East West University

Driver's Health and Body Movement Monitoring System for Early Accident Detection

By

Rejowana Ashrafi (ID: 2013-2-80-066)

Abdullah-Al-Fahad (ID: 2013-3-80-012)

Ahnaph Tahmid Alam (ID: 2013-3-80-035)

Submitted to the

Department of Electrical and Electronic Engineering

Faculty of Science and Engineering

East West University

Dhaka, Bangladesh

In partial fulfillment of the requirements for the degree of

Bachelor of Science in Electrical and Electronic Engineering

(B.Sc. in EEE)

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Approved by

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Fakir Mashuque Alamgir	Dr. Mohammad Mojammel Al-Hakim
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Approval

The project work titled “Driver’s Health and Body Movement Monitoring System for Early Accident Detection” submitted by Rejowana Ashrafi (ID: 2013-2-80-066), Abdullah-Al-Fahad (ID: 2013-3-80-012) and Ahnaph Tahmid Alam (ID: 2013-3-80-035) in the semester of spring 2018 is approved as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

____

Department Chairperson:
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Acknowledgment

At first we would like to thank the Almighty for giving us enough courage, scope, potential and intelligence to complete the project. Then we are grateful to our parents for their nonstop support. Today we are here only because of them.

We are grateful to our supervisor Fakir Mashuque Alamgir, Assistant Professor, Department of Electrical and Electronic Engineering (EEE), East West University (EWU), Dhaka. He gave us regular guidance, valuable suggestions and constant support during the project work. He inspired us a lot and gave us new ideas to implement on our project.

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At last we want to thank our parents, well-wishers and friends for their moral support and helpful discussion during the project work.

Authorization

We hereby declare that, we are the sole authors of this project. We authorize, East West University to lend this project to other institutions or individuals for the purpose of scholarly research.

Rejowana Ashrafi	Abdullah-Al-Fahad	Ahnaph Tahmid Alam
(ID: 2013-2-80-066)	(ID: 2013-3-80-012)	(ID: 2013-3-80-035)

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Rejowana Ashrafi	Abdullah-Al-Fahad	Ahnaph Tahmid Alam
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Dhaka, Bangladesh
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ABSTRACT

The purpose of this project is to save people from accident. Approximately 1.3 million people die in road crashes each year, on average 3,287 deaths a day [1]. The U.S. National Highway Traffic Safety Administration reported that drowsy and careless driving is the cause of an estimated 40,000 injuries and 1550 deaths in car crashes every year in U.S. [2]. Over 90% of all road fatalities occur in low and middle-income countries, which have less than half of the world's vehicles [1]. Following the report of NCPSRR (The National Committee to Protect Shipping, Roads and Railways) 4,284 people were killed and 9,112 others injured in 3,472 road accidents across Bangladesh in 2017 [3]. Road accident is one of the major problems and the number of accident is increasing day by day. Many of these deaths could be avoided if driver drowsiness and carelessness could be properly monitored and drivers are given early warnings. That is why we are making this project so that we can reduce the number of accidents and save few lives. We collected 14 years data of accidents in Bangladesh and then we analyzed it and found a pattern of the accident. And then we build two devices. One device will monitor the physical condition of the driver and another device will monitor the head movement of the driver. The system will keep monitoring the driver's condition. If the driver loses his focus from the road or driving, the system will alert and help to get back him focused on the road. The system is carefully designed for low-power consumption and the cost of the device is also low.

KEYWORDS: Driver drowsiness detection, Driver condition detection (Care), PIR, Gyroscope.

CHAPTER 1: INTRODUCTION

Now a day's self-driving car appeared to be an available developed vehicle technology. The producers of the self-driving cars are ensuring that those cars are comparatively safer. So at this time a question can raise that in the self-driving car age what is the point of this type of device or safety issue. The question can be answered through recent news and it will make clear view. On the 23rd march, 2018 a self-driving car struck and killed a woman in Tempe, Arizona [4].So the reality is that there is still a long way to go to make a self-driving vehicle safe. And people trust and the availability of the Self driving car is still a big question. It is very usual to become careless and drowsy of drivers while driving for a distances such as driving on highway in Bangladesh. It is known that around one fourth of all the accidents are directly or secondarily caused, over speed, carelessness and drowsy drivers. Drowsiness, over speed and carelessness causes more road accident than drink driving. In order to reduce road accident the improvement of a system for drowsiness, over speed and carelessness detection is one of the demanded issues. Among various ideas, we selected this project that will reduce the number of accident. The purpose of the project is to build a cost effective wearable device to detect over speed drowsiness and carelessness. This project is not only just a scientific approach, but also introduces a prototype that can be applied in reality. The device will detect Drowsiness and carelessness of driver by analyzing driver's heart beat and movement for reducing road accident. Moreover the device will be compact and portable.

1.1 Background

The number of road accidents is raising at a high rate, significantly highway accidents, in Bangladesh over the past few years. Following a research conducted by the Accident Research Institute (ARI) of BUET, road accidents claimed on average 12,000 lives annually and lead to about 35,000 injuries. World Bank statistics stated that the annual fatality rate from road accidents was found to be 85.6 fatalities per 10,000 vehicles [5].These statistics are numerically shocking but they fail to reflect the social tragedy related to each life lost to road accidents.

