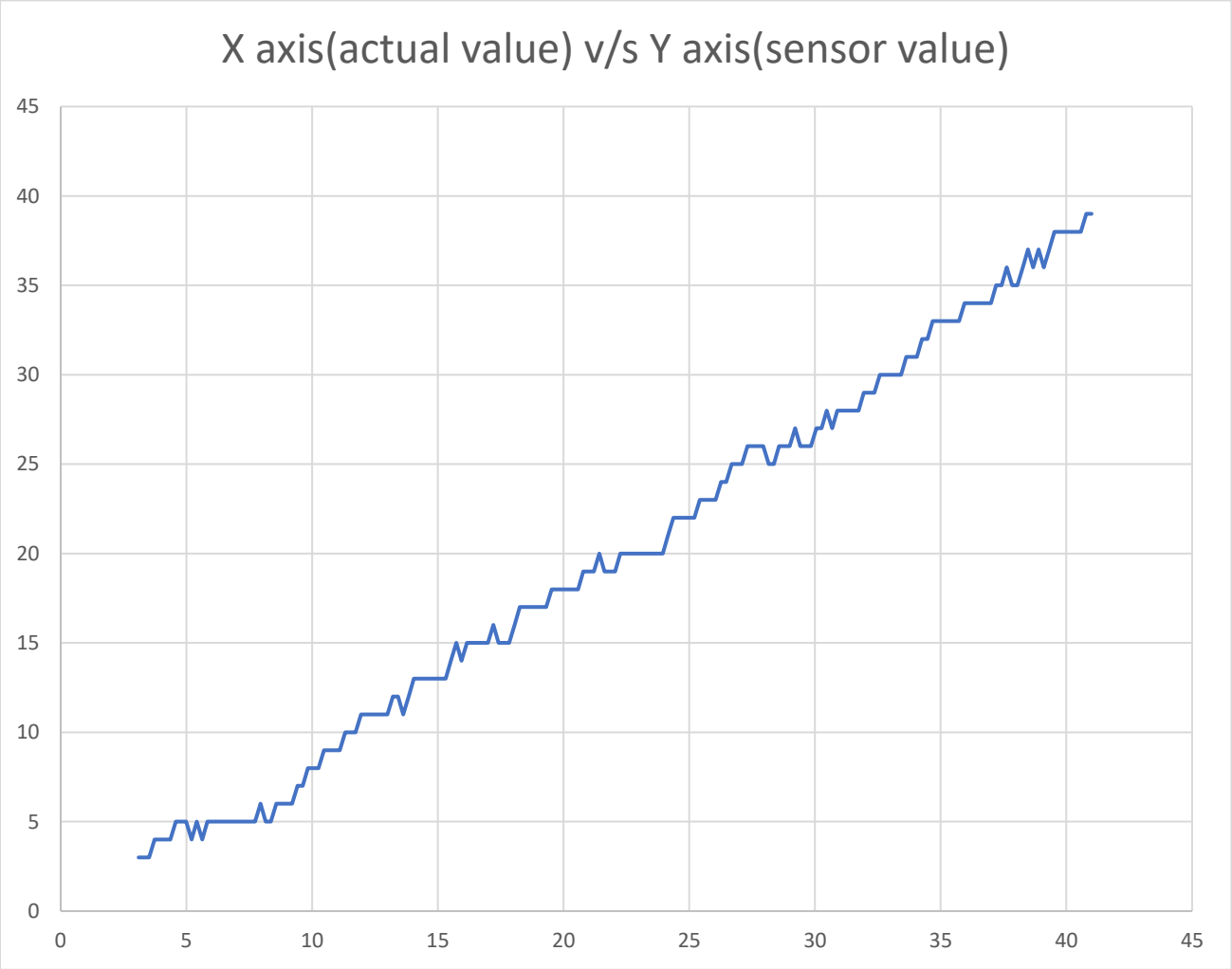
HC-SR04 Connection with Arduino Nano:

The HC-SR04 sensor has two pins controlling the trigger (TRIG) and the echo received by wave (ECHO). To generate a trigger, the TRIG should be active during at least 10uS (set to + 5V) and then set to 0V again. Then we must wait until the ECHO signal is active and measure the elapsed time between the trigger and the echo. TRIG pins and ECHO can be connected to any Digital IO of Arduino pin.



Comparison between actual reading and ultrasonic sensor reading:

Here we have also done the comparison between actual readings and ultrasonic sensor reading. For that we positioned the obstacles manually in known distances, and plotted the graph. In this experiment, we tested the ultrasonic sensor, which provided good accuracy and repeatability. And the plot comes out to be linear. So, we can consider sensor readings as an actual value.



