CHAPTER-3

SYSTEM DEVELOPMENT

The Chapter describes the system development with the help of block diagrams and circuit diagrams of the designed sections. Brief description of components is also discussed along with the Proteus Simulation model of the designed sections. It is required to find out a safe and authenticate solution to control the death rate due to not wearing helmets.

Literature suggests RFID is a good solution for authentication of a system. RFID as authenticity module for many applications are discussed but for vehicle authenticity not such systems are proposed. High speed system needs to be designed to focus on the safety of two-wheeler drivers. Exposures to RF frequencies are not likely to adversely affect human health. Flex sensor temperature tolerance range is – 35^0C to $+80^0$C. Arduino is open source platform which can be used for implementation of industrial applications.

3.1 Embedded System

A special purpose designed system is generally known as embedded system. This system is designed such a way so that the controller supports the features of device, it controls. Embedded systems are designed to perform specific tasks. Embedded system can be a part of integrated system which can monitor or control the specific parameters. Some of the features of embedded system are to perform specific task, it should be energy efficient, support small code size, low cost, quick response i.e. high speed, real time execution, sensors interfacing, user friendly, flexible, availability of cross complier, intelligent communication and integrity.

The invention of microcontroller leads to the embedded system industry. Since then based on the demand of devices different processors and controller are designed. After identifying the task to be performed next step is to choose appropriate controller.

3.1.1 Microcontroller

A microcontroller is an on chip system comprising of a core processor, memory, and programmable input/output peripherals. Program memory in the form of RAM, flash and ROM is also included on the chip. Classification of microcontroller can be done on the basis of Bits, memory, instruction set, architecture or manufacturer.

Depending on the requirement of the system, microcontroller can be chosen. Criterion for selecting microcontroller includes- availability, size, compatibility, cost etc. Considering the features, availability and I/O pins required for current work, Arduino is used to design the system.

Arduino Uno

Fig.3.1 shows the snapshot of Arduino Uno. This is open source ATmega 328P controller based platform. Arduino Uno has six analog I/O pins and 14 digital I/O pins out of which 6 can act as PWM outputs. It operates on 5V DC and 16 MHz of frequency. To get started simply connect it to computer with USB cable. Programming is done with Arduino software (IDE). It has 32 KB of flash memory, 2 KB SRAM and 1 KB EEPROM. It doesn't require any external hardware programmer to load the program. It can communicate serially with the pins RX and TX. Communication in SPI mode is done with the pins SS, MOSI, MISO, SCK. For TWI mode SDA and SCL pins are available.

Fig.3.1 Arduino Uno

3.2 Sensor

Sensor plays an important role in any embedded system designed to monitor or control a process. A sensor is a device which detects the changes in the parameter values for which it is designed and provides a corresponding output, generally in the form of electrical signal. Broadly depending on the type of output signal generated on change in quantity sensors are of two types.

Digital Sensor

A digital sensor is where digital type of data is transmitted on occurrence of an event. Whenever an event will occur they will be activated generated signal as active high or active low output.

Analog Sensor

It produces the output voltage with respect to the change in environmental parameters. It continuously senses the change in environment.

In the system discussed in this thesis Flex sensor is used which is an analog sensor.

3.2.1 Flex Sensor

The flex sensor is like a variable resistor. With bend positions of the body, resistance of the flex sensor increases. They can be used in the applications as door sensors, robot whisker sensors, or a primary component in creating sentient stuffed animals.

The use of sensor with voltage divider is the simplest way to incorporate it in a project. This circuit requires one resistor along with the sensor. The 47kΩ resistor is connected at the ground side, and the flex sensor at the 5V side. It means as the flex sensor's resistance increases (the sensor is bending) the voltage on input pin of controller will decrease. Fig.3.2 shows snapshot of the flex sensor.

Fig.3.2 Flex sensor

3.3 Authenticity

In the embedded system wherever security issues arises, developer needs some modules to ensure the access of system only by authorize person. As discussed in chapter-1 a lot of authenticity modules are available depending upon the level security required for the system. For the current work RFID is identified as authenticity module.

3.3.1 RFID

RFID module can be directly connected to microcontroller in UART mode or with a RS232 converter to PC. This RFID Reader Module works with any 125 KHz RFID tags. It operates on +5V DC power supply with range of 10c.m. Table 1.1 shows the pin description of the RFID reader.

Table 1.1 Pin description of RFID reader

S.No.	Pin	Description
1	Vcc	+5V
2	GND	Ground
3	BEEP	Beep & LED
4	NC	(Not connected)
5	NC	(Not connected)
6	SEL	RS232 Select line
7	RS232	RS232 pin

8	D1	Data pin1
9	D0	Data pin0

A twelve byte code is to be extracted for RFID tag**.** The twelve byte codes of individual RFID tags in arrays and compare the code with live code fetched from tag. If it matches with the desired value then required decision can be taken. Fig.3.3 shows the snapshot for the RFID reader and tags.