A proper estimation of the economic cost of lives taken by road accidents in Bangladesh would surely reflect the considerable loss of addition to GDP. According to WHO, the economic cost of road accidents to developing countries is 2-3% of GDP (Gross domestic product)[5].For a developing country like Bangladesh, allowing its citizen to perish to road accidents is not only tragic but unacceptable.

1.2 Report Organization

In chapter-2, we have discussed about the software and hardware equipment that we have used in the project to construct the device. In Chapter-3, we have discussed about the data analysis and experiments that we have conducted for the project purpose. In Chapter-4, we have discussed about the block diagram and the working principle of the device. In Chapter-5, we have discussed about the features, drawbacks and discussion about the device.

CHAPTER 2: HARDWARE AND SOFTWARE

In this project we have used different types of hardware and software. Arduino Nano R3 board, MPU 6050 (or GY-521) gyro and accelerator sensor, motion sensor and Pulse sensor are the main hardware. Arduino IDE, Microsoft Excel were mainly use in this project as software.

2.1 Hardware

2.1.1 Arduino Nano R3 board

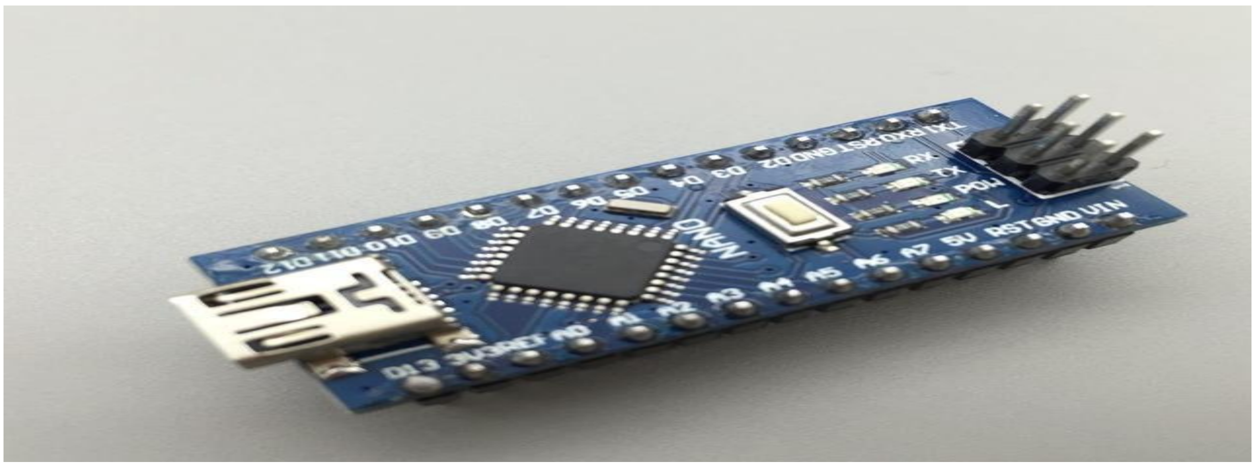


Figure 2.1: Arduino Nano R3 board [6]

Arduino Nano is a ground mount breadboard which is joined version of Arduino with compact of USB. This Arduino size is small. It has two versions both are Diecimila and Duemilanove. Here Diecimila is the old version and Duemilanove is current version. Arduino Nano has is based on ATmega328P microcontroller [6].

Specification:

- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V

- Operating Voltage at logic level : 5 V
- Digital input & output Pins: 14 (6 provide PWM output)
- Analog Input Pins: 8
- DC Current per input & output Pin: 40 mA
- Flash Memory: 32 KB (2KB used by boot loader)
- SRAM: 2 KB
- EEPROM: 1 KB
- Dimensions: 0.70” x 1.70”
- Clock Speed: 16 MHz

