CHAPTER-6

RESULT ANALYSIS

The Chapter elaborates the experimental outcomes of the research, with the analysis of the received data from the developed system. The analysis of statistical data collected from the experimental setup is done with the concept of hypothesis and threshold value is calculated. Experiment is performed on age group of 18-25years in different time slot during year 2016. The system analysis is done with the help of LabVIEW GUI.

6.1 System Analysis with LabVIEW GUI

LabVIEW has two panels- Front Panel and block diagram. The front panel is basically GUI for human interface with LabVIEW.

Two different GUI has been designed for complete analysis- GUI to record and analyze sensory data at helmet node and GUI to analyze complete system with RFID and sensory data at two-wheeler node.

6.1.1 LabVIEW GUI to Record and Analyze the Sensory Data

The block diagram is the virtual space where actual graphical programming for the system is developed. The data is collected through the VISA source and various parameters are defined to develop the code. The incoming data is compared with the match pattern and from here the decimal string is converted to the number that is received through the VISA source and finally is displayed with the graph on front panel. Total twenty four byte data is sent by helmet node in a specific format given as below-

FSR1:---	FSR2:---	FSR3:---	FSR4:---
8 byte	8 byte	8 byte	8 byte

Here FSR is abbreviation used for flex sensor. Total thirty two bytes of data is received from the sensors in form of level and mean of all the three sensors.

Fig.6.1 shows the LabVIEW block diagram. VISA serial is to define four parameters named- baud rate (9600), data bits (8), parity (none) and stop bit.

Match patterns are used to take the inputs from the sensors and convert it into string and displayed through graphs. All the input signals are also merged to display the combined graphs for all the inputs. Data record is generated with the help of case structure.

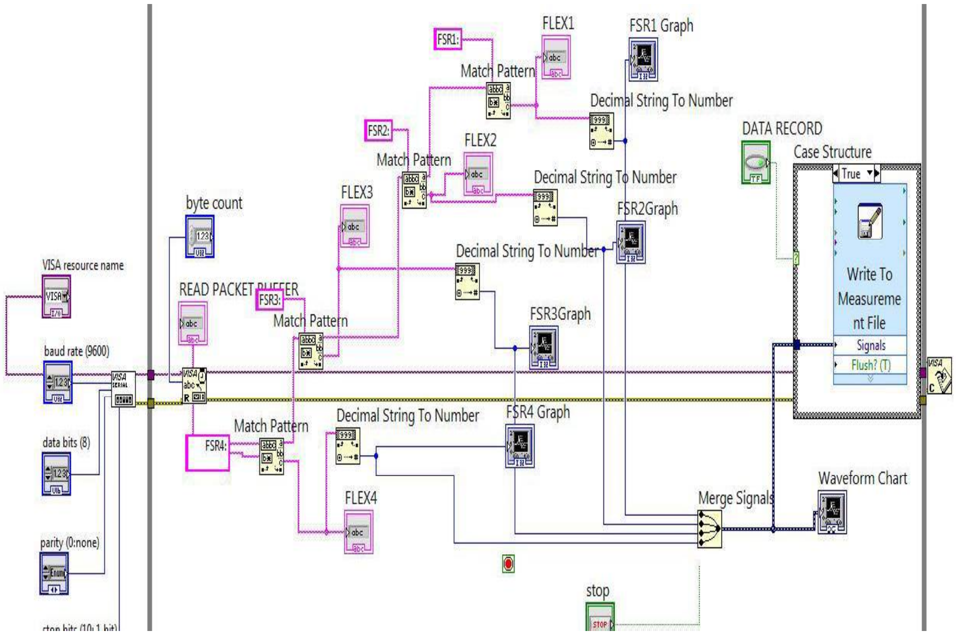

Fig.6.1 Block diagram for LabVIEW GUI for flex sensor analysis and data logger

Fig.6.2 shows the front panel for the recording and analyzing the sensory data at helmet node. It is developed by connecting all the input blocks as shown in Fig.6.1. Fig.6.2 describes the GUI with sensor waveforms, data record, combined waveform chart, VISA resource name, baud rate, data bits, parity, stop bit and read packet buffer.

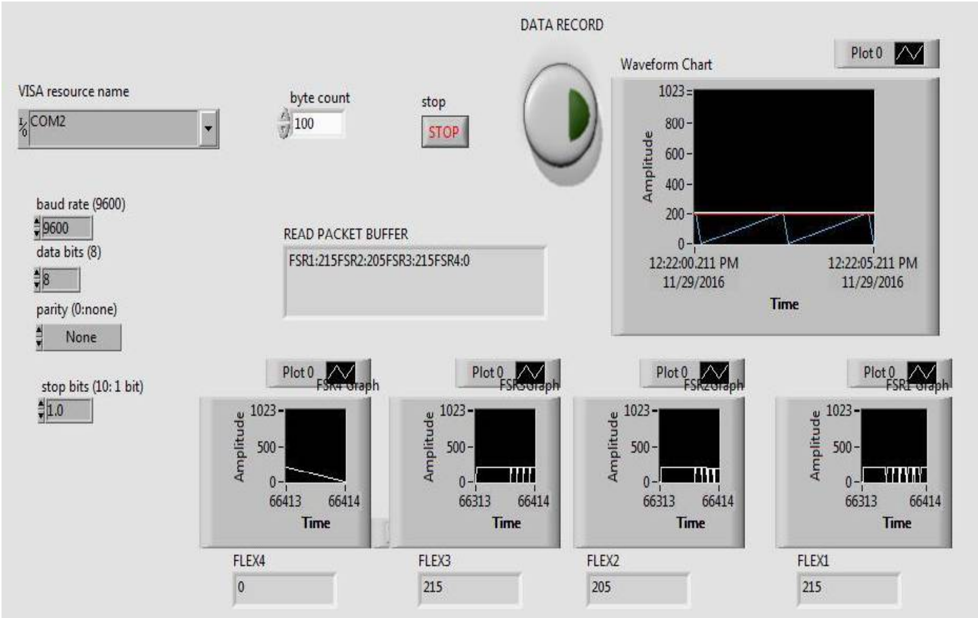

Fig.6.2 Front Panel for LabVIEW GUI for flex sensor analysis and data logger

On clicking the data record button (as shown in Fig.6.2) on GUI an excel sheet is generated showing the flex sensor values with date and time. Fig.6.3 shows data record for sensor values on 9th feb 2017 at time 12:25:35 to 12:26:02.

	A	B	C	D	E	F
1	Time	FLEX1	Time 1	FLEX2	Time 2	FLEX3
2	02/09/2017 12:25:35.356	215	02/09/2017 12:25:35.356	215	02/09/2017 12:25:35.356	205
3	02/09/2017 12:25:51.276	215	02/09/2017 12:25:51.276	215	02/09/2017 12:25:51.276	205
4	02/09/2017 12:25:51.443	215	02/09/2017 12:25:51.443	215	02/09/2017 12:25:51.443	205
5	02/09/2017 12:25:51.629	215	02/09/2017 12:25:51.629	215	02/09/2017 12:25:51.629	205
6	02/09/2017 12:25:51.790	215	02/09/2017 12:25:51.790	215	02/09/2017 12:25:51.790	205
7	02/09/2017 12:25:51.988	215	02/09/2017 12:25:51.988	215	02/09/2017 12:25:51.988	205
8	02/09/2017 12:25:52.153	215	02/09/2017 12:25:52.153	215	02/09/2017 12:25:52.153	205
9	02/09/2017 12:25:52.308	215	02/09/2017 12:25:52.308	215	02/09/2017 12:25:52.308	205
10	02/09/2017 12:25:52.443	215	02/09/2017 12:25:52.443	215	02/09/2017 12:25:52.443	205
11	02/09/2017 12:25:55.055	215	02/09/2017 12:25:55.055	215	02/09/2017 12:25:55.055	205
12	02/09/2017 12:25:58.399	215	02/09/2017 12:25:58.399	215	02/09/2017 12:25:58.399	205
13	02/09/2017 12:25:58.608	215	02/09/2017 12:25:58.608	215	02/09/2017 12:25:58.608	205
14	02/09/2017 12:25:58.782	215	02/09/2017 12:25:58.782	215	02/09/2017 12:25:58.782	205
15	02/09/2017 12:25:58.943	215	02/09/2017 12:25:58.943	215	02/09/2017 12:25:58.943	205
16	02/09/2017 12:26:01.634	215	02/09/2017 12:26:01.634	215	02/09/2017 12:26:01.634	205
17	02/09/2017 12:26:01.819	215	02/09/2017 12:26:01.819	215	02/09/2017 12:26:01.819	205
18	02/09/2017 12:26:02.083	215	02/09/2017 12:26:02.083	215	02/09/2017 12:26:02.083	205
19	02/09/2017 12:26:02.237	215	02/09/2017 12:26:02.237	215	02/09/2017 12:26:02.237	205
20	02/09/2017 12:26:02.388	215	02/09/2017 12:26:02.388	215	02/09/2017 12:26:02.388	205
21	02/09/2017 12:26:02.530	215	02/09/2017 12:26:02.530	215	02/09/2017 12:26:02.530	205
22						

Fig.6.3 Snapshot for the data logger recording

6.1.2 LabVIEW GUI to Analyze the Complete System

The data is collected through the VISA source and various parameters are defined to develop the code. VISA serial is to define four parameters named- baud rate (9600), data bits (8), parity (none) and stop bit. Input is taken through match pattern and converted into string to display it on graph. Here input is average value of all the sensors. Another input is taken from RFID tag.

On receiving the two types of inputs indicator control loop is written in such a way that if both the signals are matched with pre-defined values then indictor will be ‘green’ otherwise ‘red’. Here green indicator signifies ignition of vehicle and red signifies vehicle is not ignited. Fig. 6.4 shows the block diagram for the LabVIEW GUI designed to analyze the working of the system.

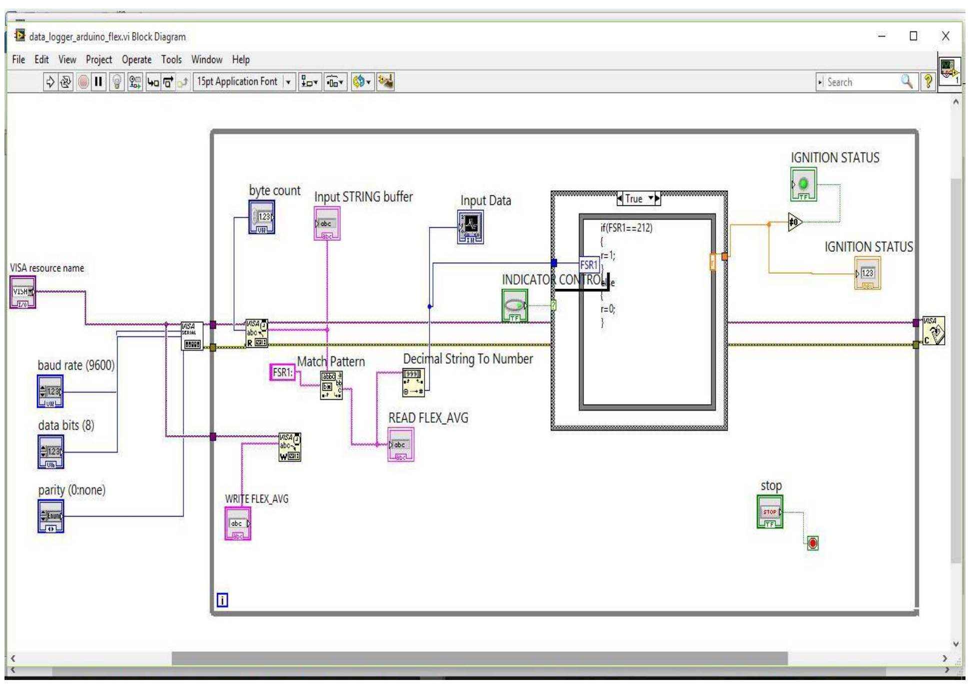

Fig.6.4 Block Diagram for Lab VIEW for system analysis

Fig. 6.5 shows the front panel for the LabVIEW GUI which indicates that the vehicle is not ignited.