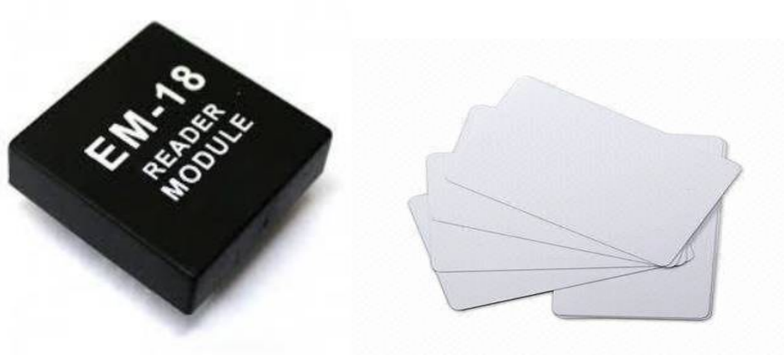

Fig.3.3 RFID reader and tags

3.4 Communication Media

Literature suggests number of communication media to communicate between two or more section of an embedded system. Communication media can be wired and wireless depending on the application and requirement. Also for wireless communication number of module are available in the market depending upon the range of communication.

One of the most popular wireless media now-a-days is RF modem. Radio frequency communication works on electromagnetic waves as transmission medium. RF frequency can propagate through non-shielding materials upto some extent. RF module is license free and operates on IEEE802.15.4 standard. ISM band includes 802 family standards with 802.15.1 bluetooth, 802.11 WLAN and 802.15.4e. World-wide compatibility is ISM-band at 2.4 GHz. In India ISM frequency band for RF module is 433MHz and 2.4 GHz. On the basis of its properties RF modem is used as communication module for the current work.

3.4.1 RF Modem

RF modem is used for applications that needs wireless data transmission. It works on +5V power supply with TTL logic. It has adjustable data rate and reliable transmission distance, with automatic switching between TX and RX mode. It uses FSK technology, half duplex mode, and license free 2.4 GHz band. Fig.3.4 shows the RF modem.

Fig.3.4 RF modem (model no.-1124 from Sunrom)

3.5 System Description

An authentic approach in the form of an intelligent helmet is proposed in this thesis. A system is designed for safety of driver and authentic ignition for two-wheeler. System is designed so that it can sense whether the driver is wearing helmet or not, which is considered as essential parameter to start the two-wheeler. This is to ensure the safety of driver. Along with safety, RFID reader is attached with bike to ensure that only authorized person can ignite the vehicle. When both the signals one from sensors placed in helmet and other from RFID are matched with predefined values, then only two-wheeler would be ignited through relay.

Fig.3.5 shows the flowchart for the complete system process. Here abbreviation used for two-wheeler node is TWN and HN for helmet node

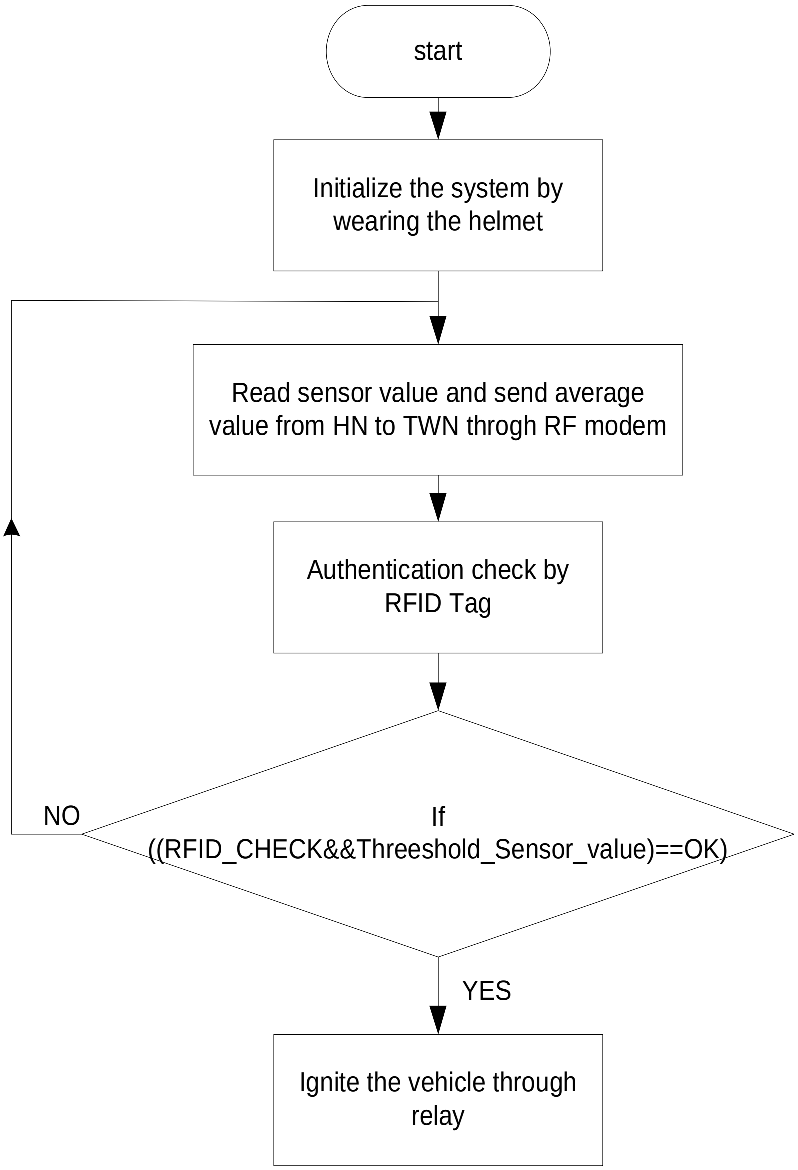

Fig.3.5 Flow chart for the system

Pictorial diagram for the system is shown in Fig.3.6. It shows the complete process of system flow in pictorial form.