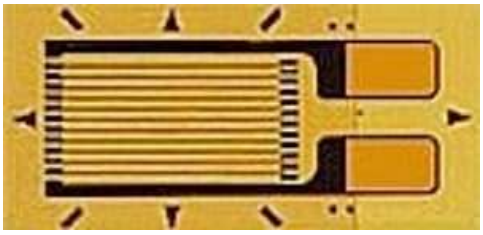
Sr.no.	Actual value	Sensor value	Sr.no.	Actual value	Sensor value
1	3.100000000	3	9	26.68222222	25
2	4.152777778	4	10	27.31388889	26
3	4.995000000	5	11	30.89333333	28
4	16.15444444	15	12	32.57777778	30
5	18.26000000	17	13	34.68333333	33
6	19.52333333	18	14	37.63111111	36
7	20.78666667	19	15	38.47333333	37
8	21.41833333	20	16	40.78944444	39

III. Load Cell (CZL-601):

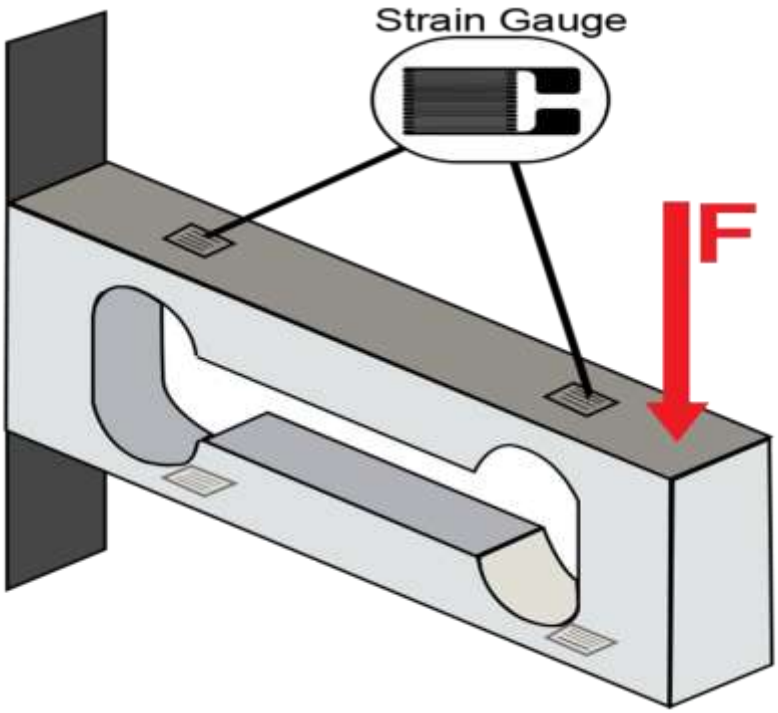
A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. This electrical signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. There are different kind of load cells. Here we have used load cell CZL-601.

Working of Load Cell:

A load cell is made by using an elastic member (with very highly repeatable deflection pattern) to which a number of strain gauges are attached. In this particular load cell, there are a total of four strain gauges that are bonded to the upper and lower surfaces of the load cell.