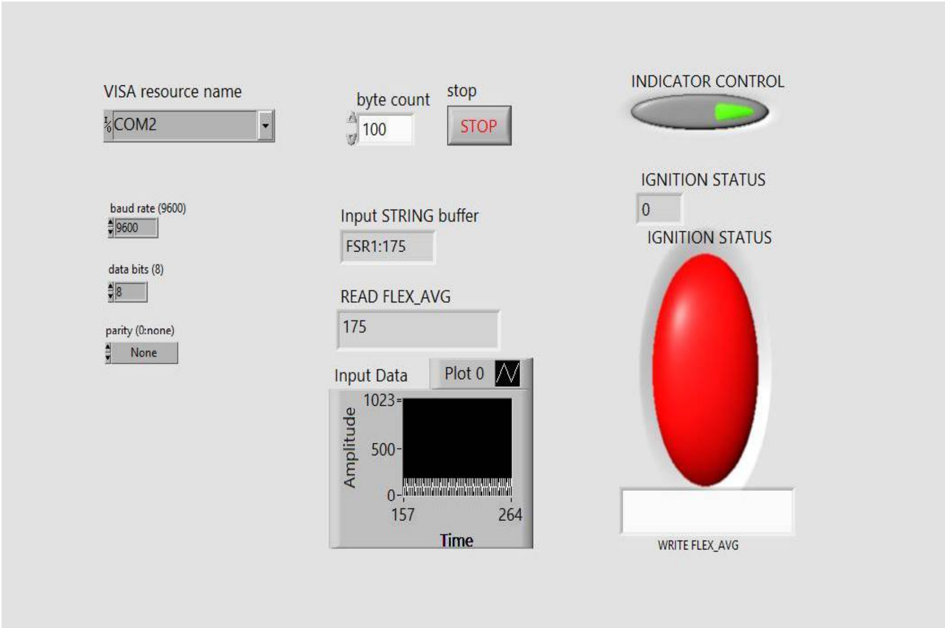

Fig.6.5 Front Panel for Lab VIEW for system analysis showing vehicle is not ignited

Fig. 6.6 shows the front panel for the LabVIEW GUI which indicates that the vehicle is ignited.

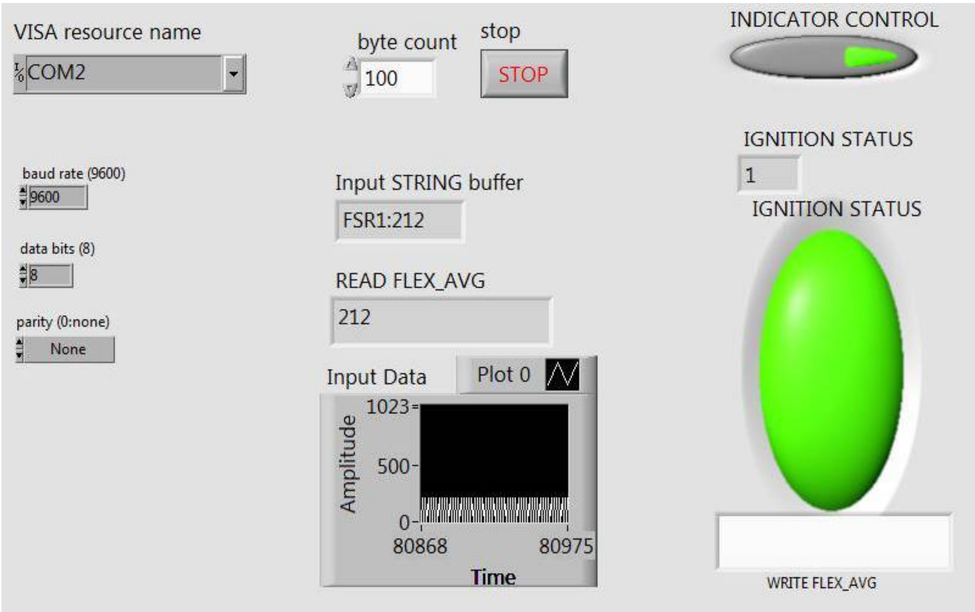

Fig.6.6 Front Panel for Lab VIEW for system analysis showing vehicle is ignited

6.2 Cloud Server

The global server is designed to analyze the sensor data. The importance of "Internet of things" would be in terms of analyzing the sensory data from anywhere in the world. By creating a cloud server, sensory data is transmitted on the cloud through Node MCU. This can be helpful for generating an alert signal, if helmet pressure exceeds from a threshold level, which indicates the driver meets with an accident. By checking the coordinates of the location on cloud server, information can be sent to the nearest hospital or police station for quick help. In this thesis data analysis of each sensor node is done for calculating the threshold value of sensors to ignite the vehicle with experimental data and sensory data is transmitted on cloud through "IoT". The future scope of the work can be to calculate the threshold value of impact which can determine the accident has been occurred.

6.2.1 Steps to Design Cloud Server

Step1 Write code on Arduino IDE and verify.

Step2 Open Thingspeak.com and register as new user (free registration). Channels can be bought from thingspeak for faster data logging.

Step3 Click on channels, Click on new channel. Write channel name. Total eight fields are available; Check on field numbers required for the project. Select all eight fields, click on make public and save it.

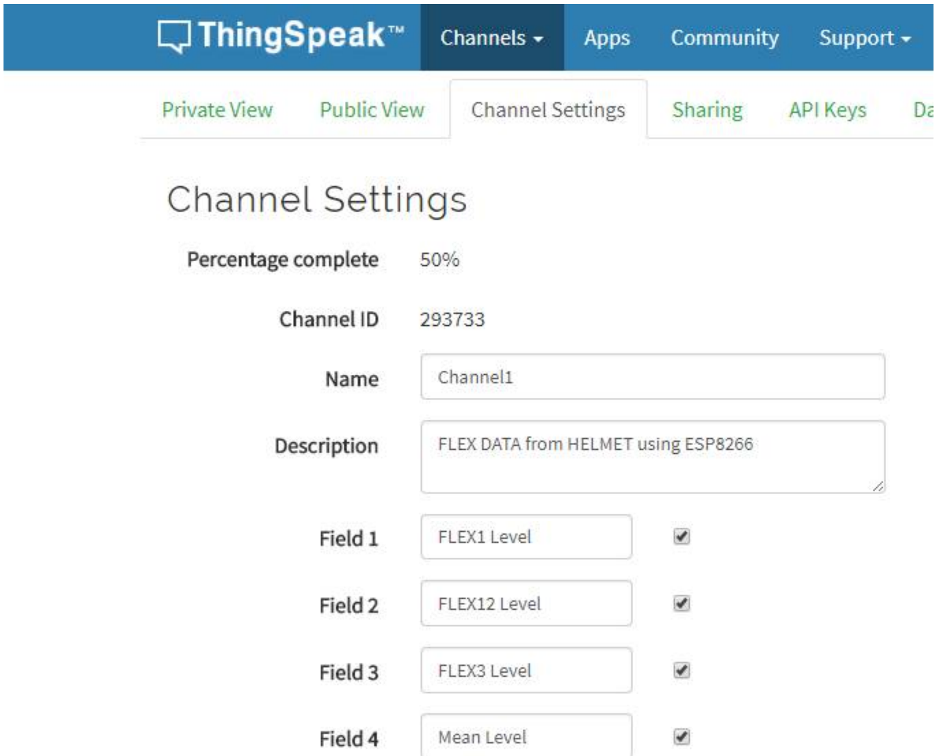

Fig.6.7 Channels settings at Thingspeak

Step4 Click on API key. Select write API key. Copy this API key and paste in the program.

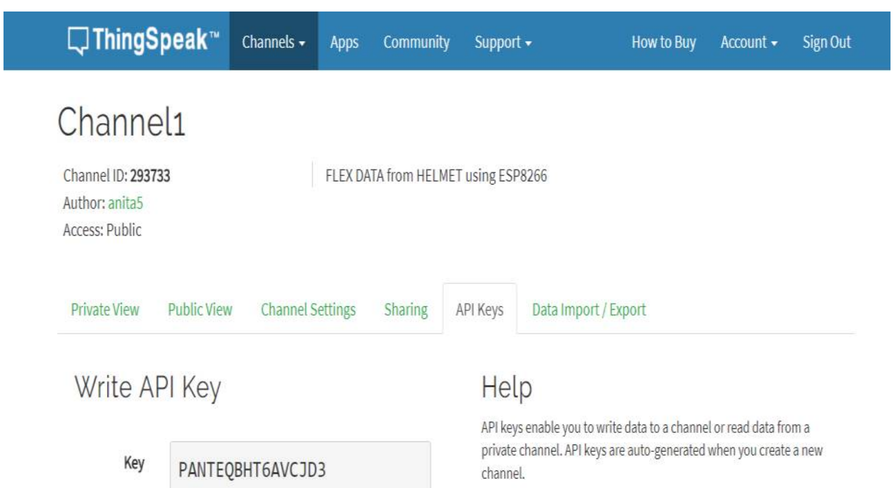

Fig.6.8 Write API key

Step5 Go to channels and check the data on Fields.

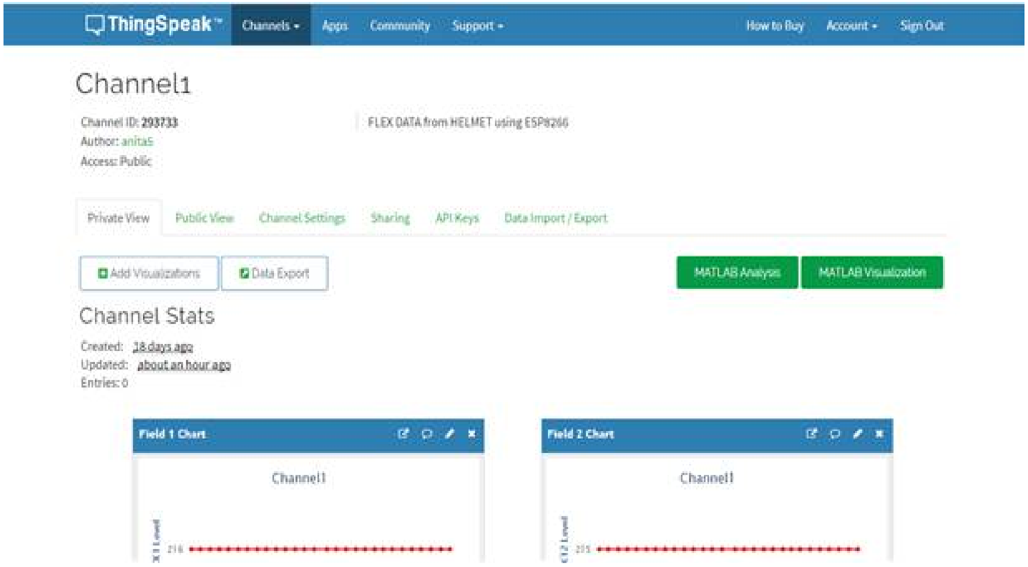

Fig.6.9 Channel fields

6.2.2 Sensory Data Analysis on Cloud Server

Data Analysis is done for each flex output and mean values in terms of level and voltage w.r.t time. Fig.6.10 shows the flex1 level as ‘216’ at field1 of channel‘1’ chart.

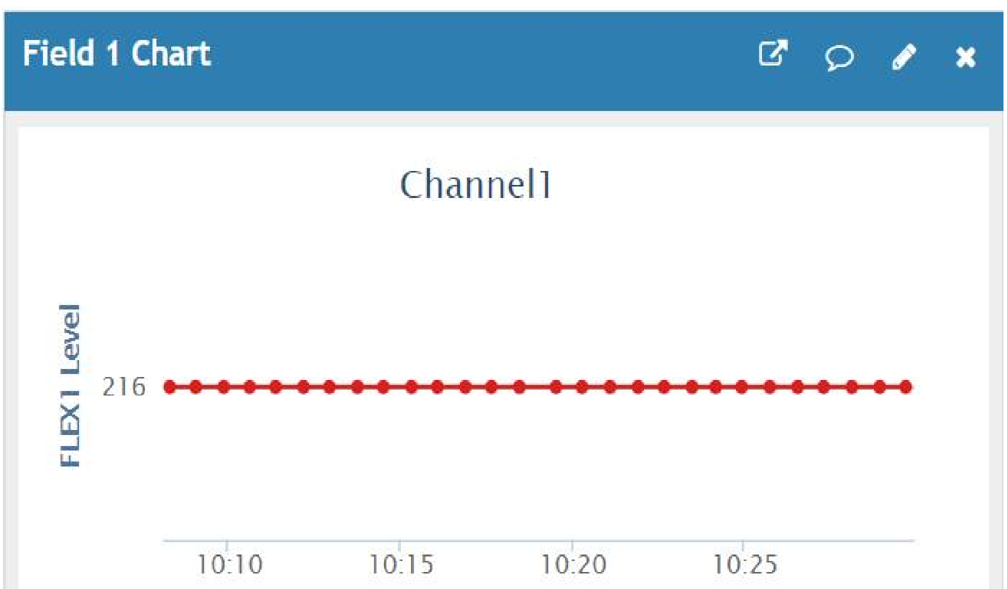

Fig.6.10 Channe1‘l’ field1 showing Flex1 level

Fig.6.11 shows the flex2 level as '215' at field2 of channel'1' chart.