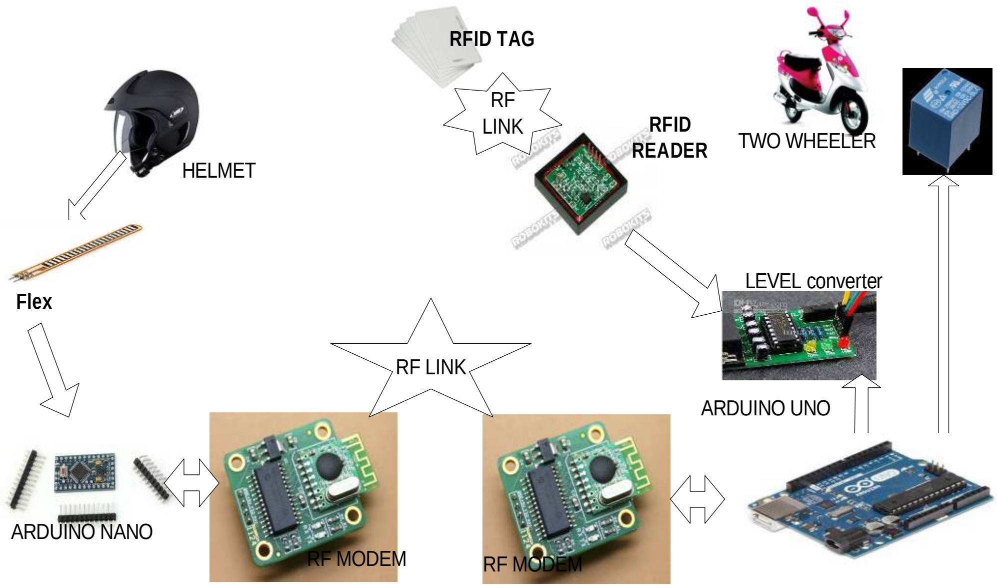

Fig.3.6 Pictorial diagram of the system

The system is developed in three sections

- Helmet node (transmitter section)- It comprises of three flex sensors, controller unit, power supply (rechargeable battery), a serial port (to charge the battery) and RF modem.
- Two-wheeler node (receiver section)- It comprises of RF modem, controller unit, RFID reader (to authentic the user), battery, relay (to ignite the vehicle).
- Server/ Data logger- It comprises of RF modem, controller unit, power supply (battery), USB to serial port (to interface with PC/LabVIEW)

Fig.3.7 shows the data flow between all the three sections. Sensors are located inside the helmet, two-wheeler node is placed on the vehicle and server circuit is connected to PC/laptop to interface with LabVIEW. Helmet node (HN) is transmitting the average value of flex sensors to two wheeler node (TWN) and to data logger through RF modem for analysis purpose. After analysis of the data received from the helmet node, the value is shared with two-wheeler node and all threshold values are set accordingly.

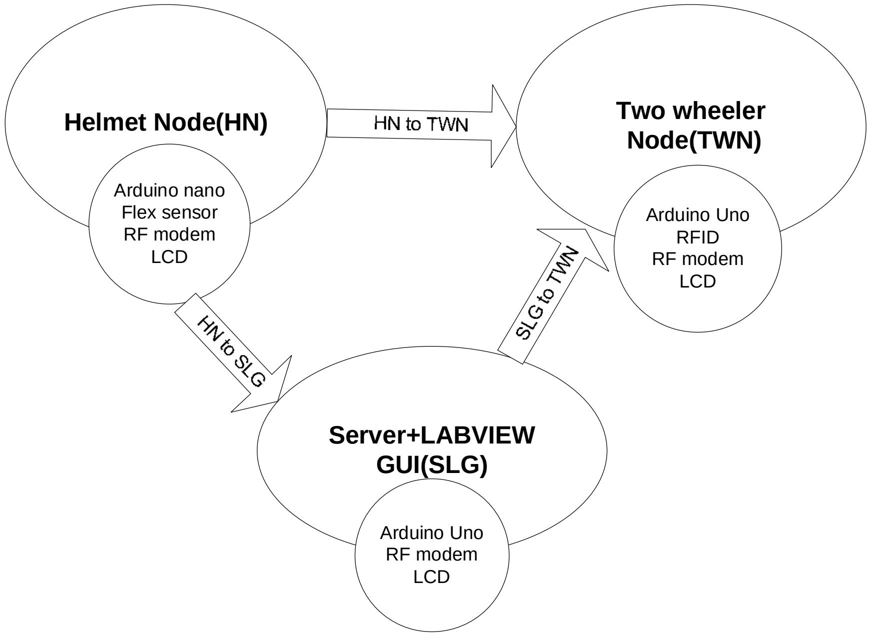

Fig.3.7 Data flow between all the three sections

3.5.1 Helmet Node (Transmitter Section)

The section comprises of three flex sensors which generates value corresponds to the change in angle and this value is transmitted to controller unit as shown in Fig.3.8. These flex sensors are analog in nature and provides analog value so they are connected to the ADC pin of the controller unit. To transmit the average value of the sensors RF Modem is used which operates at 2.4GHz frequency. Here helmet node is designed in two different methods-

1. It is designed with Arduino Uno, flex sensors and RF modem to communicate only with the two wheeler node. Its operating range is 100 meters with 2.4 GHz RF modem. Fig.3.8 shows the block diagram of the helmet node for method1.