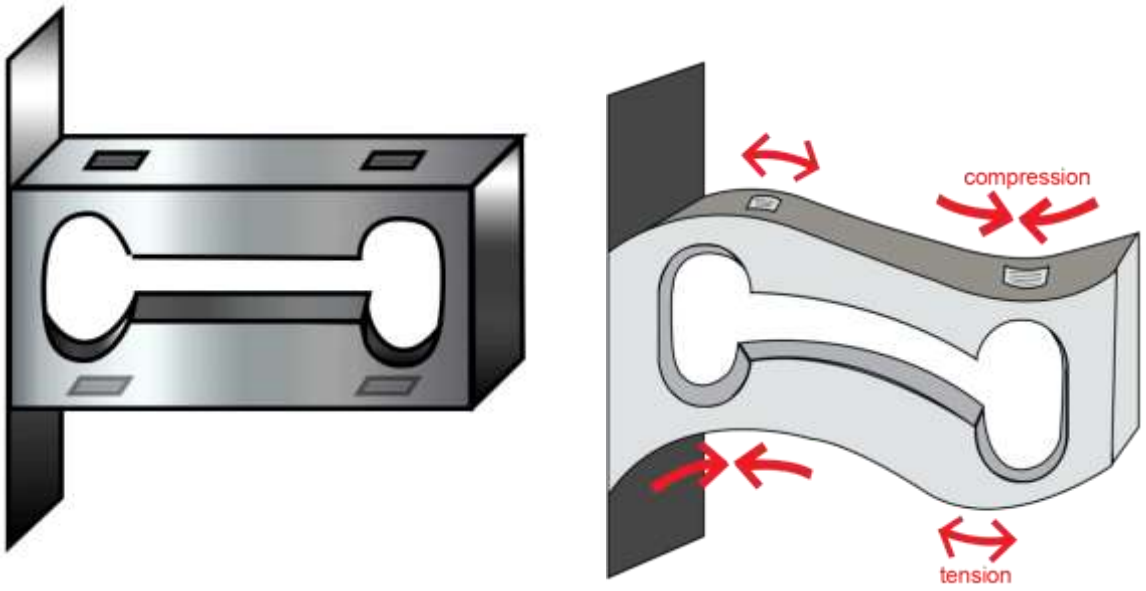


STRAIN GAUGE

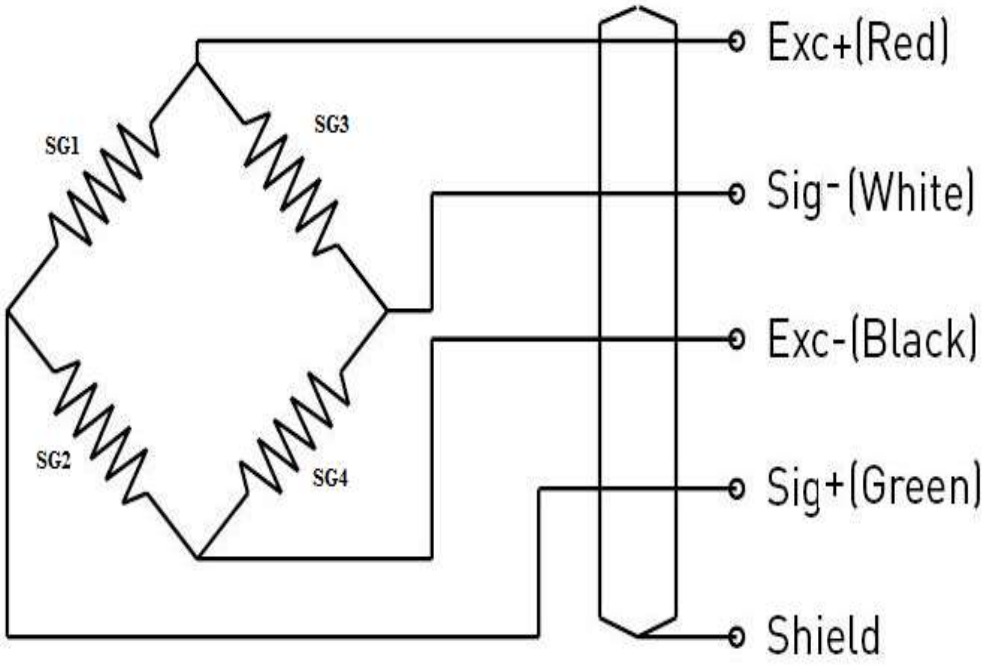


LOAD CELL WITH FOUR STRAIN GAUGES

When the load is applied to the body of a resistive load cell as shown below, the elastic member, deflects as shown and creates a strain at those locations due to the stress applied. As a result, two of the strain gauges are in compression, whereas the other two are in tension.



Working of load cell is based on the concept of Wheatstone bridge. Each load cell consists of four strain gauges that are connected into a Wheatstone bridge formation as shown.

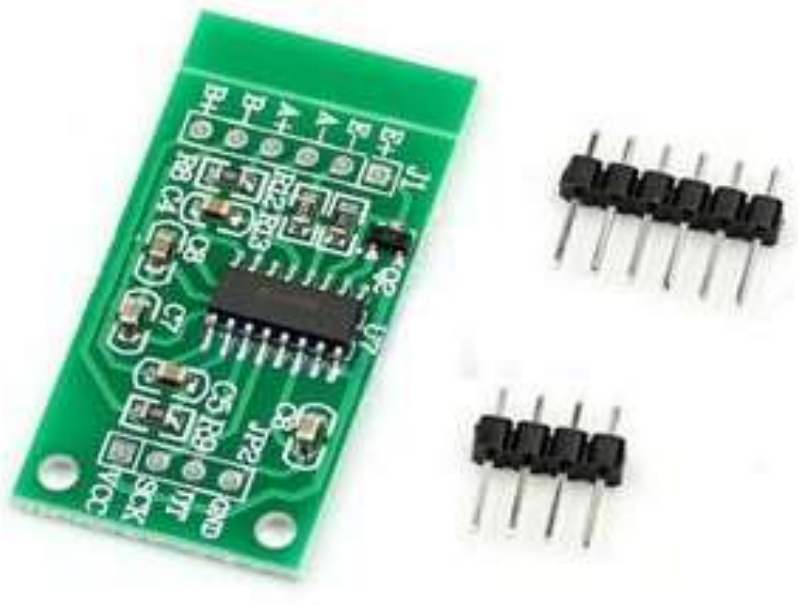


Wheatstone bridge is basically two potential dividers connected in parallel. SG1 and SG2 form one of the potential divider circuits. SG3 and SG4 form the other divider circuit. Output voltage of the load cell is taken from the midpoint of the potential divider circuits. When strain is applied to the bridge, gauge measures the strain as an electrical signal, because the strain changes the electrical resistance of the wire. When the metallic member to which the strain gauges are attached, is stressed by the application of force, the resulting strain leads to change in resistance in one or more of the resistors. This change in resistance results in change in output voltage. The electrical signal output from load cell is typically in the order of a few millivolts range. This small change in output voltage can be measured and digitized after careful amplification of small milli-volt level signal to a higher amplitude like 0 to 5 volts. For amplification and digitization, we have used HX-711 A/D converter. The most common application of this sensor is in weighing machines. Every weighing machine which shows weight makes use of load cell as sensing element.

Specifications:

- Material: Aluminium alloy
- Rated load: 40KG
- Comprehensive error: 0,03% F.S.
- Rated output: 2±0.02mV/V
- Repeatability: 0.01% Full scale
- Zero Balance: +/- 1% Full scale
- Excitation Voltage: 9~12V
- Safe Load: 120% of Rated Capacity
- Ultimate Load: 150% of Rated Capacity

IV. Load Cell Amplifier Module (HX-711):



HX711 is a precision 24-bit analog to digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor. The input multiplexer selects either Channel A or B differential input to the low-noise programmable gain amplifier (PGA). Channel A can be programmed with a gain of 128 or 64, corresponding to a full-scale differential input voltage of ±20mV or ±40mV respectively, when a 5V supply is connected to AVDD analog power supply pin. Channel B has a fixed gain of 32. On chip power supply regulator eliminates the need for an external supply regulator to provide analog power for the ADC and the sensor. Clock input is flexible. It can be from an external clock source, a crystal, or the on-chip oscillator that does not require any external component. On-chip power on-reset circuitry simplifies digital interface initialization. There is no programming needed for the internal registers. All controls to the HX711 are through the pins.