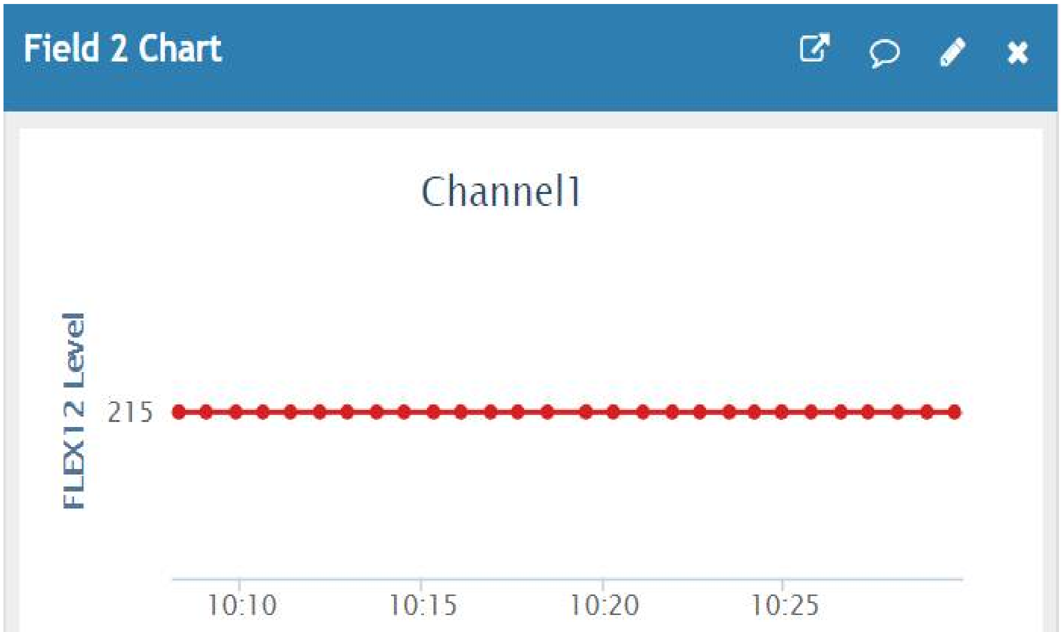

Fig.6.11 Channe1'l' field2 showing Flex2 level

Fig.6.12 shows the flex3 level as '202' at field3 of channel'1' chart.

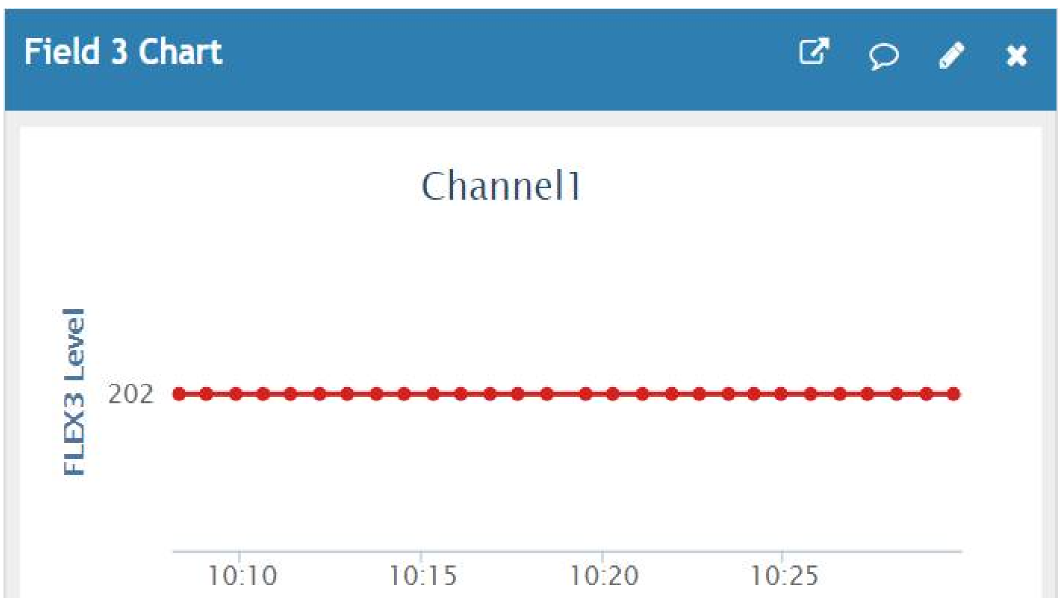

Fig.6.12 Channe1'l' field3 showing Flex3 level

Fig.6.13 shows the mean level values of three flex sensors as '211' at field4 of channel'1' chart.

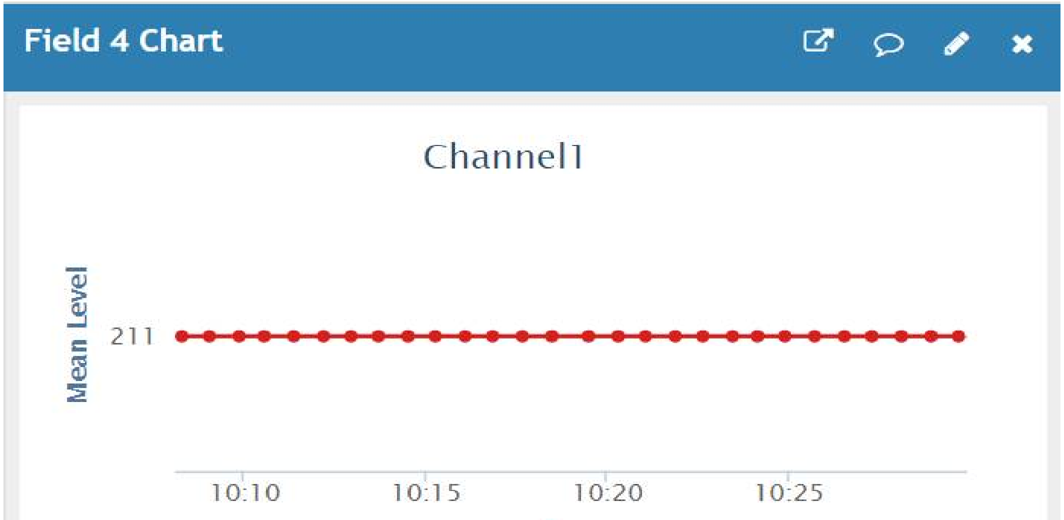

Fig.6.13 Channe1'l' field4 showing mean level of three flex sensors

Fig.6.14 shows the voltage output (mV) of flex1 as '1054' at field5 of channel'1' chart.

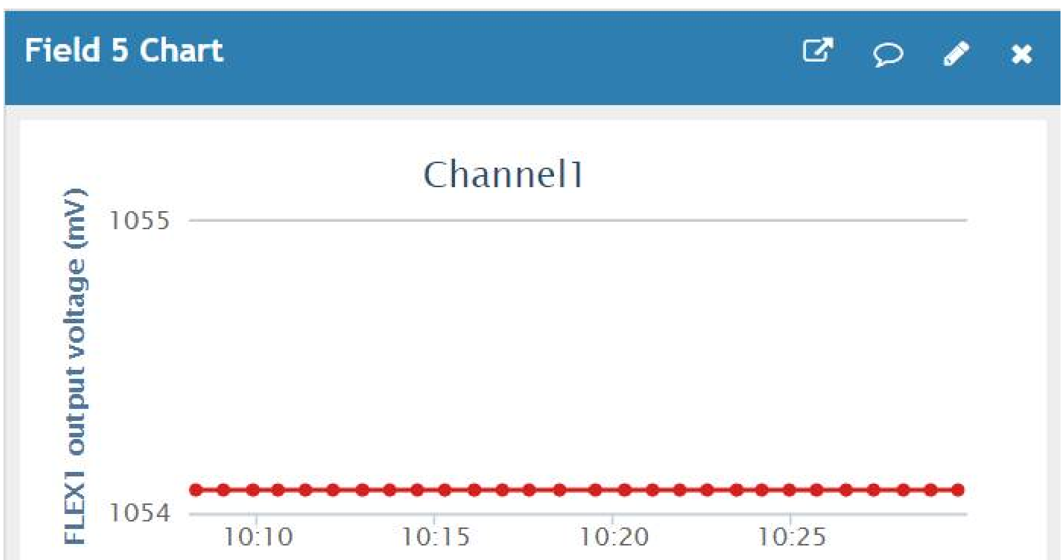

Fig.6.14 Channe1'l' field5 showing flex1 output voltage (mV)

Fig.6.15 shows the voltage output (mV) of flex2 as '1049' at field6 of channel'1' chart.

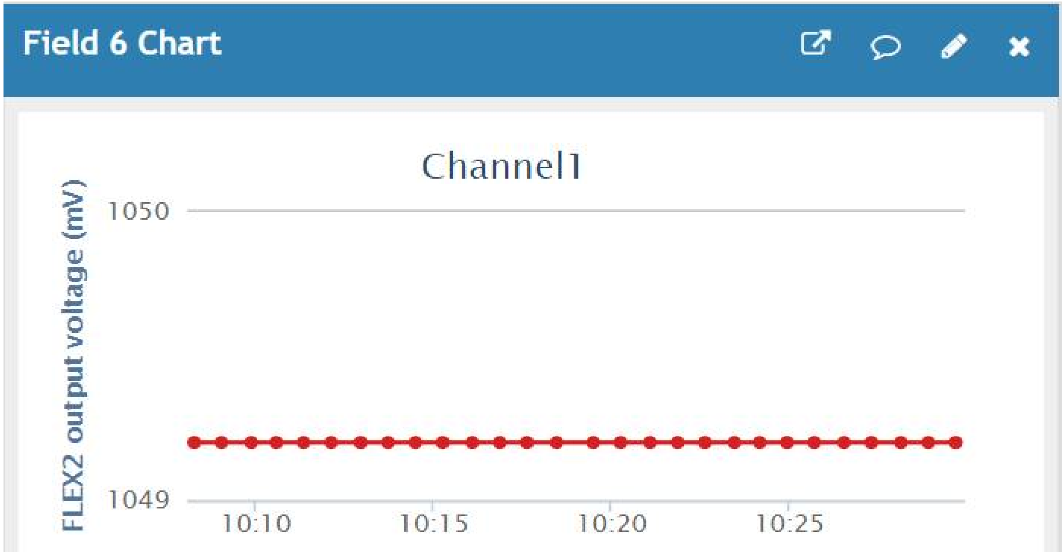

Fig.6.15 Channe1'l' field6 showing flex2 output voltage (mV)

Fig.6.16 shows the voltage output (mV) of flex1 as '986' at field6 of channel'1' chart.

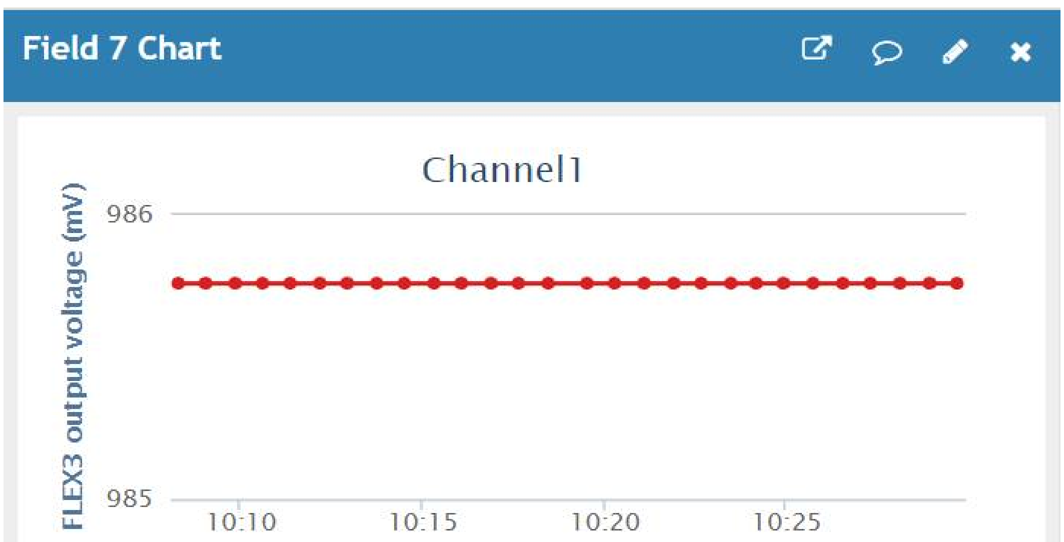

Fig.6.16 Channe1'l' field7 showing flex3 output voltage (mV)

Fig.6.17 shows the mean voltage output (mV) of three flex sensors as '1035' at field8 of channel'1' chart.