2.1.2 MPU 6050 (or GY-521) gyro and accelerator sensor

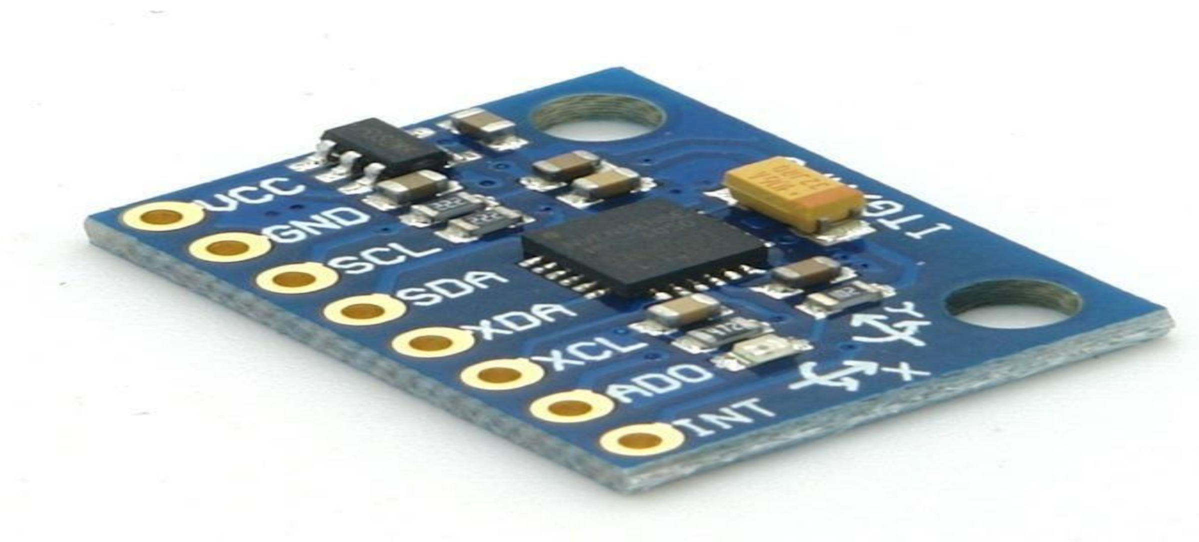


Figure 2.2: MPU 6050(or GY-521) gyro [7]

We have used MPU6050 (GY-521) for sensing the movement of the head. MPU 6050 is integrated 3-axis motion tracking device. This combined with 3-axis gyroscope, 3-axis accelerometer, 3-axis compass and with a Digital Motion processor (DMP).It has three analog to digital converters (ADC) for digitizing the output of the gyroscope. Also there are three analog to digital converters (ADC) for digitizing the output of the accelerometer. It is also compact with pressure sensor. It is enable of I2C (Inter-Integrated Circuit) communication [7].

Specification:

- Accelerometer ranges: ±2, ±4, ±8, ±16g
- Gyroscope ranges: ± 250, 500, 1000, 2000 °/s
- Voltage range: 3.3V - 5V (the module has a low drop-out voltage regulator)

2.1.3 PIR Sensor

Figure 2.3: PIR motion sensor [8]

PIR (Passive Infrared) sensor detects a human being moving around within approximately 10m from the sensor. It will work from 5V to 12V but the sensor uses 1.6mA at 3.3V.Most of the PIR sensors have a 3-pin connection at the side or bottom. One pin will be ground, another will be signal and the last pin will be power. Interfacing PIR with microcontroller is very easy [9].

Specification:

- Digital output: 3.3v High/Low TTL
- Working voltage: 5V-20V DC Effective angle: < 120°
- Ranging distance : 3-7M (adjustable)

- Delay: 0.3s - 18s (adjustable)
- Trigger: H repeatable (default), L unrepeatable.

2.1.4 Pulse sensor

Figure 2.4: Pulse Sensor [10]

Pulse sensor measure the heart rate. The sensor will detect the amount of blood then this it will calculate the beats per minute of the heart. It essentially combines a simple optical heart rate sensor with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings. Also it consumes power with just 4mA current draw at 5V so it’s great for mobile applications [10].

Specification:

- 0.625" Diameter and 0.125" Thick

CHAPTER 3: EXPERIMENTAL STUDIES

We have analyzed the accidents that occurred in the highways of Bangladesh**.** Following the accidental police form of Bangladesh there are four types of accidents such as fatality, grieve simple and collision. We have considered all the accident severity for the year 1998 to 2011. There are few factors of road accidents. Those are:

1. Over speed
2. Lack of carefulness
3. Falling asleep or feeling unrest
4. Close contact
5. Breaking the Signal or giving wrong signal
6. Over taking
7. Over turning
8. Drink and drive (Alcohol)
9. Pedestrian
10. Passenger
11. Road condition
12. Road factor
13. Weather
14. Vehicle defect
15. Over load
16. Tire burst
17. Animal and
18. Other