Specifications:

- Power Supply voltage:2.6 – 5.5 V
- Operation temperature range: -40 ~ +85℃
- Two Wire Serial Interface (Clock and Data)
- 24 Bit high precision ADC.
- Selectable Gain Amplifier – 32, 64 and 128
- Selectable Sampling rate – 10SPS or 80SPS

HX-711 Connection with CZL-601 and Arduino Nano:

Here We are interfacing 40Kg load cell CZL-601 to the Arduino Nano using HX711 Load cell amplifier module. Most Load cell have four wires red, black, green and white. On HX711 board we have E+, E-, A+, A- and B+, B- connections.

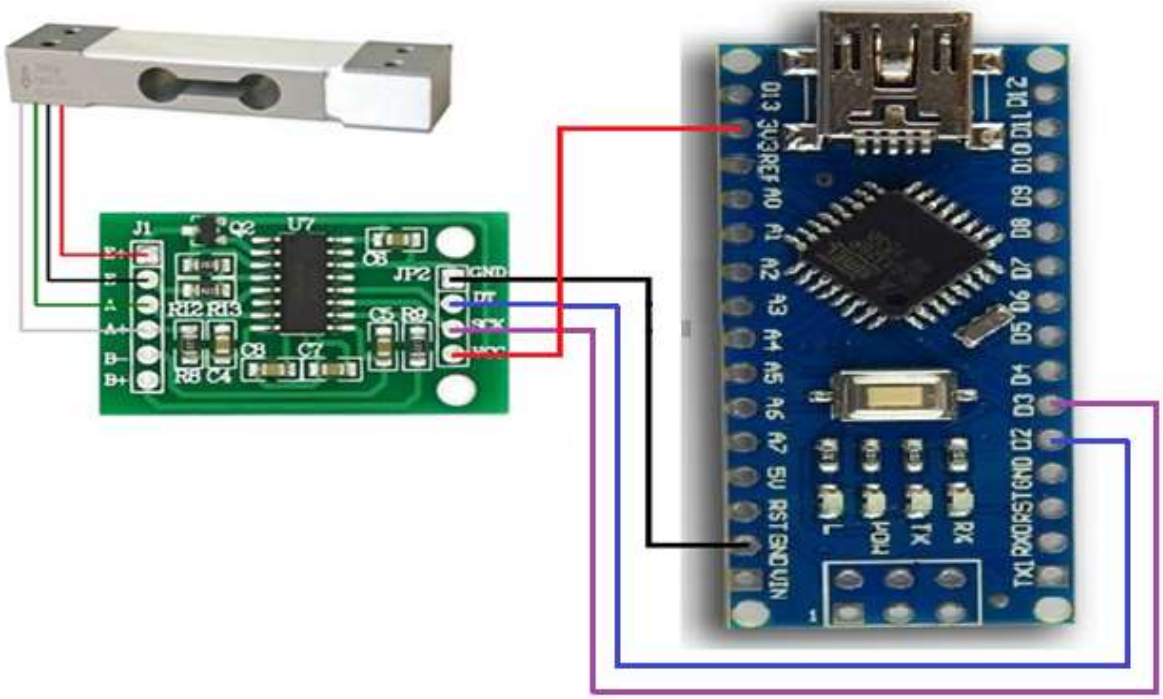
Connection of load cell with HX-711 are:

- Red wire to E+
- Black wire to E-
- Green wire to A-
- White wire to A+

Connection of HX711 to Arduino Nano:

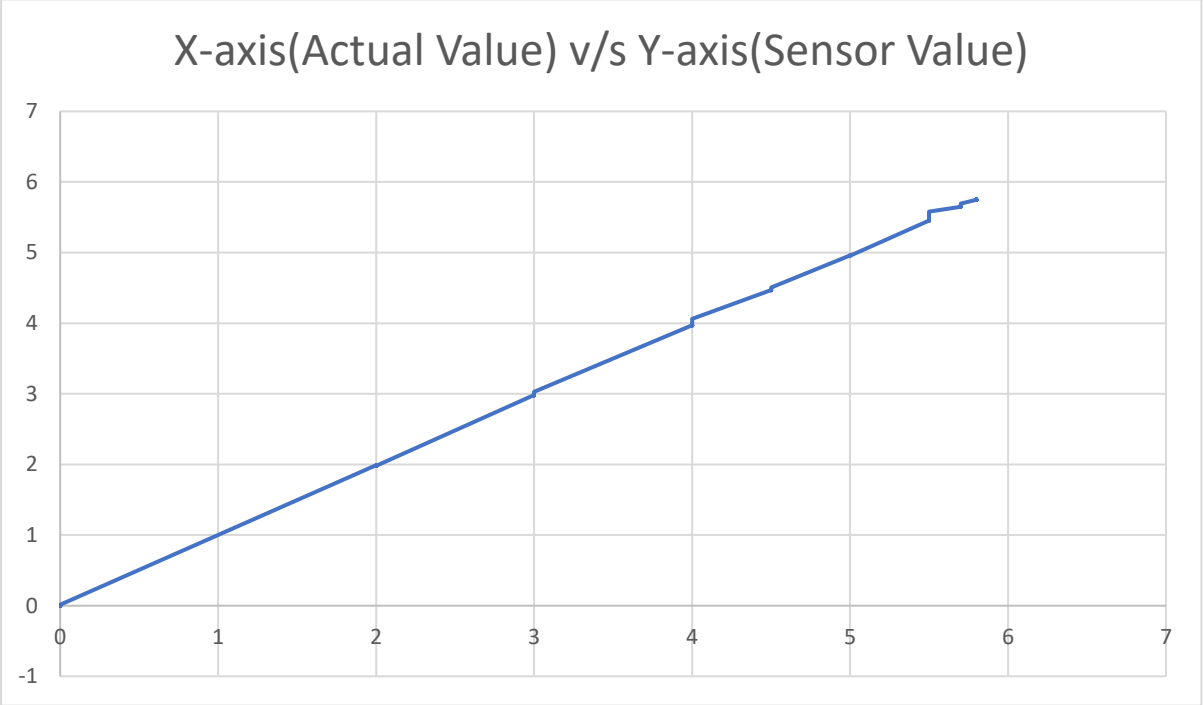
- VCC to 3.3V
- GND to GND
- SCK to Digital pin
- DT to Digital pin