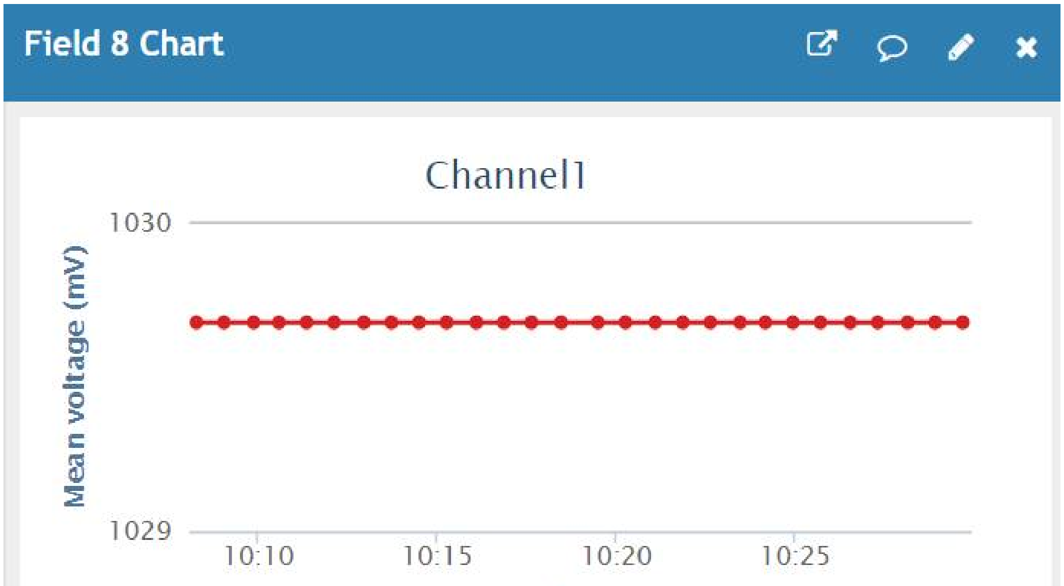

Fig.6.17 Channe1‘l’ field8 showing mean output voltage (mV) of three flex sensors

Fig.6.18 shows the channel location of the user.

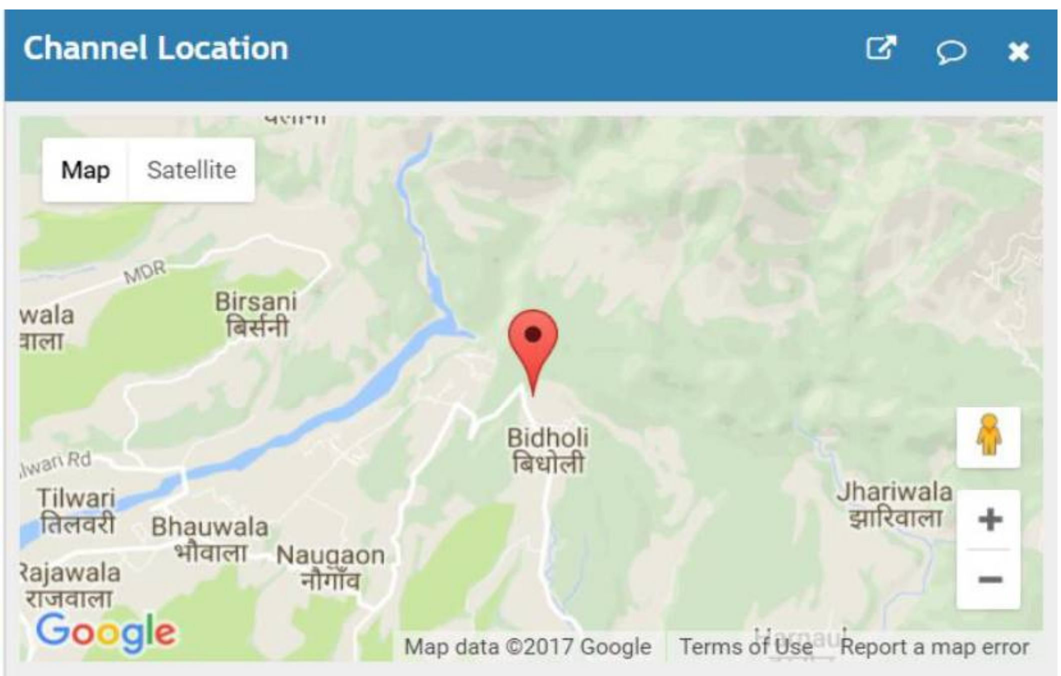

Fig.6.18 Channe1 location of the user

6.3 Result Analysis for the Experimental Set up

Samples are collected from the people of age group 18-25 years. The threshold level for the average of sensors, to ignite the vehicle is calculated on the basis of statistical data and its analysis using null hypothesis with '**t**' test. Flex sensor gives the output in terms of the levels so analysis is done for both in terms of levels and voltage at output pin of sensor.

The number of samples are ten so '**t**' test is applied to calculate threshold value of the sensor. '**t**' test calculations are done with null hypothesis '212'. Calculation are done with 1% level significance for **'t'** test.

Samples are collected from the month of Feb 2016 to October 2016 at University of Petroleum and Energy Studies, Dehradun with a variation of temperature from 21^0 C to 41^0 C.

6.3.1 Result Analysis for the Month of Feb. 2016

Arduino controller has inbuilt ADC with 10 bit resolution. It operates on 5V. The samples it receives from analog pin is divided into 2^{10} (1024) levels. Every level is equal to 4.88 mV. The output voltage of sensors is converted into levels by ADC and Arduino reads the levels which can be displayed on display unit.

Table 6.1 & 6.2 shows the sample data collected in the month of Feb. 2016.

Table 6.1 Samples from the people of age group of 18-25 years in the month of Feb 2016 with temperature variation (21^0 C to 27^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	213	213	203	209.66
2	217	214	205	212
3	217	215	204	212
4	214	212	214	213.33
5	216	215	209	213.33

6	216	216	208	213.33
7	217	215	211	214.33
8	215	216	208	214
9	215	218	207	213.33
10	215	216	209	213.33

Table 6.2 Samples in form of voltage as output of flex sensor from the people of age group of 18-25 years in the month of Feb 2016 with temperature variation (21^0C to 27^0C)

Samples	**Flex1 (V)**	**Flex2**	**Flex3**	**Mean**
1	1.04	1.04	0.99	1.024
2	1.06	1.05	1.001	1.03
3	1.06	1.05	0.99	1.03
4	1.04	1.03	1.04	1.042
5	1.05	1.05	1.021	1.042
6	1.05	1.055	1.01	1.042
7	1.06	1.05	1.03	1.047
8	1.05	1.055	1.01	1.04
9	1.05	1.06	1.01	1.042
10	1.05	1.055	1.021	1.042

't' test is applied on the mean values of sensors mentioned in Table 6.1 and calculation are done with the help of slandered formulas given below-

$$t = \frac{\bar{x} - \mu_{H0}}{\sigma_s / \sqrt{n}} \qquad \text{Eq.6.1}$$

With degree of freedom = (n-1)

Where

$$\sigma_s = \sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n-1}}$$ Eq.6.2

Table 6.3 '**t**' test on the samples collected in the month of Feb. 2016

S.No.	**Samples**	**xi-$\bar{x}$**	**(xi-$\bar{x}$)^2**
1	209.66	-3.2	10.24
2	212	-0.86	0.7396
3	212	-0.86	0.7396
4	213.33	0.47	0.2209
5	213.33	0.47	0.2209
6	213.33	0.47	0.2209
7	214.33	1.47	2.1609
8	214	1.14	1.2996
9	213.33	0.47	0.2209
10	213.33	0.47	0.2209

$\bar{x}$ is mean value of the samples = 212.86

The null hypothesis μ_{H0} = 212

The value of $\sum(xi-\bar{x})^2$ = 16.284

The value of σ_s = 1.345

Calculating 1% level significance, the value of 't' =2.02

The value from t-distribution table = 3.250.

Value calculated by null hypothesis is lesser than value from table so it is acceptable hypothesis.

Fig.6.19 shows the graphs for the flex1 sample variation in the output level in the month of Feb.2016.

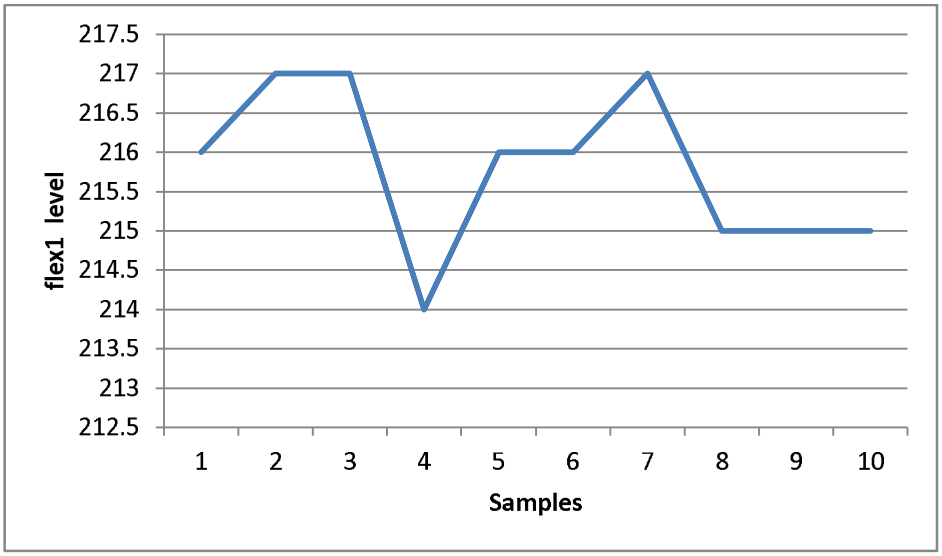

Fig.6.19 Sample variation in the output level values for flex1 in the month of Feb.2016

Fig.6.20 shows the graphs for the flex2 sample variation in the output level in the month of Feb.2016.

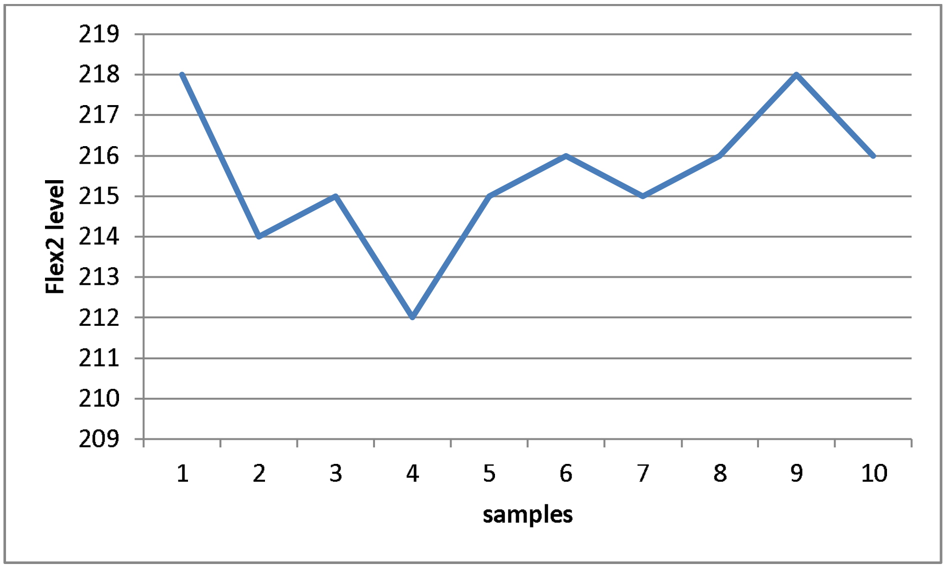

Fig.6.20 Sample variation in the output level values for flex2 in the month of Feb.2016

Fig.6.21 shows the graphs for the flex3 sample variation in the output level in the month of Feb.2016.