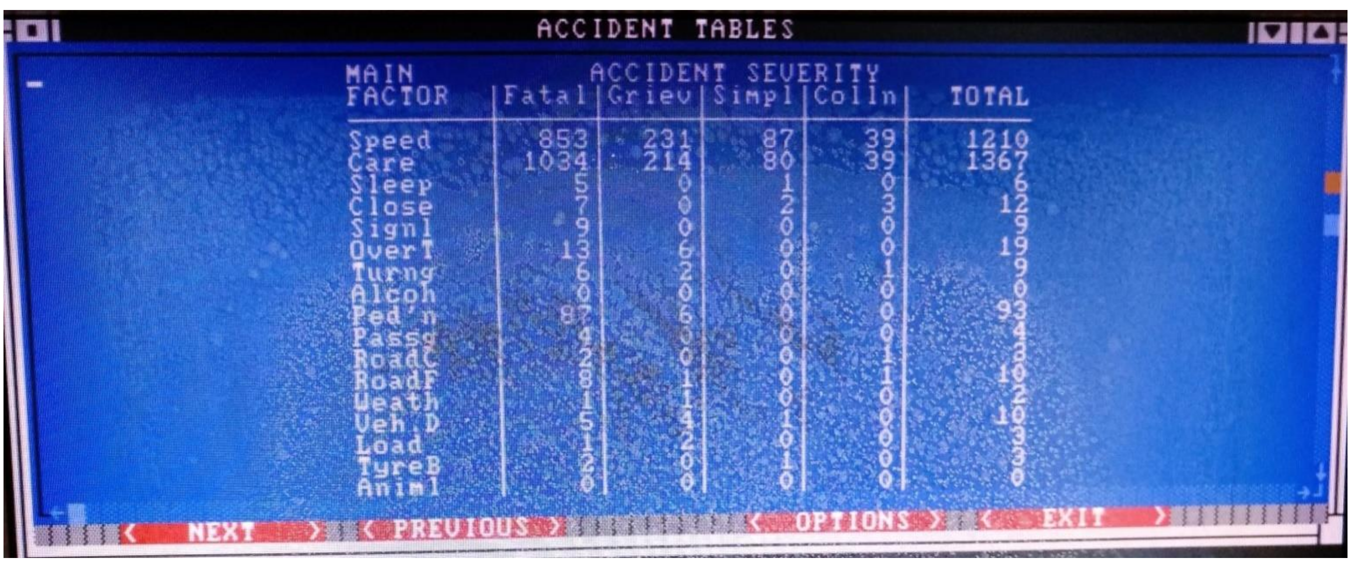
The factors can play two types of role such as main factor and second factor. Main factor are directly involved to conduct the accident. And second factor is indirectly involved in the accident. But sometimes second factor are directly involved to accident. For example let a bus is running at over speed and the driver is careless about the driving and watching the scenario. Here if the bus hit another bus then speed will be the main and carelessness will be the second factor for the accident.

From the analysis of fourteen years highway accidental data of Bangladesh we have found that about 77.81%accidents occur due to carelessness, over speed and sleep as a main factor. And 75.67% accidents occur due to carelessness, over speed and sleep as a second factor. So it is obvious that most of the accidents occur due to over speed, carelessness and falling asleep and those can be main or second factor.

Through this project we will try reduce the accidents those occur due to over speed, lack of carefulness and sleep. We will keep the other factors aside.

3.1 Source of Data

We have collected some accidental data from the Accident Research Institute (ARI). Those data are collected from the FIR that is submitted by police. Those data are stored at the regional office of ARI. Then all the accumulated data are send to ARI. Those data were researched for 2 years by ARI. After two years ARI upload the data into their server those can be accessed through MAAP5 (Micro Computer Accident Analysis Package version 5) software. MAAP5 software provides the data in vise versa tabular form. The data can’t be copied from the software. Sample of the data at MAAP5 is shown in figure 3.1. We have taken the data in written form and researched for our project. We have collected the accidental data for the highway routes of Bangladesh as major accidents due to carelessness, drowsiness and speed occurs in the highways.


ACCIDENT TABLES

MAIN FACTOR	ACCIDENT SEVERITY Fatal	Griev	Simpl	Colln	TOTAL
Speed	853	231	87	39	1210
Care	1034	214	80	39	1367
Sleep	5	0	1	0	6
Close	7	0	2	3	12
Signl	9	0	0	0	9
OverT	13	6	0	0	19
Turng	6	2	0	1	9
Alcoh	0	0	0	0	0
Ped'n	87	6	0	0	93
Passg	4	0	0	0	4
RoadC	2	0	0	1	3
RoadF	8	1	0	1	10
Weath	1	1	0	0	2
Veh D	5	4	1	0	10
Load	1	2	0	0	3
TyreB	2	0	1	0	3
Animl	0	0	0	0	0

Figure 3.1: Sample of the data of the main factor for N1 highway (MAAP5)

3.2 Highways in Bangladesh

The road network of Bangladesh are divided into various types such as national highways (designated by a number preceded by "N"), regional highways (R numbers), and zilla or district roads (Z numbers). The total length is more than 21,000 km [11] .The length of the National highway is 3,790.861 km. In this project we have worked with 8 national highways those are given below:

N1 (Dhaka–Chittagong Highway):

The N1 is known as Dhaka–Chittagong Highway road in Bangladesh. It connects country's two largest cities, Dhaka and Chittagong. The highway is approximately 455 km (283 mi) in length [11]. The highway is known along various stretches as the Chittagong–Cox's Bazar Highway and the Cox's Bazar–Teknaf Highway. The N1 is one of the busiest roads in the country and a top development priority. Construction of a larger Dhaka-Chittagong expressway has been proposed to decrease traffic on the highway.