HX711 Module operates at 3.3V and communication is done using serial SDA and SCK pins. You can see an arrow is shown on Load cell. This arrow shows the direction of force on the load cell. You can make arrangement shown in figure using metal strips. Attach metal strip on the Load cell using bolts.

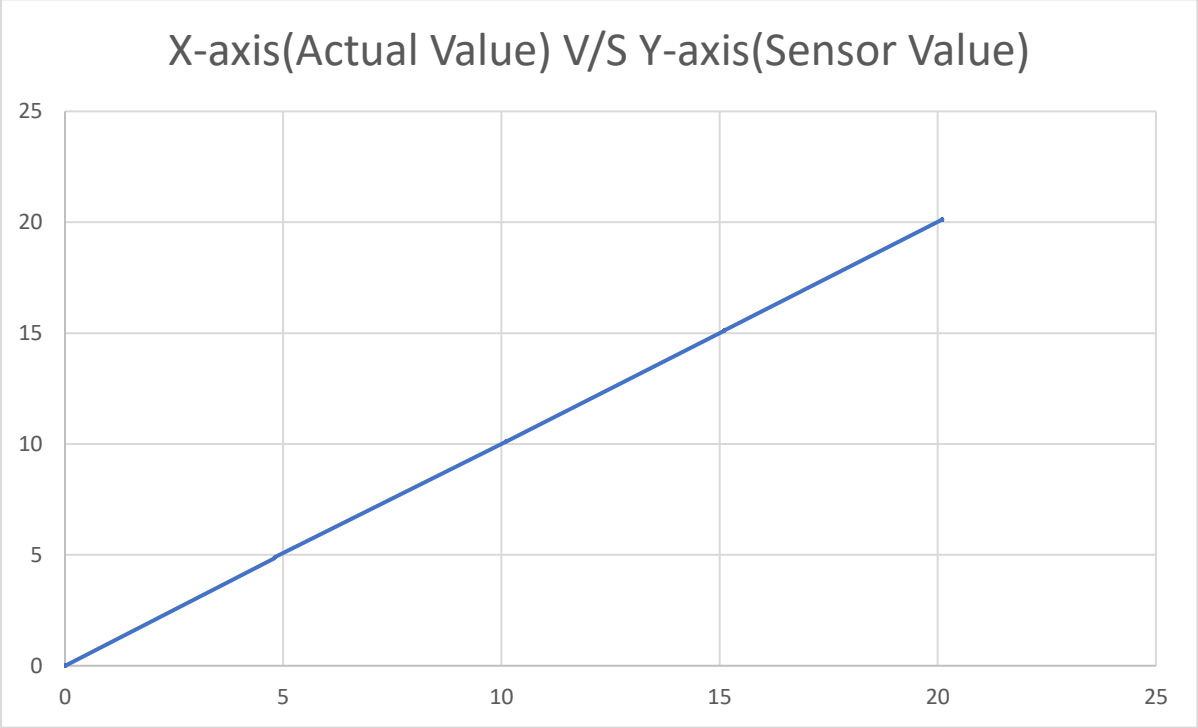


Comparison between actual reading and load cell reading:

a) For lower value of weight (0 to 6 kg):