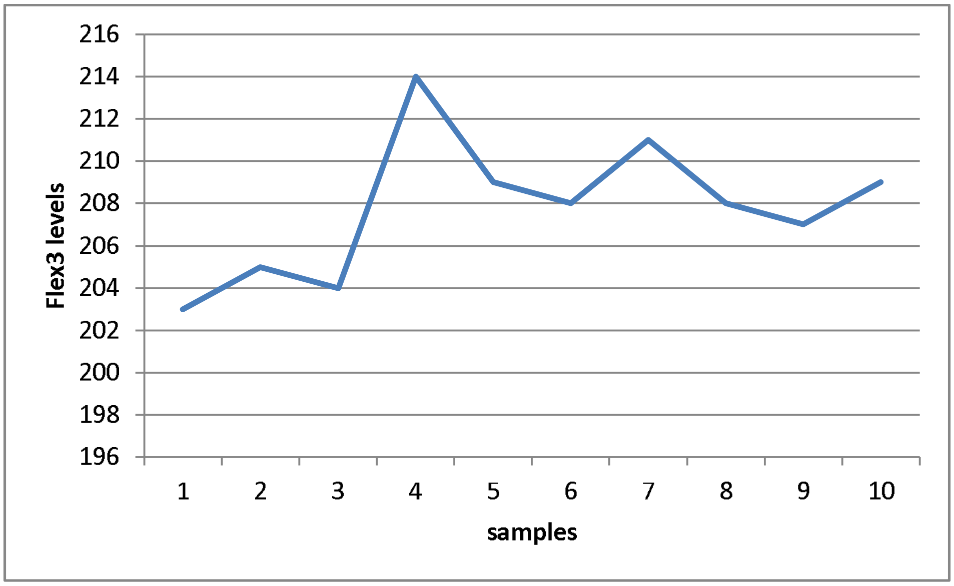

Fig.6.21 Sample variation in the output level values for flex3 in the month of Feb.2016

Fig.6.22 shows the graphs for the mean values of sample variation in the output level in the month of Feb.2016.

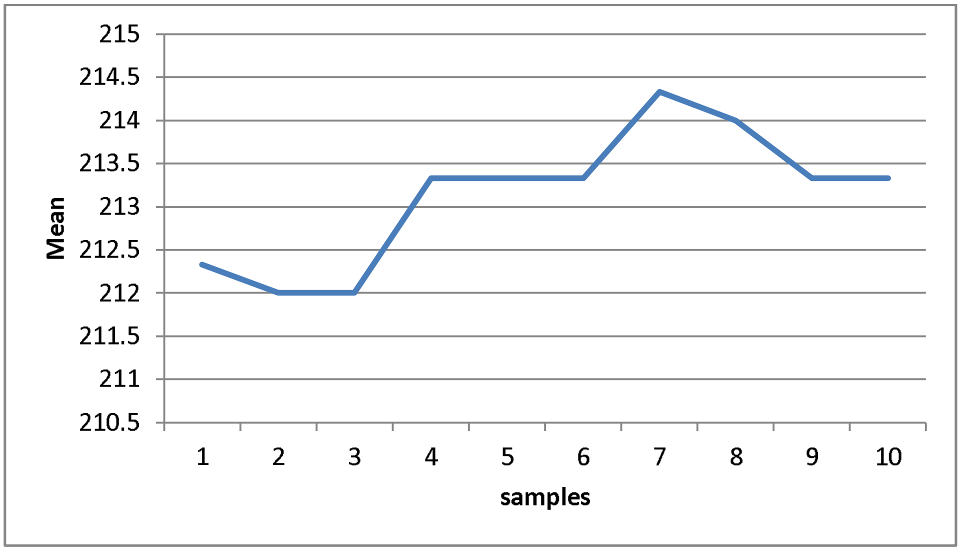

Fig.6.22 Flex sensors mean level variations for samples in the month of Feb.2016

6.3.2 Result Analysis for the Month of April 2016

Table 6.4 & 6.5 shows the sample data collected in the month of April 2016.

Table 6.4 Samples from the people of age group of 18-25 years in the month of April 2016 with temperature variation (31^0 C to 36^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	216	215	205	212
2	215	216	205	212
3	212	214	214	213.33
4	214	212	214	213.33
5	215	216	205	212
6	216	215	211	214
7	217	215	211	214.33
8	215	213	206	212
9	215	216	211	214
10	216	215	205	212

Table 6.5 Samples in form of voltage as output of flex sensor from the people of age group of 18-25 years in the month of April 2016 with temperature variation (31^0C to 36^0C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	1.055	1.05	1.001	1.03
2	1.05	1.055	1.001	1.03
3	1.03	1.04	1.04	1.042
4	1.04	1.03	1.04	1.042
5	1.05	1.055	1.001	1.03
6	1.055	1.05	1.03	1.04
7	1.06	1.05	1.03	1.047

8	1.05	1.04	1.006	1.03
9	1.05	1.055	1.03	1.04
10	1.055	1.05	1.001	1.03

't' test is applied on the mean values of sensors mentioned in Table 6.4 and calculation are done with the help of slandered formulas given below-

$$t = \frac{\bar{x} - \mu_{H0}}{\sigma_s / \sqrt{n}} \qquad \text{Eq.6.3}$$

With degree of freedom = (n-1)

Where

$$\sigma_s = \sqrt{\frac{\sum \left(x_i - \bar{x} \right)^2}{n-1}} \qquad \text{Eq.6.4}$$

Table 6.6 '**t**' test on the samples collected in the month of April 2016

S.No.	Samples	$x_i-\bar{x}$	$(x_i-\bar{x})^2$
1	212	-1.03	1.0609
2	212	-1.03	1.0609
3	213.33	0.3	0.09
4	213.33	0.3	0.09
5	212	-1.03	1.0609
6	214	0.97	0.9409
7	214.33	1.3	1.69
8	212	-1.03	1.0609
9	214	0.97	0.9409
10	212	-1.03	1.0609

$\bar{x}$ is mean value of the samples = 212.89

The null hypothesis $\mu_{H0} = 212$

The value of $\sum(xi-\bar{x})^2 = 9.056$

The value of $\sigma_s = 1.0031$

Calculating 1% level significance, the value of 't' = 2.834

The value from t-distribution table = 3.250.

Value calculated by null hypothesis is lesser than value from table so it is acceptable hypothesis.

Fig.6.23 shows the graphs for the flex1 sample variation in the output level in the month of April 2016.

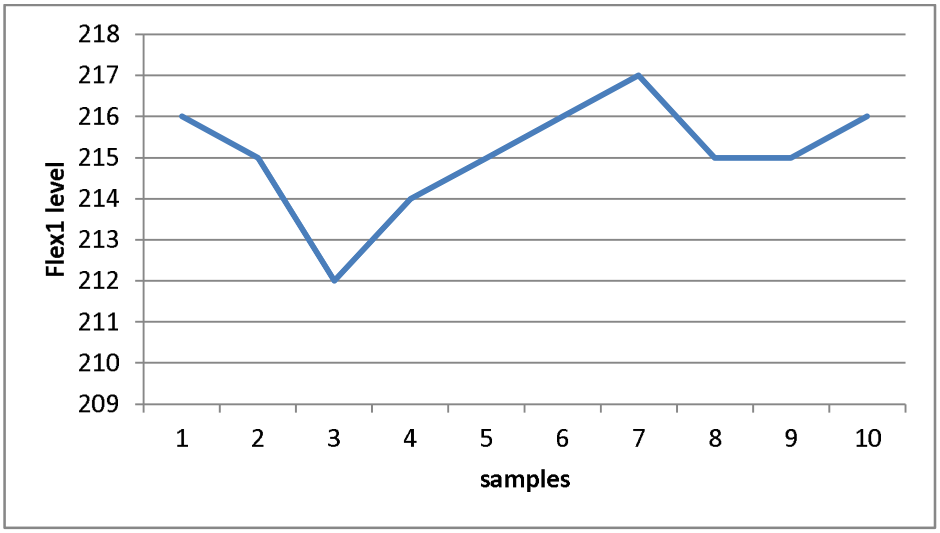

Fig.6.23 Sample variation in the output level values for flex1 in the month of April 2016

Fig.6.24 shows the graphs for the flex2 sample variation in the output level in the month of April 2016.

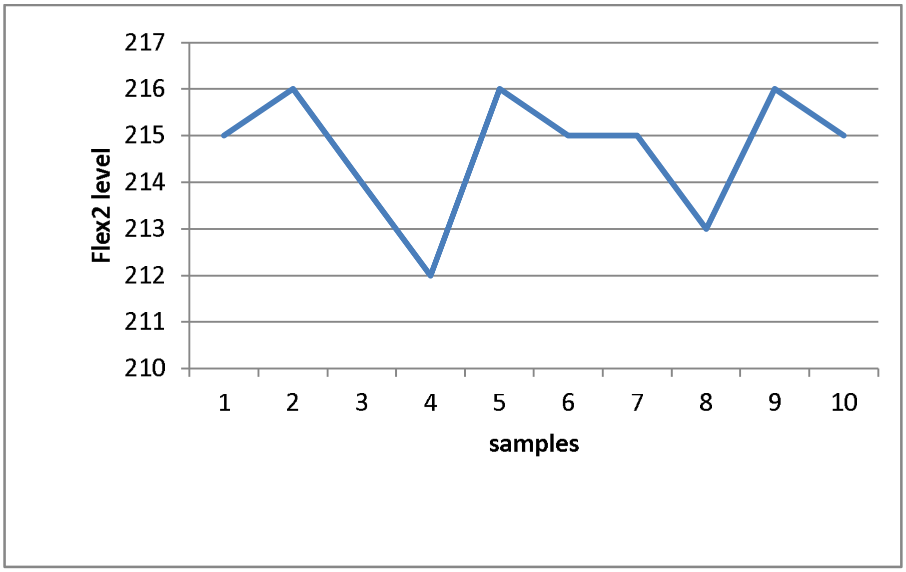

Fig.6.24 Sample variation in the output level values for flex2 in the month of April 2016

Fig.6.25 shows the graphs for the flex3 sample variation in the output level in the month of April 2016.

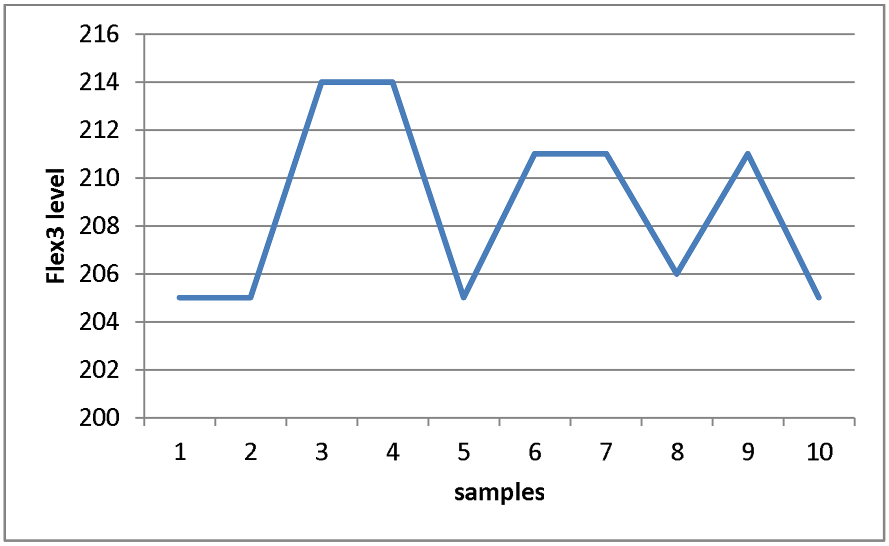

Fig.6.25 Sample variation in the output level values for flex3 in the month of April 2016

Fig.6.26 shows the graphs for the mean values of sample variation in the output level in the month of April 2016.