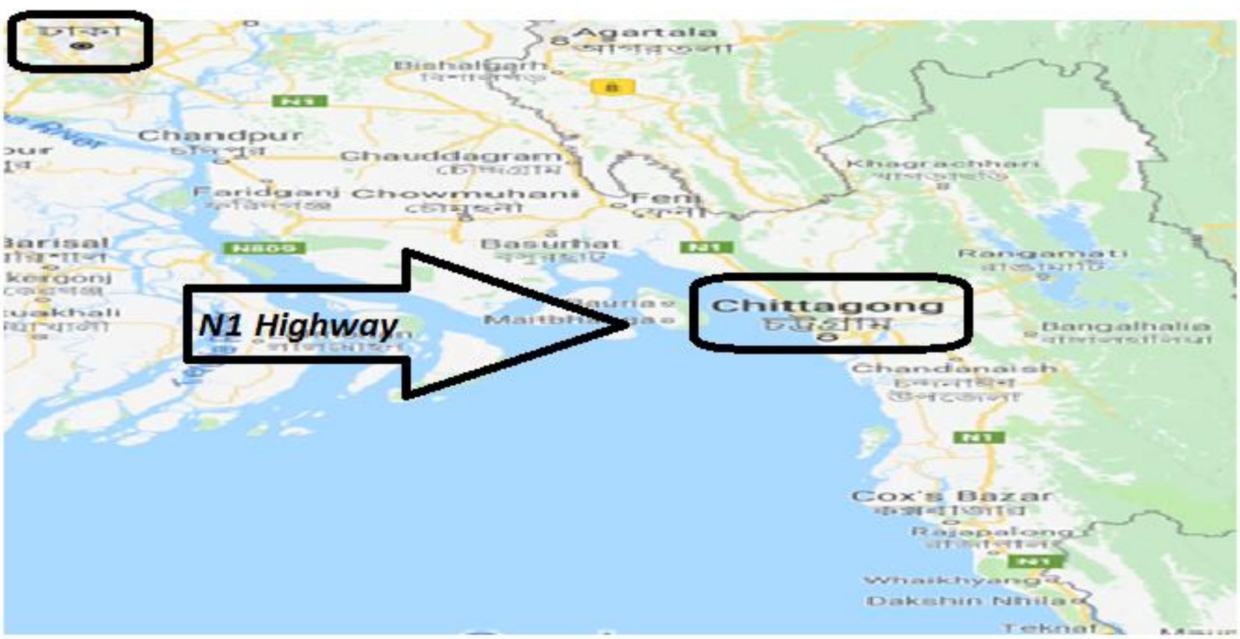


Figure 3.2: N1 Highway (Dhaka-Chittagong Highway)

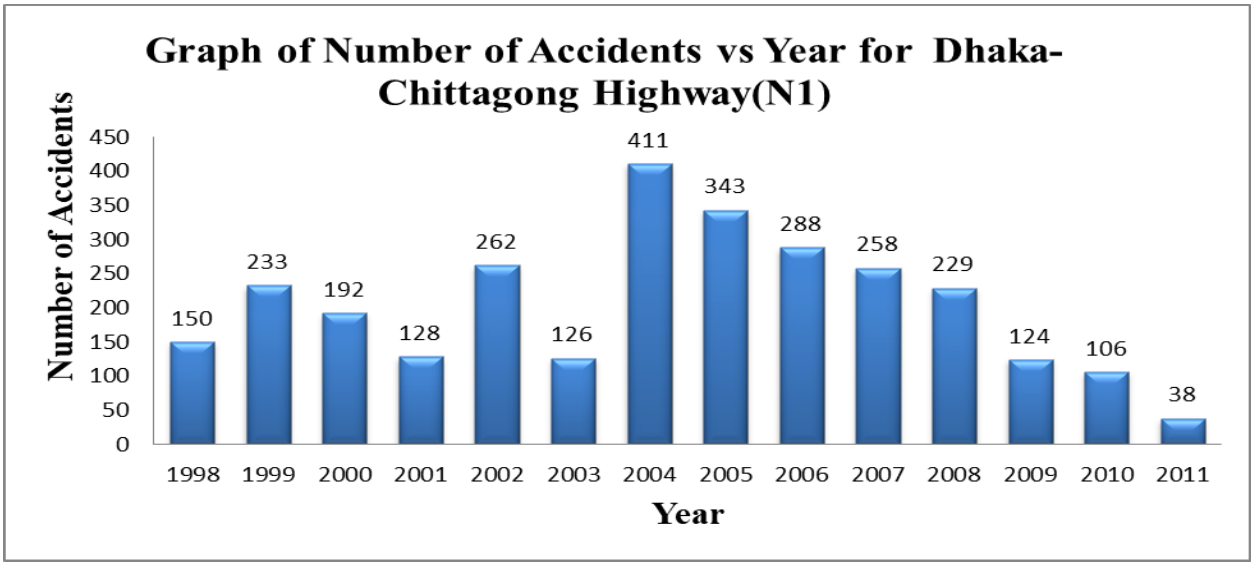


Figure 3.3: Graph of Number of Accidents vs year for Dhaka-Chittagong Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.3] shows the number of accidents in Dhaka Chittagong Highway from the year 1998 to 2011.