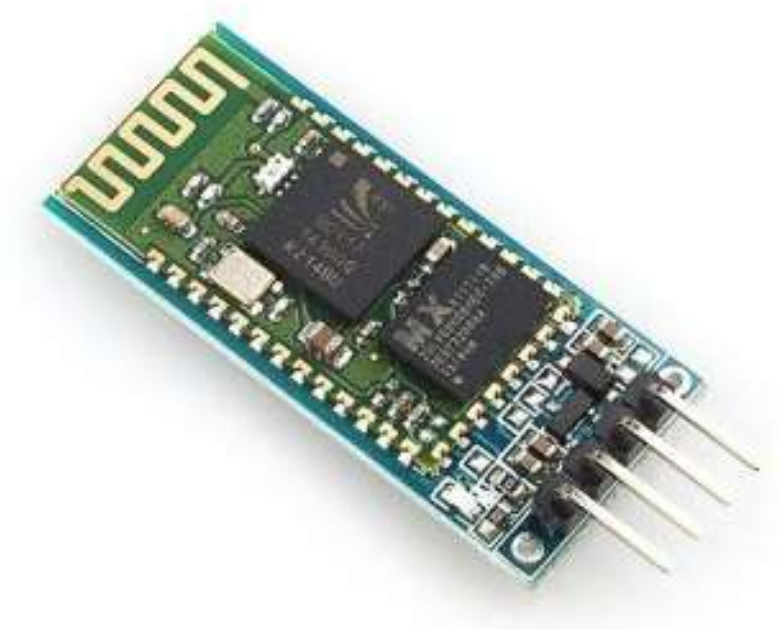


b) For higher value of weight (0 to 20 kg):



Sr. no.	Actual value (0 – 6 kg)	Sensor value	Sr.no.	Actual value (0 – 20 kg)	Sensor value
1	0	0.002	1	0	0.001
2	2	1.99	2	4.8	4.848
3	3	2.982	3	10.1	10.103
4	4	3.972	4	15.1	15.094
5	5.5	5.453	5	20.1	20.114

V. Bluetooth Module HC-05:



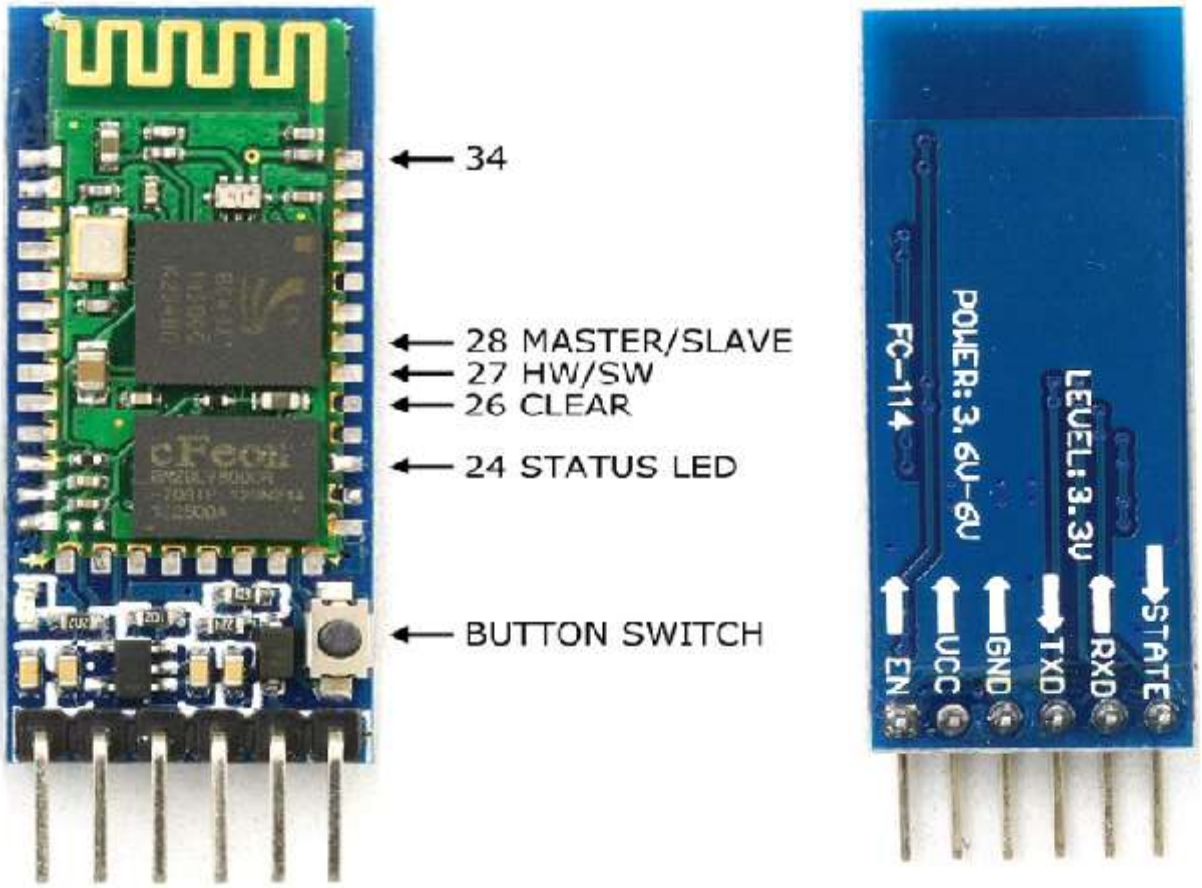
HC-05 module is a Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. By default, the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by at COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded project, etc.

Hardware Features:

- Typical -80dBm sensitivity.
- Up to +4dBm RF transmit power.
- 3.3 to 5 V I/O.
- PIO (Programmable Input/Output) control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

Software Features:

- Slave default Baud rate: 9600, Data bits:8, Stop bit:1, Parity: No parity.
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE: “1234” or “0000” as default.
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.