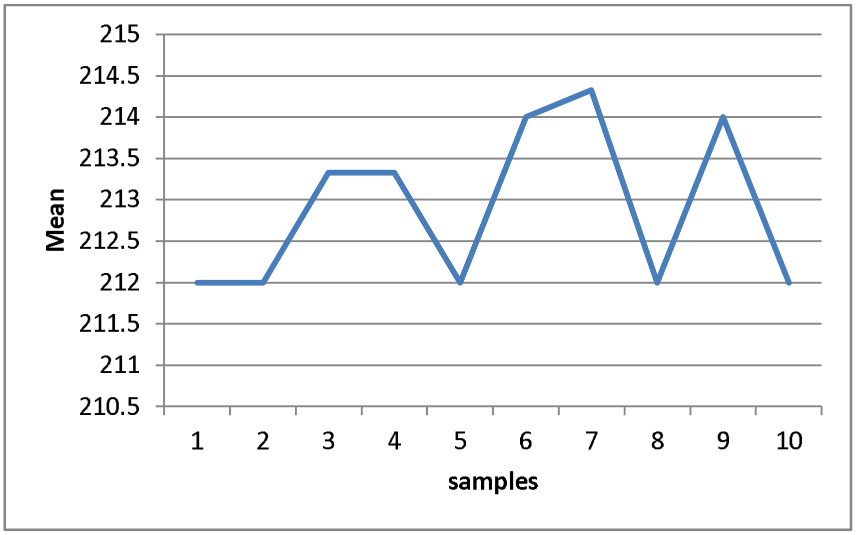

Fig.6.26 Flex sensor mean level variations for samples in the month of April 2016

6.3.3 Result Analysis for the Month of June 2016

Table 6.7 & 6.8 shows the sample data collected in the month of June 2016.

Table 6.7 Samples from the people of age group of 18-25 years in the month of June 2016 with temperature variation (34^0 C to 41^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	215	216	209	213.33
2	215	216	205	212
3	217	215	204	212
4	216	216	208	213.33
5	217	215	204	212
6	215	216	211	214
7	215	216	205	212
8	217	216	207	213.33
9	215	216	211	214
10	215	217	204	212

Table 6.8 Samples in form of voltage as output of flex sensor from the people of age group of 18-25 years in the month of June 2016 with temperature variation (34^0 C to 41^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	1.05	1.055	1.021	1.042
2	1.05	1.055	1.001	1.03
3	1.060	1.05	0.99	1.03
4	1.055	1.055	1.016	1.042
5	1.06	1.05	0.99	1.03
6	1.05	1.055	1.03	1.04
7	1.05	1.055	1.001	1.03
8	1.06	1.055	1.01	1.042
9	1.05	1.055	1.03	1.04
10	1.05	1.060	0.99	1.03

't' test is applied on the mean values of sensors mentioned in Table 6.8 and calculation are done with the help of slandered formulas given below-

$$t = \frac{\bar{x} - \mu_{H0}}{\sigma_s / \sqrt{n}}$$ Eq.6.5

With degree of freedom = (n-1)

Where

$$\sigma_s = \sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n-1}}$$ Eq.6.6

Table 6.9 't' test on the samples collected in the month of June 2016

S.No.	Samples	xi-$\bar{x}$	(xi-$\bar{x}$)^2
1	213.33	0.198	0.039204
2	212	-1.132	1.281424
3	212	-1.132	1.281424
4	213.33	0.198	0.039204
5	212	-1.132	1.281424
6	214	0.868	0.753424
7	212	-1.132	1.281424
8	213.33	0.198	0.039204
9	214	0.868	0.753424
10	212	-1.132	1.281424

$\bar{x}$ is mean value of the samples = 212.79

The null hypothesis $\mu_{H0} = 212$

The value of $\sum(xi-\bar{x})^2 = 8.0315$

The value of $\sigma_s = 0.944$

Calculating 1% level significance, the value of 't' = 2.674

The value from t-distribution table = 3.250.

Value calculated by null hypothesis is lesser than value from table so it is acceptable hypothesis.

Fig.6.27 shows the graphs for the flex1 sample variation in the output level in the month of June 2016.

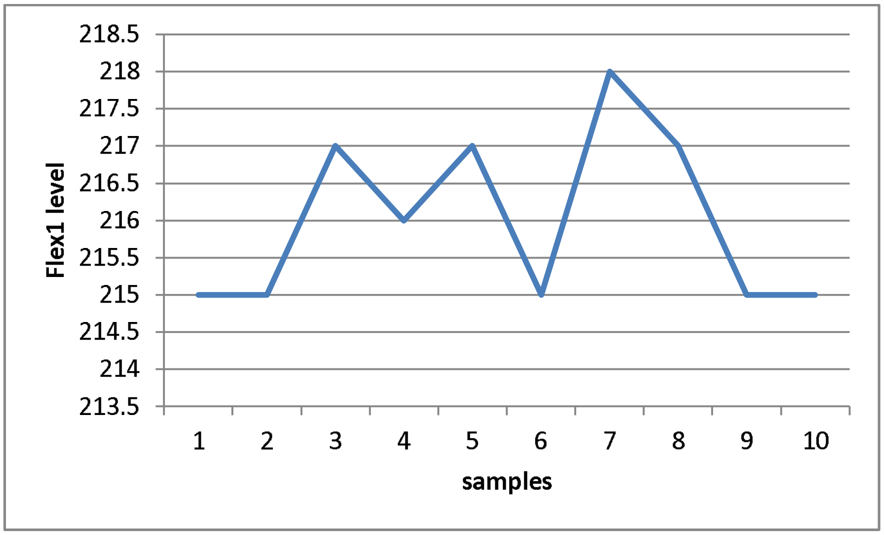

Fig.6.27 Sample variation in the output level values for flex1 in the month of June 2016

Fig.6.28 shows the graphs for the flex2 sample variation in the output level in the month of June 2016.

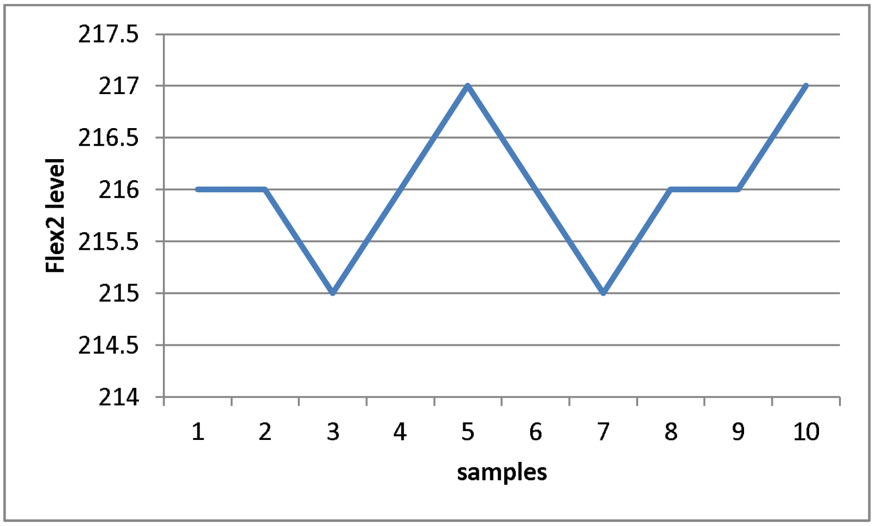

Fig.6.28 Sample variation in the output level values for flex2 in the month of June 2016

Fig.6.29 shows the graphs for the flex3 sample variation in the output level in the month of June 2016.

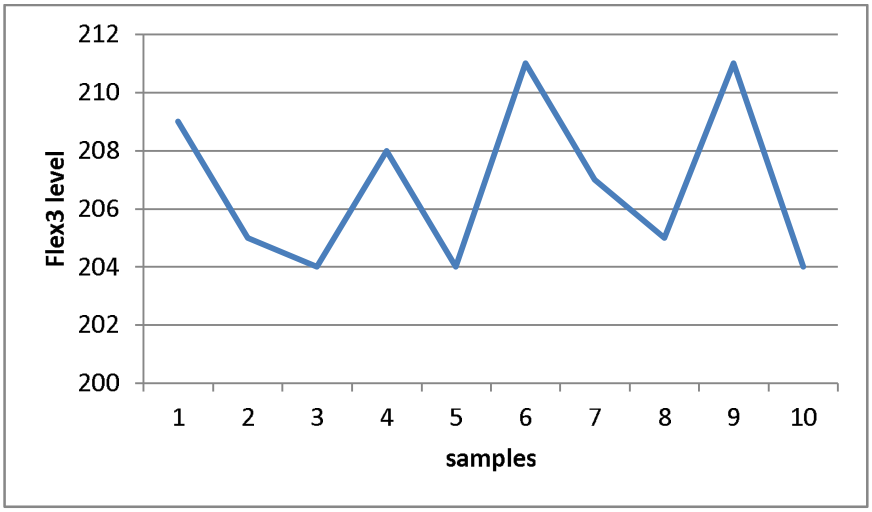

Fig.6.29 Sample variation in the output level values for flex3 in the month of June 2016

Fig.6.30 shows the graphs for the mean values of sample variation in the output level in the month of June 2016.

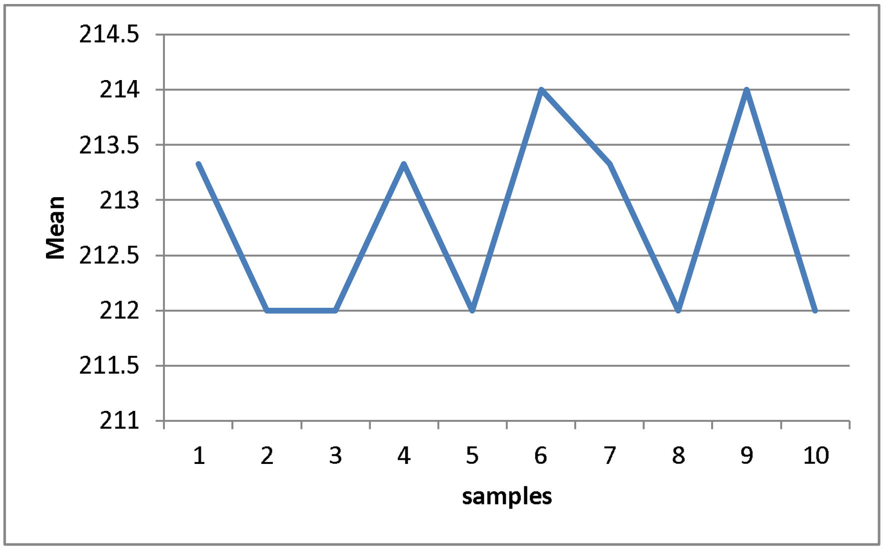

Fig.6.30 Flex sensors mean level variations for samples in the month of June 2016

6.4.4 Result Analysis for the Month of August 2016

Table 6.10 & 6.11 shows the sample data collected in the month of August 2016.

Table 6.10 Samples of flex sensor from the people of age group of 18-25 years in the month of August 2016 with temperature variation (32^0 C to 36^0 C)

Samples	Flex1	Flex2	Flex3	Mean
1	216	215	209	213.33
2	216	216	208	213.33
3	217	215	204	212
4	217	215	204	212
5	215	216	209	213.33
6	215	216	211	214
7	214	217	211	214
8	217	215	204	212
9	213	213	203	209.66
10	215	216	205	212

Table 6.11 Samples in form of voltage as output of flex sensor from the people of age group of 18-25 years in the month of August 2016 with temperature variation (32^0 C to 36^0 C)

Samples	Flex1	Flex2	Flex3	Mean
1	1.055	1.05	1.021	1.042
2	1.055	1.055	1.016	1.042
3	1.060	1.05	0.99	1.03
4	1.060	1.05	0.99	1.03
5	1.05	1.055	1.021	1.042
6	1.05	1.055	1.03	1.04
7	1.04	1.060	1.03	1.04
8	1.060	1.05	0.99	1.03

9	1.05	1.06	0.99	1.024
10	1.05	1.055	1.001	1.03

't' test is applied on the mean values of sensors mentioned in Table 6.10 and calculation are done with the help of slandered formulas given below-

$$t = \frac{\bar{x} - \mu_{H0}}{\sigma_s / \sqrt{n}} \qquad \text{Eq.6.7}$$

With degree of freedom = (n-1)

Where

$$\sigma_s = \sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n-1}} \qquad \text{Eq.6.8}$$

Table 6.12 '**t**' test on the samples collected in the month of August 2016

S.No.	**Samples**	**xi-$\bar{x}$**	**(xi-$\bar{x}$)^2**
1	213.33	1.198	1.435204
2	213.33	1.198	1.435204
3	212	-0.132	0.017424
4	212	-0.132	0.017424
5	213.33	1.198	1.435204
6	214	1.868	3.489424
7	214	1.868	3.489424
8	212	-0.132	0.017424
9	209.66	-2.472	6.110784
10	212	-0.132	0.017424

$\bar{x}$ is mean value of the samples = 212.56

The null hypothesis $\mu_{H0} = 212$

The value of $\sum(xi-\bar{x})^2 = 17.464$

The value of $\sigma_s = 1.393$

Calculating 1% level significance, the value of 't' = 1.282

The value from t-distribution table = 3.250.