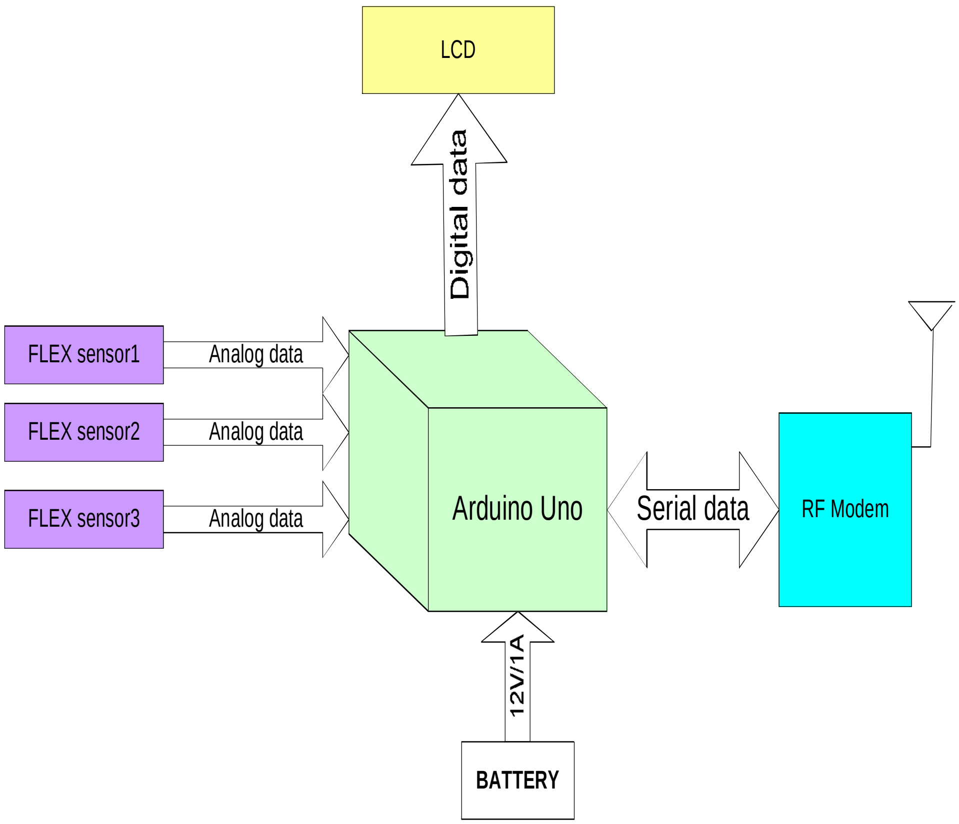

Fig.3.8 Block diagram of Helmet node for method1

2. It is designed with Arduino Uno, flex sensors and Node MCU to transmit data on cloud server. It can be accessed from anywhere in the world. It would be beneficial for data analysis of sensory data on cloud server. Its importance is more for analyzing the data to detect the accident and generate an alert signal to nearest hospital or police station for quick help by sending the coordinates of the user. In the current thesis the data is analyzed only for finding the threshold value of sensors to ignite the vehicle. Future scope can be to calculate the threshold value of the sensors to detect accident. Fig.3.9 shows the block diagram of the helmet node for method1.