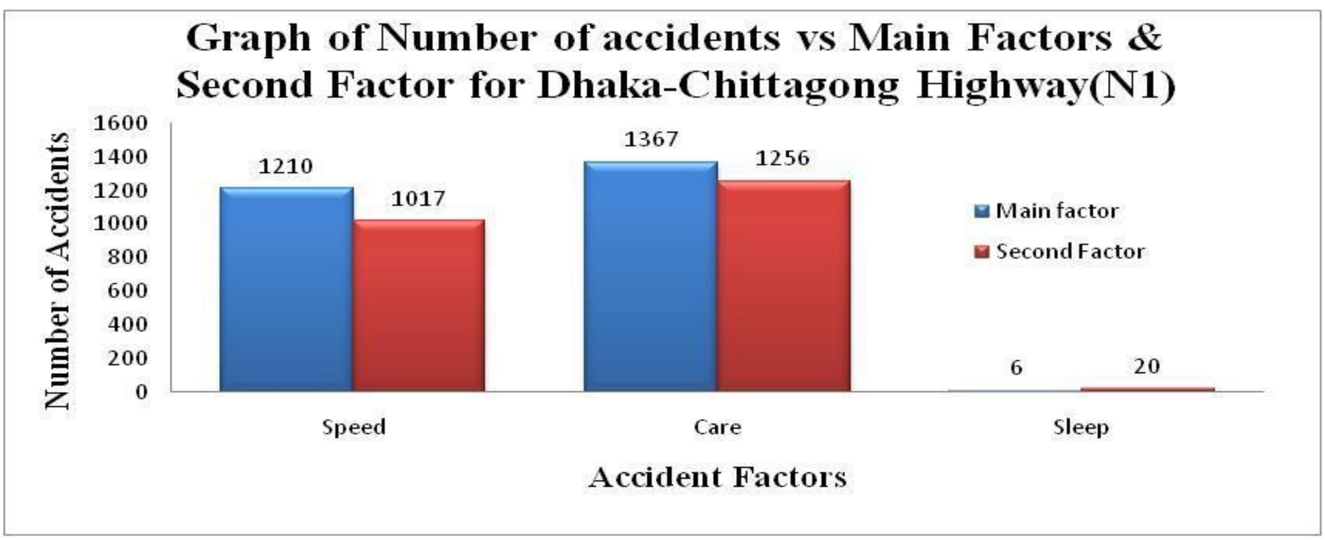


Figure 3.4: Graph of Number of Accidents vs Main factor and second factor for Dhaka-Chittagong Highway (Using the data collected from ARI, BUET)

This bar diagram[Figure 3.4] shows the number of accidents due to main factor and second factor in Dhaka Chittagong Highway from the year 1998 to 2011.Here the blue colored bar indicates the main factor and the red colored bar indicates the second factor of Bangladesh.

N2 (Dhaka–Sylhet Highway):

The N2 is known as Dhaka–Sylhet Highway and the Sylhet-Tamabil Highway road in Bangladesh. It links between country's capital Dhaka and the town of Tamabil in the Sylhet District. The highway is approximately 286 km (178 mi) in length [11]. The route passes through the city of Sylhet, crossing the Surma River on the bridge. It is part of AH1 and AH2 in the Asian Highway Network [12].This road has been called the deadliest road in the world [13].

Figure 3.5: N2 Highway (Dhaka–Sylhet Highway)