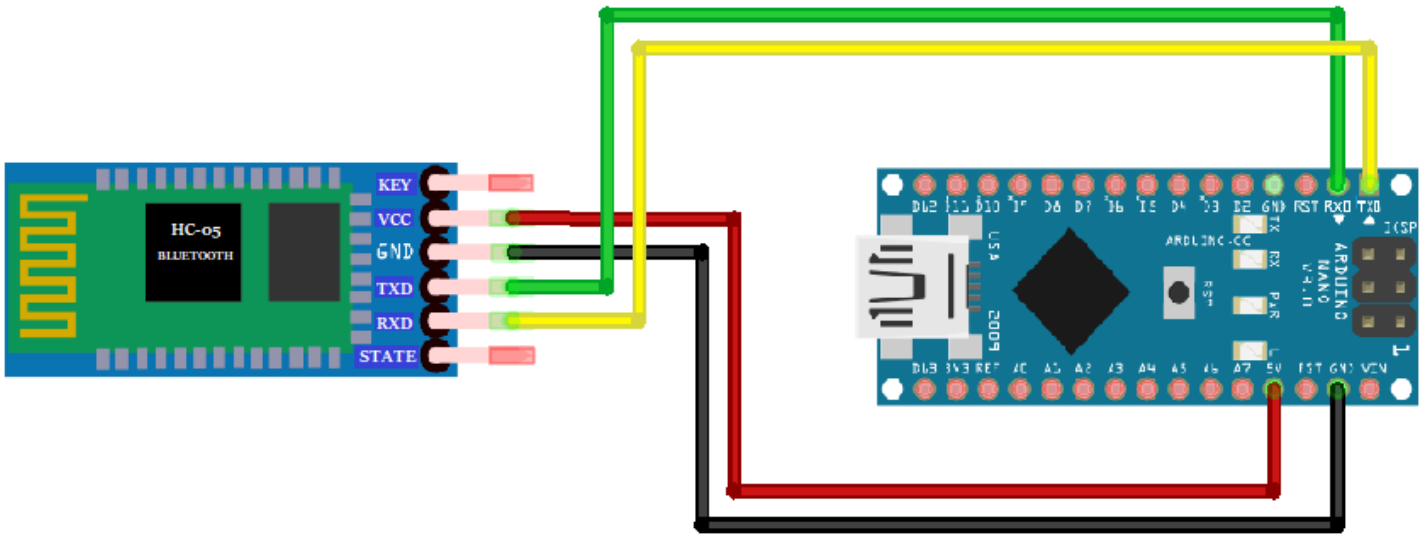
Pins of HC-05:

- **ENABLE:**

  When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e. the module remains on and communication also takes place.

- **Vcc:**
  Supply Voltage 3.3V to 5V
- **GND:**
  Ground pin
- **TXD & RXD:**
  These two pins act as an UART interface for communication
- **STATE:**
  It acts as a status indicator. When the module is not connected to / paired with any other Bluetooth device, signal goes Low. At this low state, the led flashes continuously which denotes that the module is not paired with another device. When this module is connected to/paired with any other Bluetooth device, the signal goes High. At this high state, the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.
- **BUTTON SWITCH:**
  This is used to switch the module into AT command mode. To enable AT command mode, press the button switch for a second. With the help of AT commands, the user can change the parameters of this module but only when the module is not paired with any other BT device. If the module is connected to any other Bluetooth device, it starts to communicate with that device and fails to work in AT command mode.

HC-05 Connection with Arduino Nano:



As we know that Vcc and Gnd of the module goes to Vcc and Gnd of Arduino Nano. The TXD pin goes to RXD pin of Arduino Nano and RXD pin goes to TXD pin of Arduino Nano. Here the process is quite different from others since we are going to use android mobile to control and communicate with

Arduino. Here the Bluetooth module acts as an interface between our mobile and Arduino board. Before getting into the execution process, follow the given procedure:

1. First of all, the user should install an application called Bluetooth Terminal from the play store which is a free application.
2. After installation, pair the Bluetooth module to your mobile as like connecting one device to other using Bluetooth. The default pairing code is 1234 or 0000.
3. Upload the given program to the Arduino Nano board. After uploading the code, unplug the USB from the Arduino.
4. Now use external power adapter to power the Arduino Nano board.
5. The Bluetooth SPP PRO has three types of communication mode. Here Byte stream mode is used to communicate. So, select that mode and give the input