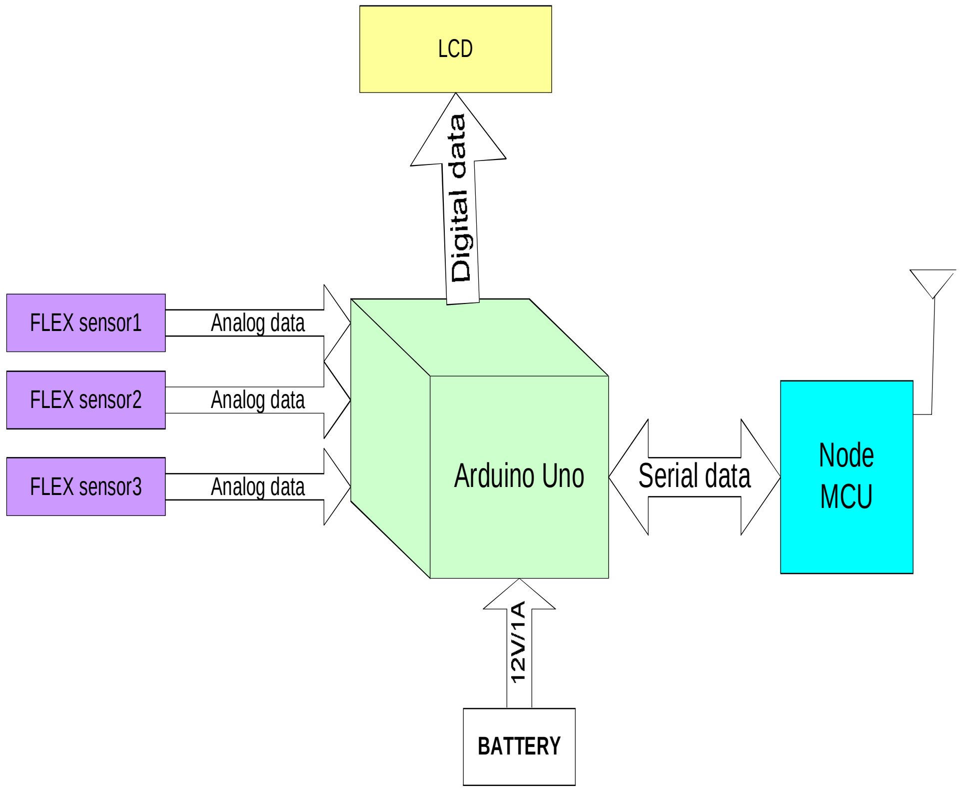

Fig.3.9 Block diagram of Helmet node for method2

3.5.2 Two-wheeler Node (Receiver Section)

Fig.3.10 shows the block diagram for two-wheeler node. In the receiver section the RF Modem receives the data transmitted by the helmet. This data contains the average value of all the sensors inside the helmet.

When a bike rider wears helmet, the helmet section sends the average value to the two-wheeler node. Then a RFID card is to be swiped and the controller unit performs AND operation on these two signals and compared with the predefined values. If both data matches with threshold values then two-wheeler is ignited through the relay.

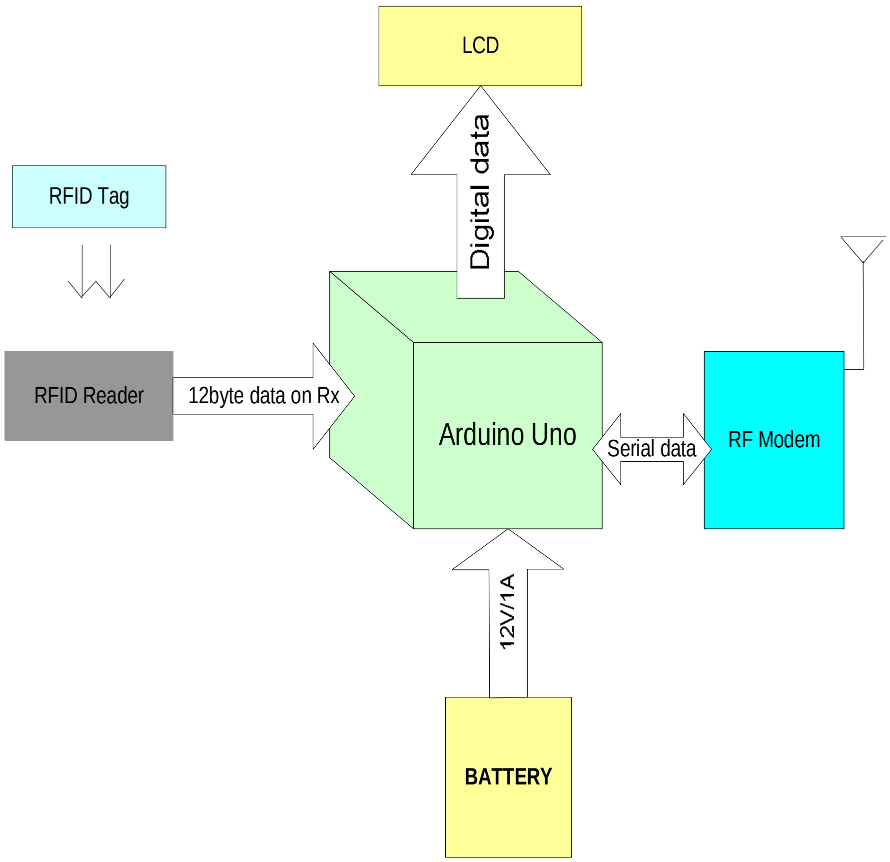

Fig.3.10 Block diagram of two-wheeler node

3.5.3 Server/Data Logger

Sensory data is analyzed with two methods. One is to analyze data for checking the working of helmet node with LabVIEW GUI and other is to analyze sensory data on cloud server.

1. Data logger as shown in Fig.3.11 comprises of a controller unit, LCD and RF modem. It is used to analyze the sensory data and system working with LabVIEW GUI.