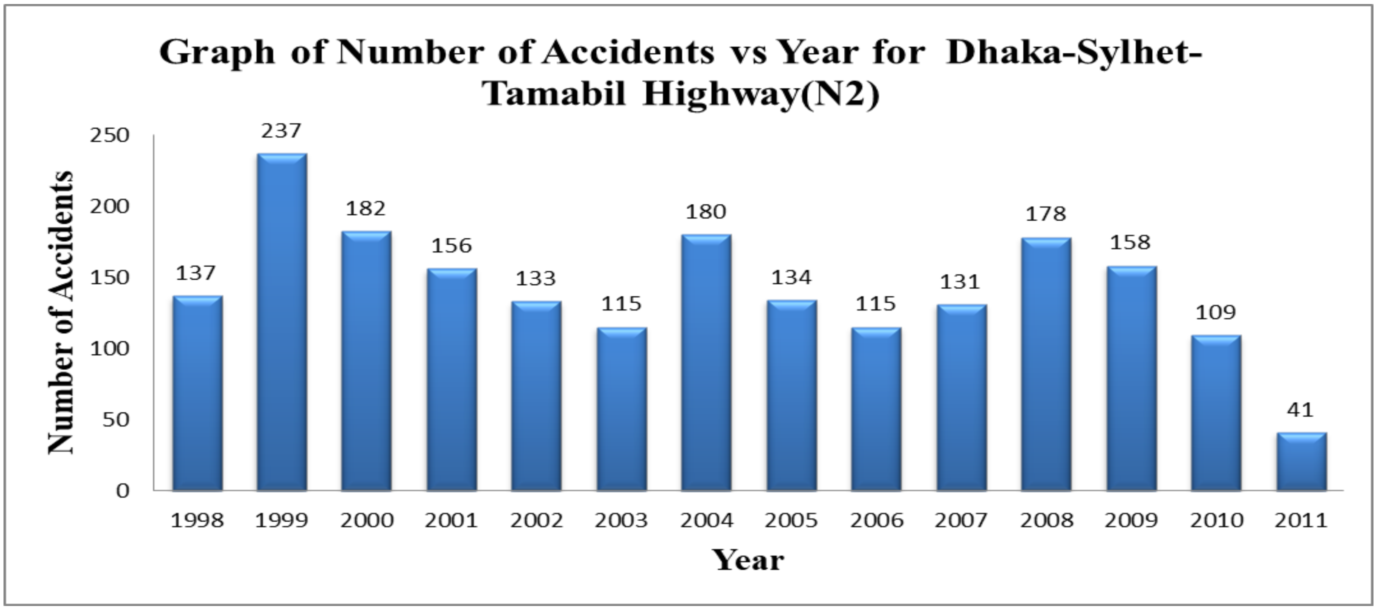


Figure 3.6: Graph of Number of Accidents vs year for Dhaka-Sylhet-Tamabil Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.6] shows the number of accidents in Dhaka-Sylhet-Tamabil Highway from the year 1998 to 2011.

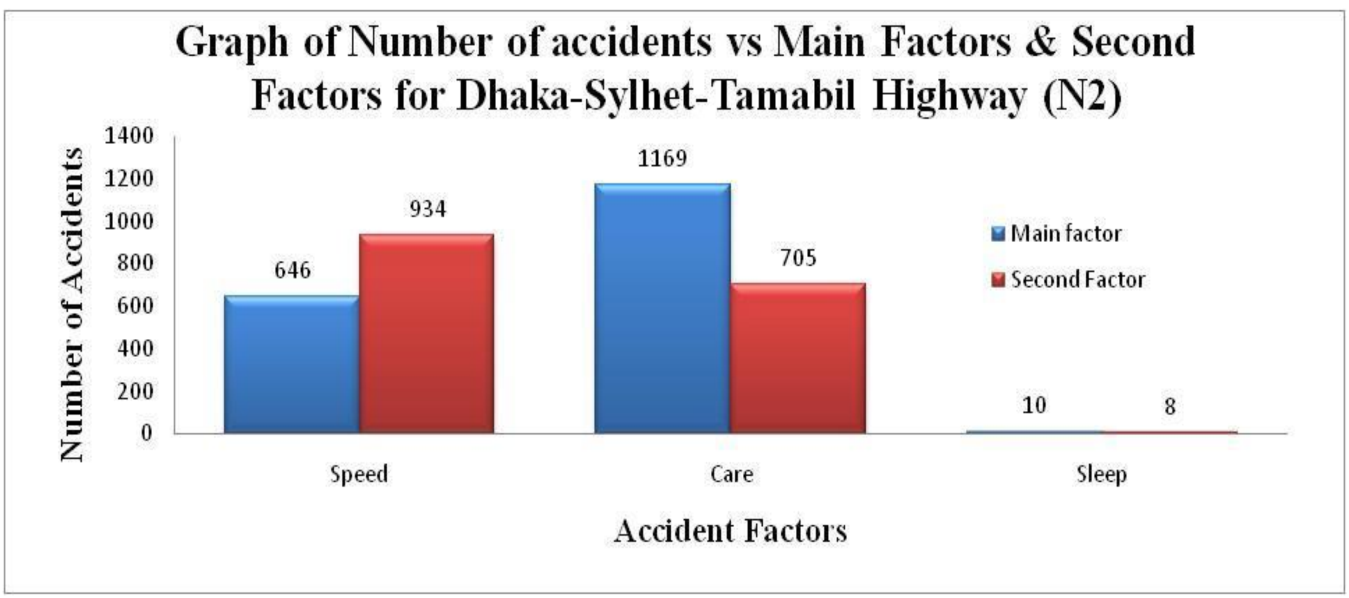


Figure 3.7: Graph of Number of Accidents vs Main factor and second factor for Dhaka-Sylhet-Tamabil Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.7] shows the number of accidents due to main factor and second factor in Dhaka-Sylhet-Tamabil Highway from the year 1998 to 2011.

N3 (Dhaka-Mymensingh Highway):

The N3 is a Bangladeshi national highway connecting the capital Dhaka and Mymensingh of Bangladesh. The highway is approximately112 km (70 mi) in length [11].

Figure 3.8: N3 Highway (Dhaka-Mymensingh Highway)