Value calculated by null hypothesis is lesser than value from table so it is acceptable hypothesis.

Fig.6.31 shows the graphs for the flex1 sample variation in the output level in the month of August 2016.

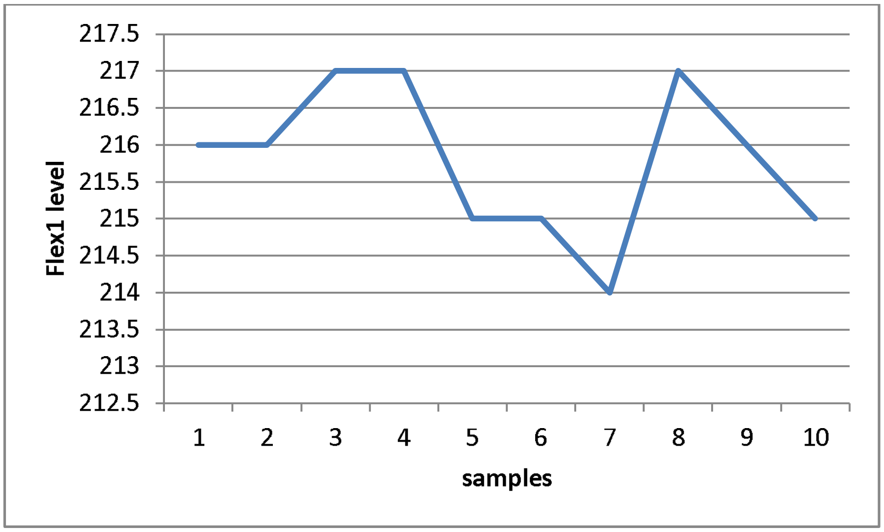

Fig.6.31 Sample variation in the output level values for flex1 in the month of August 2016

Fig.6.32 shows the graphs for the flex2 sample variation in the output level in the month of August 2016.

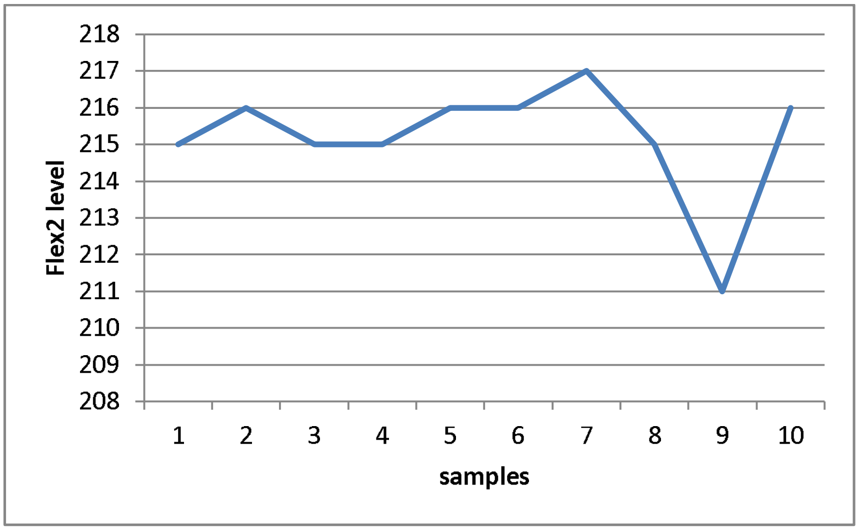

Fig.6.32 Sample variation in the output level values for flex2 in the month of August 2016

Fig.6.33 shows the graphs for the flex3 sample variation in the output level in the month of August 2016.

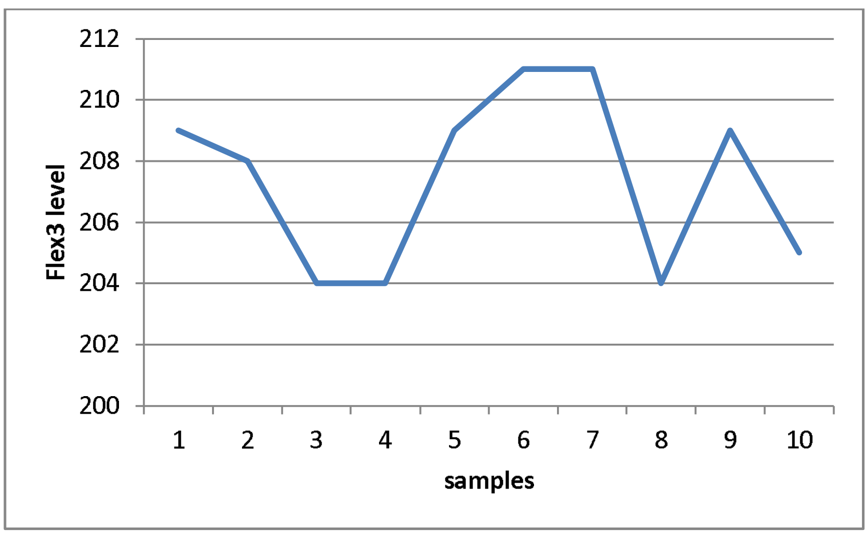

Fig.6.33 Sample variation in the output level values for flex3 in the month of August 2016

Fig.6.34 shows the graphs for the mean values of sample variation in the output level in the month of August 2016.

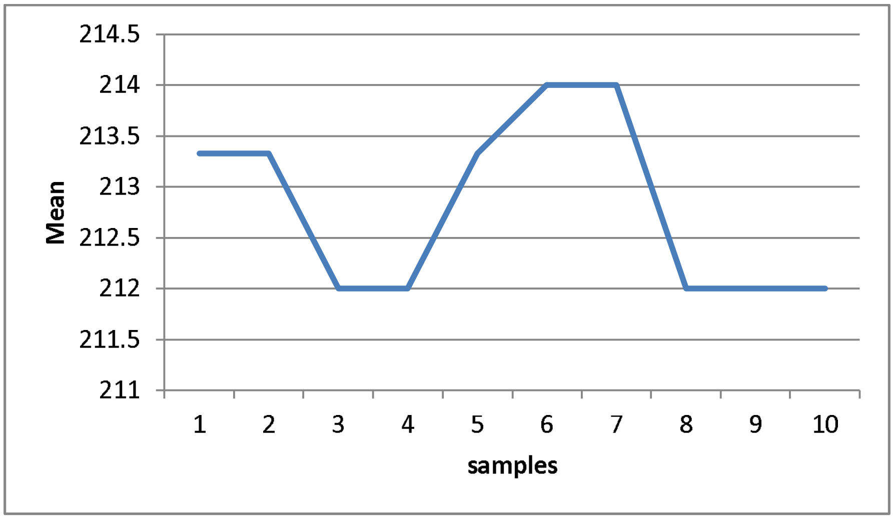

Fig.6.34 Flex sensors mean level variations for samples in the month of August 2016

6.3.5 Result Analysis for the Month of October 2016

Table 6.13 & 6.14 shows the sample data collected in the month of Oct. 2016.

Table 6.13 Samples from the people of age group of 18-25 years in the month of Oct. 2016 with temperature variation (31^0 C to 35^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	216	215	202	211
2	215	217	204	212
3	215	216	211	214
4	215	218	207	213.33
5	215	216	209	213.33
6	215	216	209	213.33
7	217	215	204	212
8	216	216	208	213.33
9	215	217	204	212
10	215	217	210	214

Table 6.14 Samples form of voltage as output of flex sensor from the people of age group of 18-25 years in the month of Oct. 2016 with temperature variation (31^0 C to 35^0 C)

Samples	**Flex1**	**Flex2**	**Flex3**	**Mean**
1	1.055	1.05	0.98	1.030
2	1.05	1.060	0.99	1.03
3	1.05	1.055	1.03	1.04
4	1.05	1.065	1.011	1.04
5	1.05	1.055	1.02	1.04
6	1.05	1.055	1.02	1.04
7	1.06	1.05	0.99	1.03
8	1.055	1.055	1.016	1.04
9	1.05	1.060	0.99	1.03
10	1.05	1.060	1.025	1.044

't' test is applied on the mean values of sensors mentioned in Table 6.13 and calculation are done with the help of slandered formulas given below-

$$t = \frac{\bar{x} - \mu_{H0}}{\sigma_s / \sqrt{n}} \qquad \text{Eq.6.9}$$

With degree of freedom = (n-1)

Where

$$\sigma_s = \sqrt{\frac{\sum \left(x_i - \bar{x} \right)^2}{n-1}} \qquad \text{Eq.6.10}$$

Table 6.15 '**t**' test on the samples collected in the month of October 2016

S.No.	Samples	xi-$\bar{x}$	(xi-$\bar{x}$)^2
1	211	-2.065	4.264225
2	212	-1.065	1.134225
3	214	0.935	0.874225
4	213.33	0.265	0.070225
5	213.33	0.265	0.070225
6	213.33	0.265	0.070225
7	212	-1.065	1.134225
8	213.33	0.265	0.070225
9	212	-1.065	1.134225
10	214	0.935	0.874225

$\bar{x}$ is mean value of the samples = 212.832

The null hypothesis μ_{H0} = 212

The value of $\sum(xi-\bar{x})^2$ = 9.696

The value of σ_s = 1.0379

Calculating 1% level significance, the value of 't' = 2.534

The value from t-distribution table = 3.250.

Value calculated by null hypothesis is lesser than value from table so it is acceptable hypothesis.

Fig.6.35 shows the graphs for the flex1 sample variation in the output level in the month of October 2016.

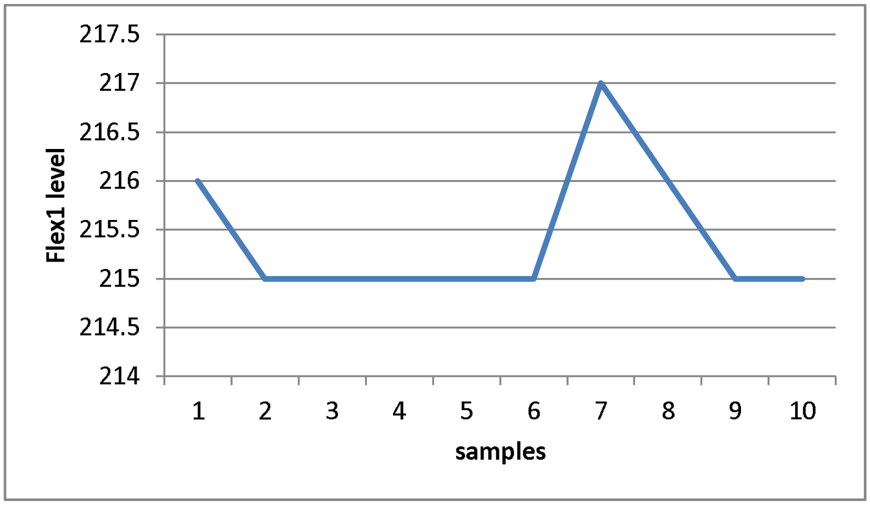

Fig.6.35 Sample variation in the output level values for flex1 in the month of October 2016

Fig.6.36 shows the graphs for the flex2 sample variation in the output level in the month of October 2016.