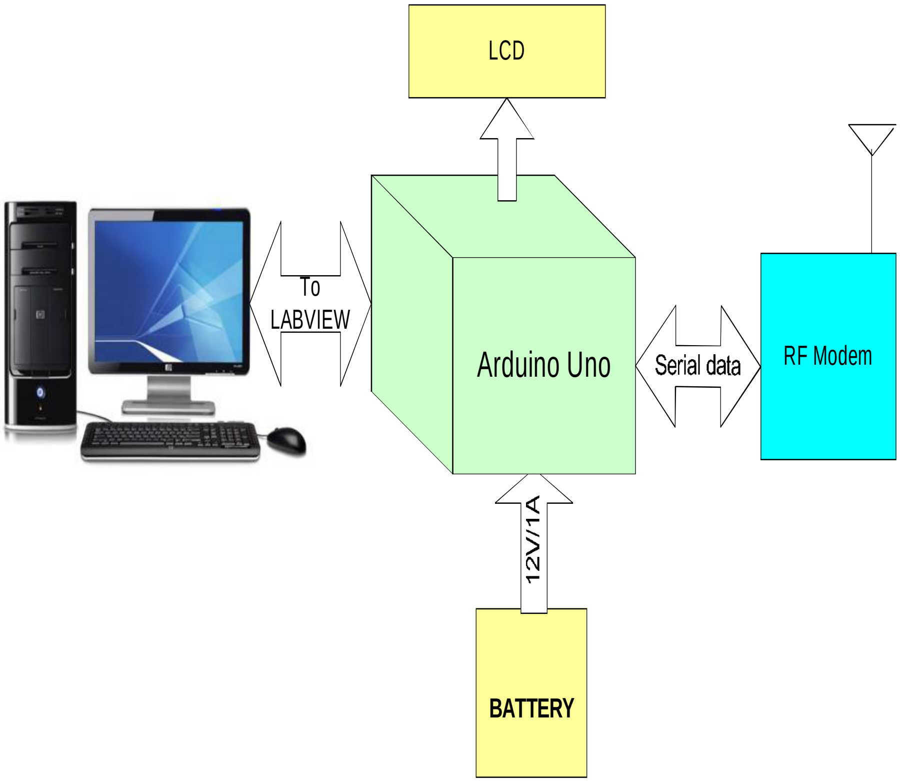

Fig.3.11 Block diagram of Server/Data logger

2. The sensory data is transmitted on the cloud server on Thingspeak.com, which is free to access. It can be accessed from anywhere in the world. This is designed for the method2 helmet node.

3.6 Circuit Diagram of the System

In the helmet node the output value from the sensors are collected and the average value is transmitted to two wheeler node through the RF Modem. Fig.3.12 shows the circuit diagram to read data from flex sensors by helmet node and the average value of sensors and RFID on two-wheeler node takes cumulative decision to authenticate the system.

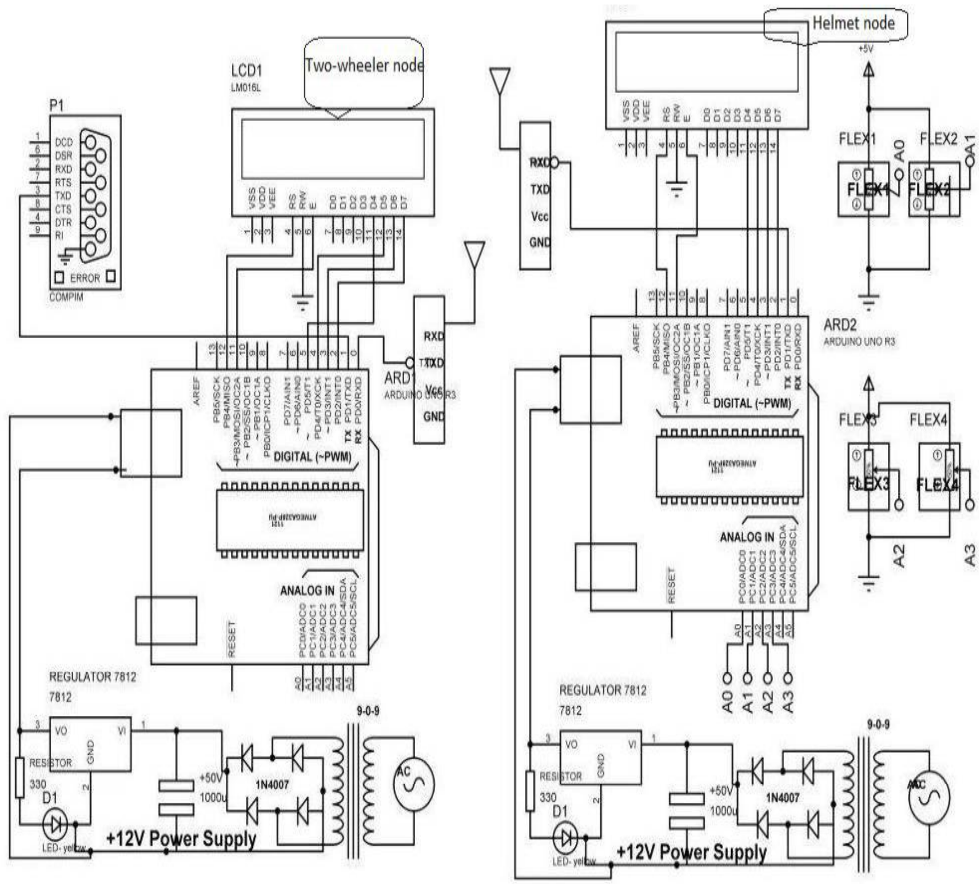

Fig.3.12 Circuit diagram of the system

3.6.1 Circuit Diagram Connections

The connections in circuit diagram are as follows-

Helmet Node

Arduino and LCD

1. Arduino pin 12 is connected to pin4 (RS) of LCD
2. Arduino GND is connected to pin6 (RW) of LCD
3. Arduino pin 11 is connected to pin6 (E) of LCD
4. Arduino pin5 is connected to pin11 (D4) of LCD
5. Arduino pin4 is connected to pin12 (D5) of LCD
6. Arduino pin3 is connected to pin13 (D6) of LCD
7. Arduino pin2 is connected to pin14 (D7) of LCD