Chapter 6: Authentication

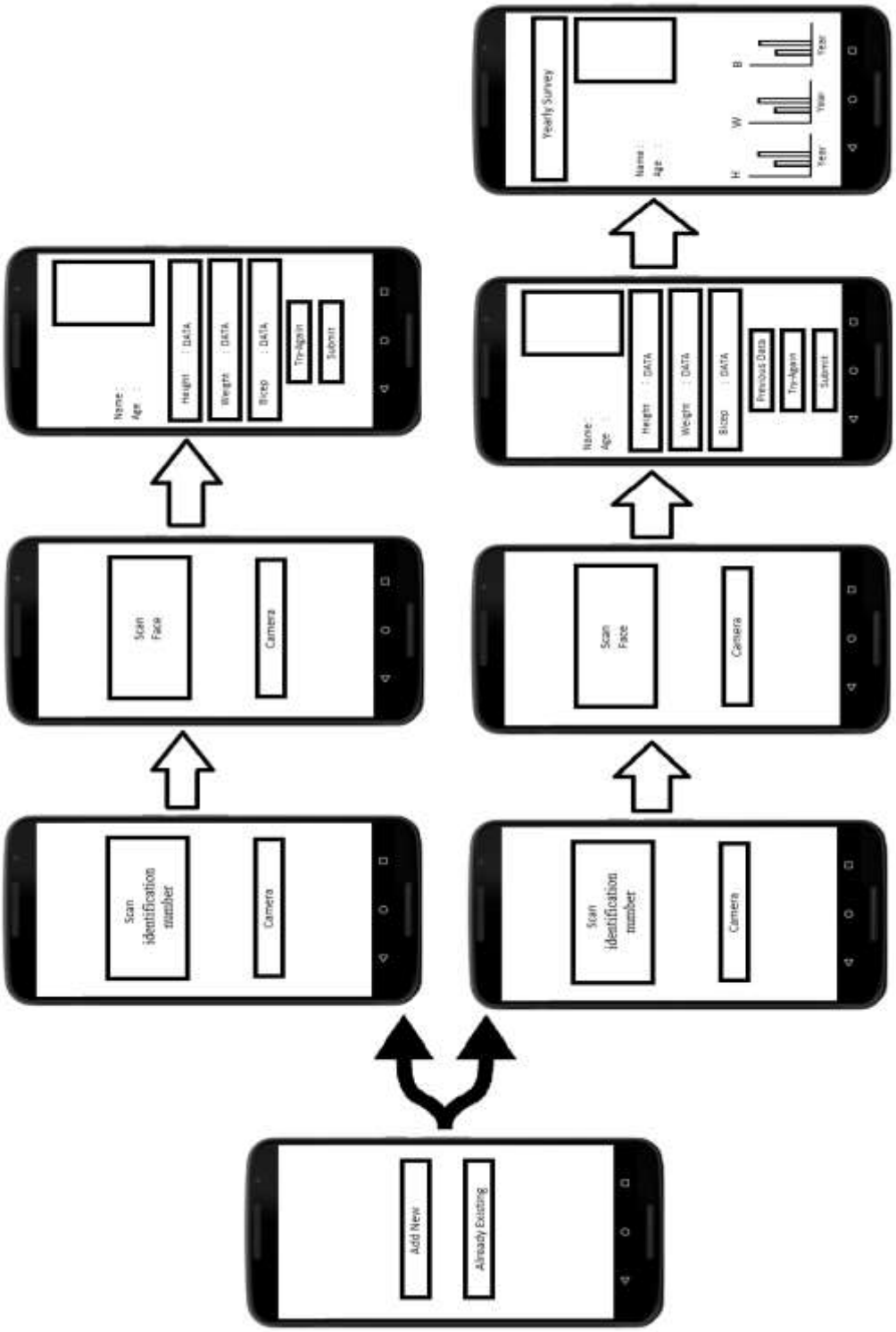
Firebase is a mobile and web application development platform and Firebase Analytics is a cost-free app measurement solution that provides insight into app usage and user engagement. Firebase auth has a built-in email/password authentication system. It also supports Authentication for Google, Facebook, Twitter and GitHub but here we have used GitHub. We will focus on email/password authentication for the most part. Firebase's Authentication system is well-documented and mostly copy/paste.

Authentication process is distributed in mainly three parts. App. Process, Django Server process, and Firebase Process. First of all, in App. district, taluka and centre and according to that centre code is selected. This code is unique code for the child care centre. Then centre code is requested to server. Entered centre code is matched with pre-existing codes, if code is from trained model then process is transferred to the App. And if trained model for the centre does not exist then server itself download the model from Firebase and add it to the trained model. Now App will open barcode scanner to get the barcode i.e. Aadhar-card. Which is unique identity for any child. Then next stage is to take student's image i.e. Face. This barcode and face of child is uploaded to the Firebase and URL is stored. It will take user-id and timestamp for the verification process. It returns URL, user-id, timestamp at database location for the test information to the server. Server gets the image and download the URL image for testing and also get user-id of child to verification.

Verification process is also divided into three parts. Perfect match, partial match and No match condition. Face of a child falls in perfectly matched condition if match is below forty. If match is below fifty then it falls into partial match and if there is no match with face then it comes into no match condition. If child falls in perfectly matched condition then only process will go ahead and get the token from the Firebase. In case of partial match, it will generate the message to take image of that particular student again. And in case of no match it will delete the image and database entry made for testing. Also, it will generate error message and restart the process form the beginning.

Using this custom token of perfectly match condition, login into firebase to authenticate user and it will return user details. That is the completion of the authentication process and data are recorded for further use in future. Then logout from User. We can also analyse the progress of particular child by graphs.

Chapter 7: Mobile application flow



Chapter 8: Acronyms

App**:** Application

Auth**:** Authentication

C_n**:** n^{th} Capacitor

EEPROM**:** Electrically Erasable Programmable Read-Only Memory

GND**:** Ground

IC: Integrated Circuit

I/P**:** Input

O/P**:** Output

PCB**:** Printed Circuit Board

R_n**:** n^{th} Resistor

R_x**:** Receiver

SPP: Serial Port Profile

T_x**:** Transmitter

UART: Universal Asynchronous Receiver-Transmitter

URL: Uniform Resource Locator

USB**:** Universal Serial Bus

Vcc**:** Power supply

MCU: Microcontroller Unit

GPS: Global Positioning System

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