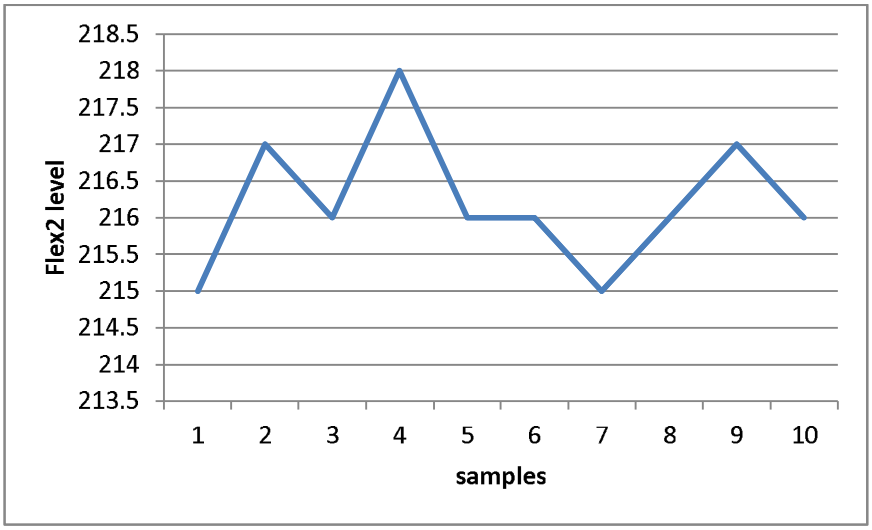

Fig.6.36 Sample variation in the output level values for flex2 in the month of October 2016

Fig.6.37 shows the graphs for the flex3 sample variation in the output level in the month of October 2016.

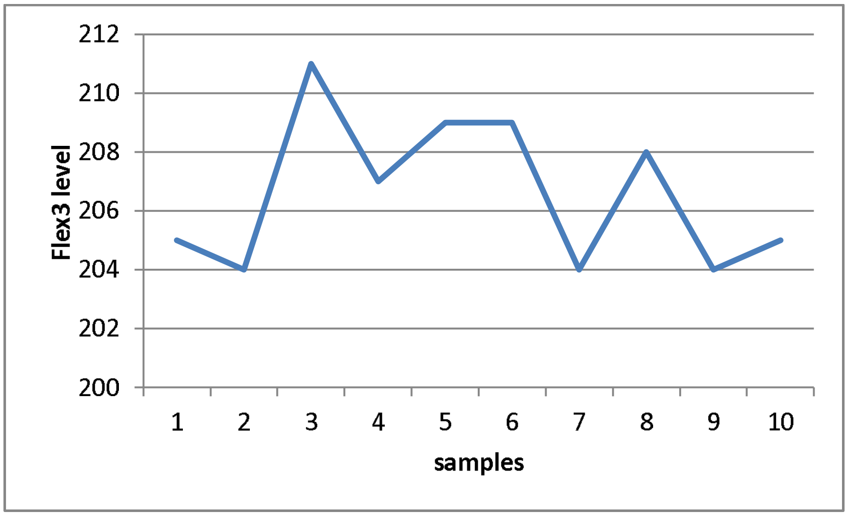

Fig.6.37 Sample variation in the output level values for flex3 in the month of October 2016

Fig.6.38 shows the graphs for the mean values of sample variation in the output level in the month of October 2016.

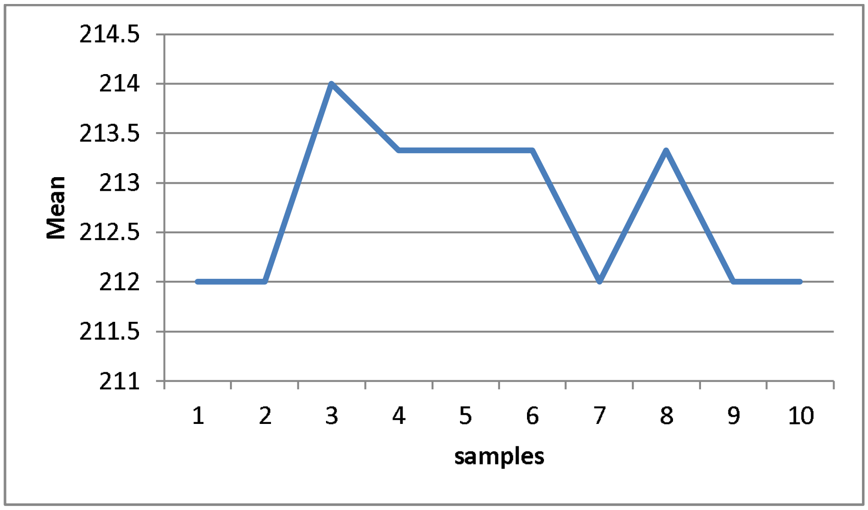

Fig.6.38 Flex sensors mean level variations for samples in the month of October 2016

Conclusion from Experimental Research- The threshold value for flex sensor values on helmet to ignite the vehicle, for the age group of 18-25 years is calculated as '212'.

6.4 Prototype of the Designed System

The system is developed with help of selected components as discussed in chapter-3. The components are assembled and with the help of LabVIEW GUI threshold value is analyzed and set in the system.

Fig.6.39, 6.40, 6.41 shows the snapshots for the developed helmet section and two-wheeler section.

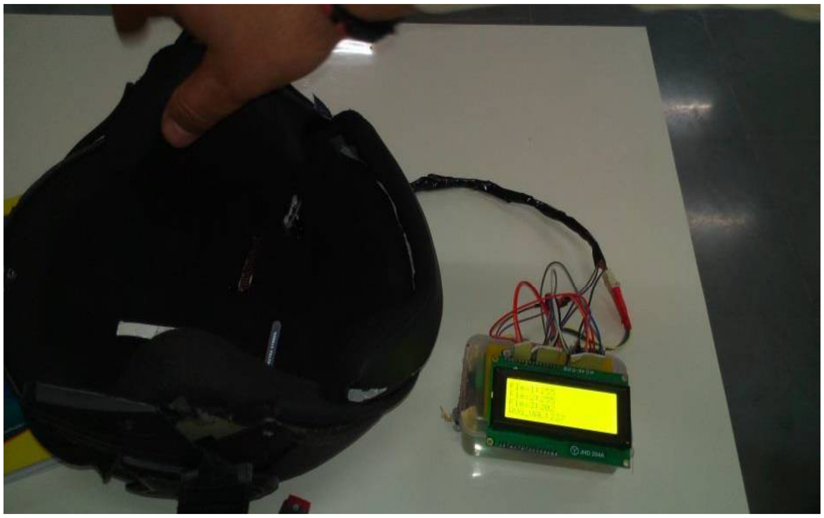

Fig.6.39 Snapshot of developed Helmet section

Fig.6.40 Snapshot of developed two-wheeler section

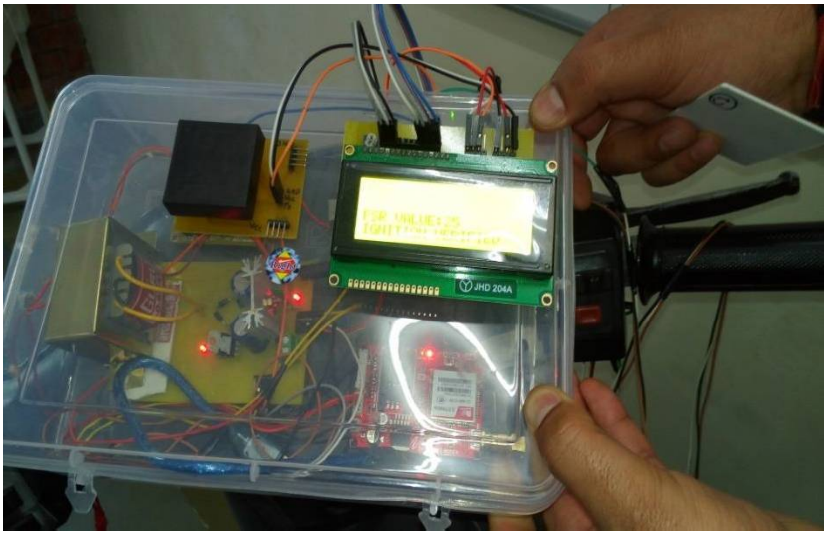

Fig.6.41 Snapshot2 of developed two-wheeler section

6.5 Cost Analysis

Cost Analysis is a very important part for actual implementation of any system. The major part for the cost includes the cost for the components used to design the system. The software cost and miscellaneous cost is also important but as firmware is developed by author, so miscellaneous cost and software cost is ignored for the analysis part. Cost analysis is performed on the basis of price of components used to develop all the three nodes- helmet node, two-wheeler node and server.

Table 6.16 Cost Analysis of Helmet Node

Component	Quantity	Cost (Rs.)
Arduino nano	1	350
Flex Sensor	3	1800
Battery	1	350
Battery charger	1	500
LCD (20*4)	1	360
LCD patch (to connect with Arduino)	1	100
RF Modem	1	350

RF Modem patch (to connect with Arduino)	1	50
Power pin extension board	1	50
Total		3910

The cost for helmet node is Rs.3910 which is for the experiment set up. It can be reduced by removing LCD which is not required in the final product, also the microcontroller can be replaced with other low cost controller or with the controller designed as discussed in chapter-5. By just removing the extra components and using current controller cost can be reduced to Rs.3400.

Table 6.17 Cost Analysis of Two-wheeler Node

Component	**Quantity**	**Cost (Rs.)**
Arduino Uno	1	550
RFID reader	1	350
RFID tag	4	200
Battery	1	350
LCD (20*4)	1	360
LCD patch (to connect with Arduino)	1	100
RF Modem	1	350
RF Modem patch (to connect with Arduino)	1	50
Power pin extension board	1	50
Total		2360

The cost for helmet node is Rs.2360 which is for the experiment set up. It can be reduced by removing LCD which is not required in the final product, also the microcontroller can be replaced with other low cost controller or with the controller designed as discussed in chapter-5. By just removing the extra components and using current controller cost can be reduced to Rs.1850.

Table 6.18 Cost Analysis of Server/data logger circuit

Component	Quantity	Cost (Rs.)
Arduino Uno	1	550
Battery	1	350
LCD (20*4)	1	360
LCD patch (to connect with Arduino)	1	100
RF Modem	1	350
RF Modem patch (to connect with Arduino)	1	50
Power pin extension board	1	50
Total		1810

The cost for helmet node is Rs.1810 which is for the experiment set up. It can be reduced by removing LCD which is not required in the final product, also the microcontroller can be replaced with other low cost controller available in the market. By just removing the extra components and using current controller cost can be reduced to Rs.950.

The total cost for complete system development is (3400+1850+950=**6200**) which can be reduced further, when system developed in bulk at the industry end.

6.7 Current Consumption Analysis

Table-6.19, 6.20 & 6.21 shows the current consumption analysis of the system

Table 6.19 Current Consumption Analysis of Helmet Node

Component	Quantity	Current (mA)
Arduino nano	1	40
Flex Sensor	3	1.5
RF Modem	1	58
Total		99.5

The total power consumption by helmet node is (99.5mA * 5V = 497.5mW) the two components that dominate power consumption helmet node are RF modem and Arduino.

The battery current system is rechargeable Lithium Ion battery with capacity of 12V/1A; hence it can be used (day/night) continuously in the system for around 10.05 hours.

Table 6.20 Current Consumption Analysis of Two-wheeler Node

Component	**Quantity**	**Current (mA)**
Arduino Uno	1	40
RFID reader	1	90
RF Modem	1	58
Total		188

The total power consumption by two-wheeler node is (188mA * 5V = 940 mW) the three components that dominate power consumption two-wheeler node are RF modem, RFID reader and Arduino. The battery available in vehicle is used to provide current to the developed system.

Table 6.21 Current Consumption Analysis of Server

Component	**Quantity**	**Current (mA)**
Arduino nano	1	40
RF Modem	1	58
Total		98

The total power consumption by helmet node is (98 mA * 5V = 490 mW) the two components that dominate power consumption helmet node are RF modem and Arduino. The power can be taken from the main power supply at homes or industries.

6.7 Chapter Summary

Chapter concluded the results analysis for the experimental research with the help of LabVIEW GUI and samples collected. It is concluded that vehicle will be ignited only if the average value from the three flex sensors exceeds the level 212 (1.03V) and RFID code matches with pre-stored RFID code to the program. If any one of these values not satisfied then vehicle will not be ignited. To analyze the sensory data and ignition system two LabVIEW GUI are designed. The major conclusion is in form of a flex sensor based system to ignite the vehicle only if driver is wearing the helmet. The total cost of the system development is calculated as Rs. 6200.