Arduino and Flex Sensors

1. Arduino pin A0 is connected to out pin of flex sensor1
2. Arduino pin +5V is connected to +Vcc pin of flex sensor1
3. Arduino pin GND is connected to GND pin of flex sensor1
4. Arduino pin A1 is connected to out pin of flex sensor2
5. Arduino pin +5V is connected to +Vcc pin of flex sensor2
6. Arduino pin GND is connected to GND pin of flex sensor2
7. Arduino pin A2 is connected to out pin of flex sensor3
8. Arduino pin +5V is connected to +Vcc pin of flex sensor3
9. Arduino pin GND is connected to GND pin of flex sensor3

Arduino and RF Modem

1. Arduino pin0 (RX) is connected to TX pin of RF modem
2. Arduino pin1 (TX) is connected to RX pin of RF modem
3. Arduino pin +5V is connected to +Vcc pin of RF modem
4. Arduino pin GND is connected to GND pin of RF modem

Two-wheeler Node

Connections of Arduino with LCD and RF modem are same as helmet node.

Arduino and RFID reader

1. Arduino pin9 (RX) is connected to pin7 (Dout) of RFID
2. Arduino pin +5V is connected to pin6 (SEL) & pin1 (+Vcc) of RFID
4. Arduino pin GND is connected to pin2 (GND) of RFID

Circuit diagram for the Server/Data Logger

Fig.3.13 shows the circuit diagram for the server/data logger. Connections of Arduino with LCD and RF modem are same as helmet node.

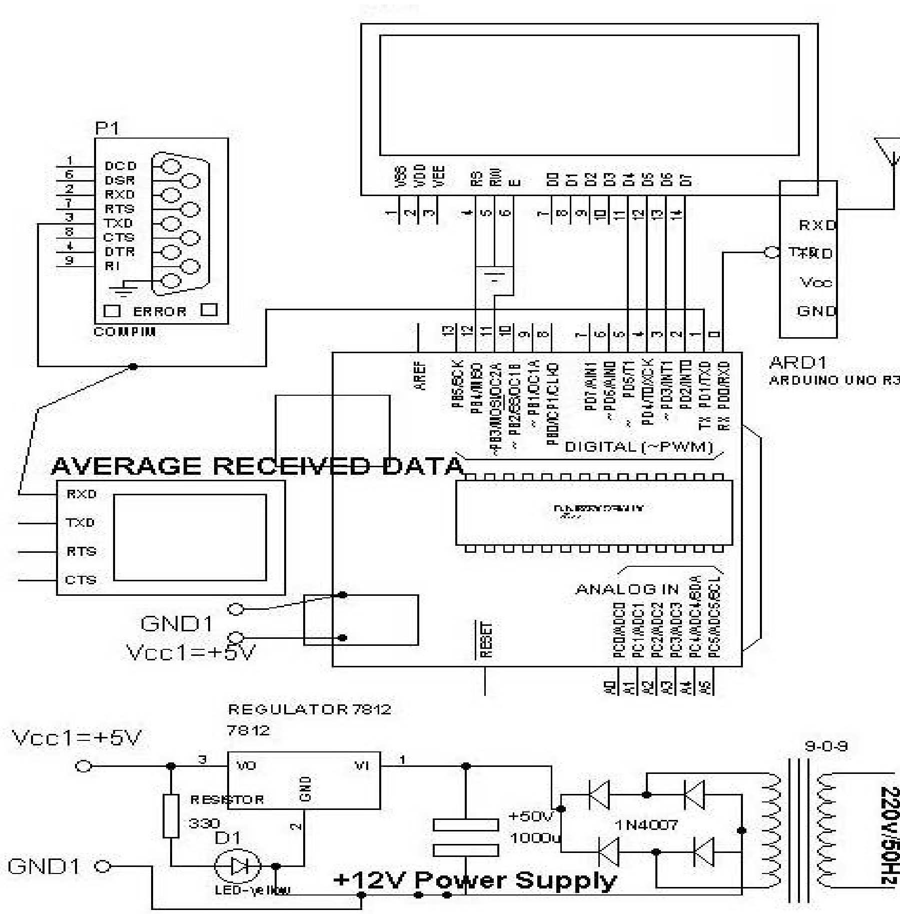

Fig.3.13 Circuit diagram for the server/data logger

3.7 Proteus Simulation Model

This software is developed by Lab center Electronics which is used for simulation, schematic capture and printed circuit board (PCB). It has Virtual System Modeling (VSM), circuit simulation, animated components and microcontroller models to simulate the designs. This is a tool to test the microcontroller designs before building a hardware prototype.

Circuit simulation is a key component of Proteus 7.0. Fig.3.14 shows the Proteus Simulation model to read data from flex sensors by helmet node through RF modem and receiving of the average value of sensors with RFID code to authenticate the system by two-wheeler node. To view the data with the LabVIEW the virtual serial port COMPIM is used in the Proteus Simulator.

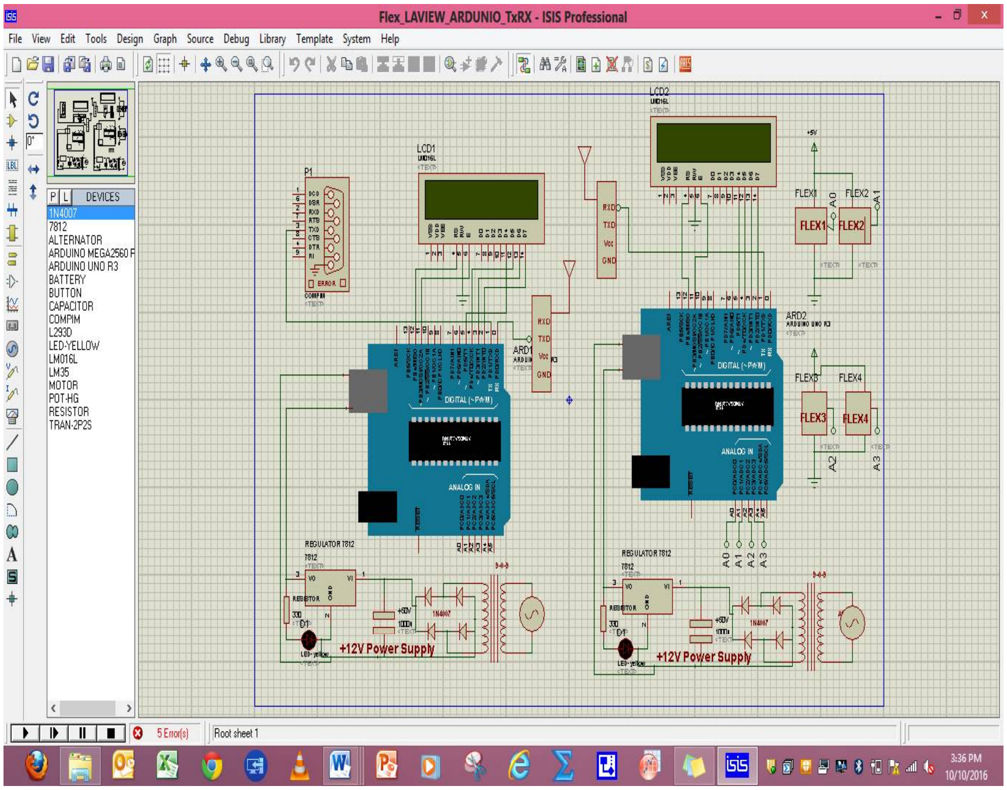

Fig.3.14 Proteus simulation model for the system

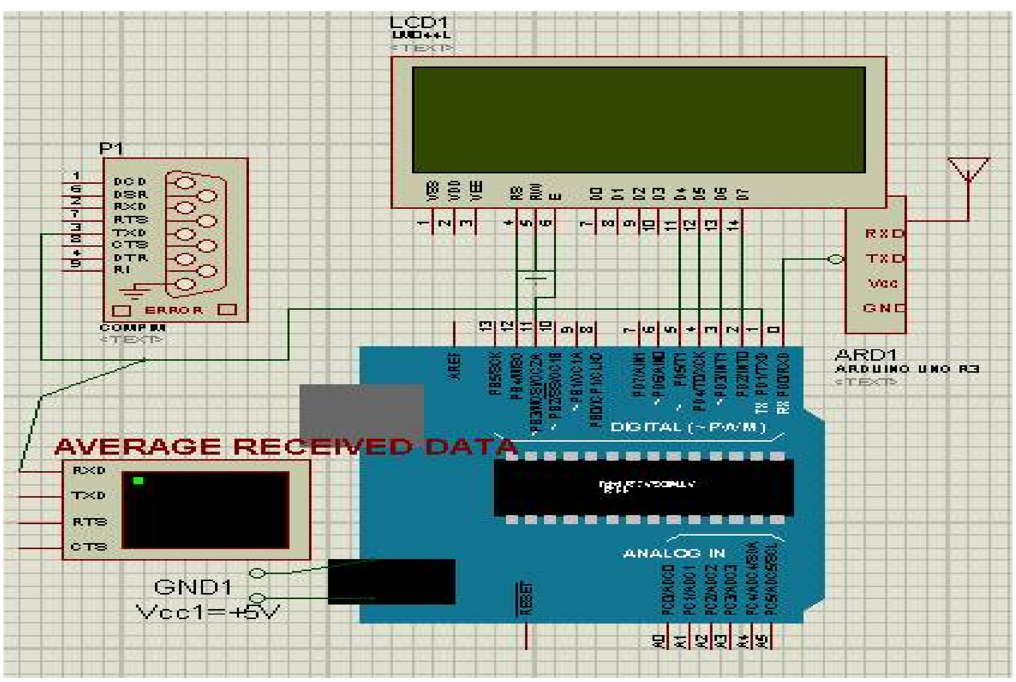

Fig.3.15 Proteus simulation model for the server

Fig.3.15 shows the Proteus simulation model for the server. The circuit shows the connection of Arduino with LCD, RF modem and COMPIM. Simulation result shows the proper working of the section.

3.8 Chapter Summary

On the basis of the problem statement of the thesis, this chapter describes the selection of components to develop the system. Brief description of major components is included. The chapter concludes the block diagram and circuit diagrams of both sections of system- Helmet node and two-wheeler node. Simulation with the help of Proteus simulation software is also discussed to check the feasibility of designed system with selected components, before its actual hardware implementation.