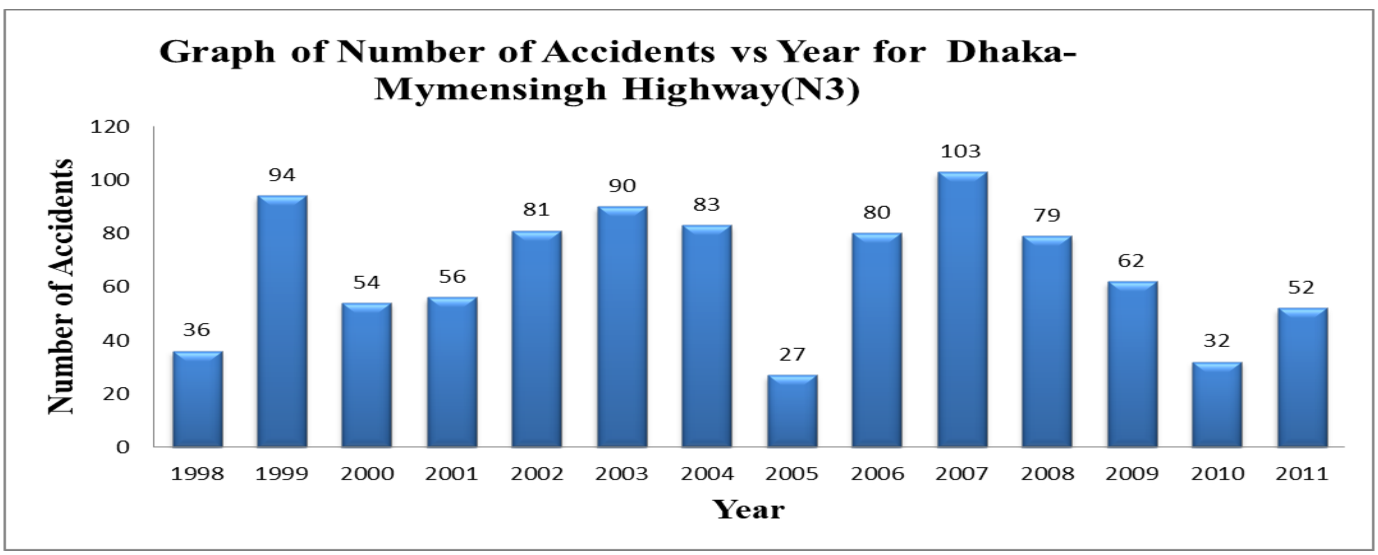


Figure 3.9: Graph of Number of Accidents vs year for Dhaka-Mymensingh Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.9] shows the number of accidents in Dhaka-Mymensingh Highway from the year 1998 to 2011

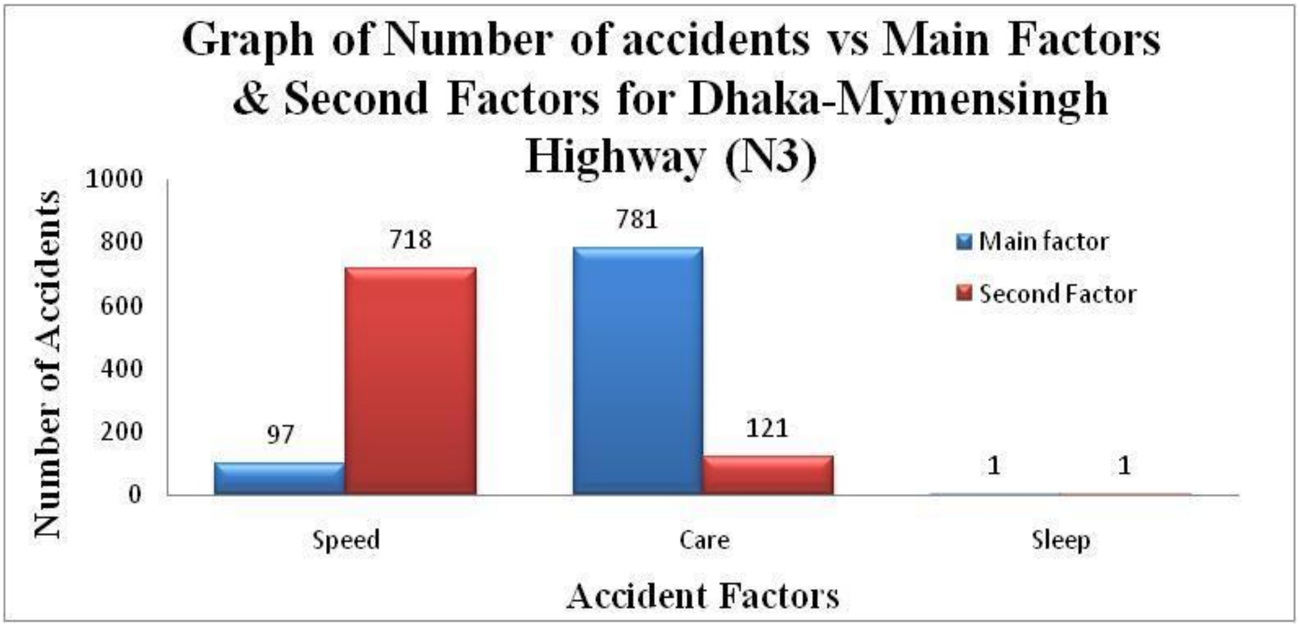


Figure 3.10: Graph of Number of Accidents vs Main factor and second factor for Dhaka-Mymensingh Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.10] shows the number of accidents due to main factor and second factor in Dhaka-Mymensingh Highway from the year 1998 to 2011.

N4 (Joydebpur-Jamalpur Highway):

The N4 is a Bangladeshi national highway connecting Joydebpur near the Bangladeshi capital Dhaka and Jamalpur. The highway is approximately146 km in length [11].

Figure 3.11: N4 Highway (Joydebpur-Jamalpur Highway)

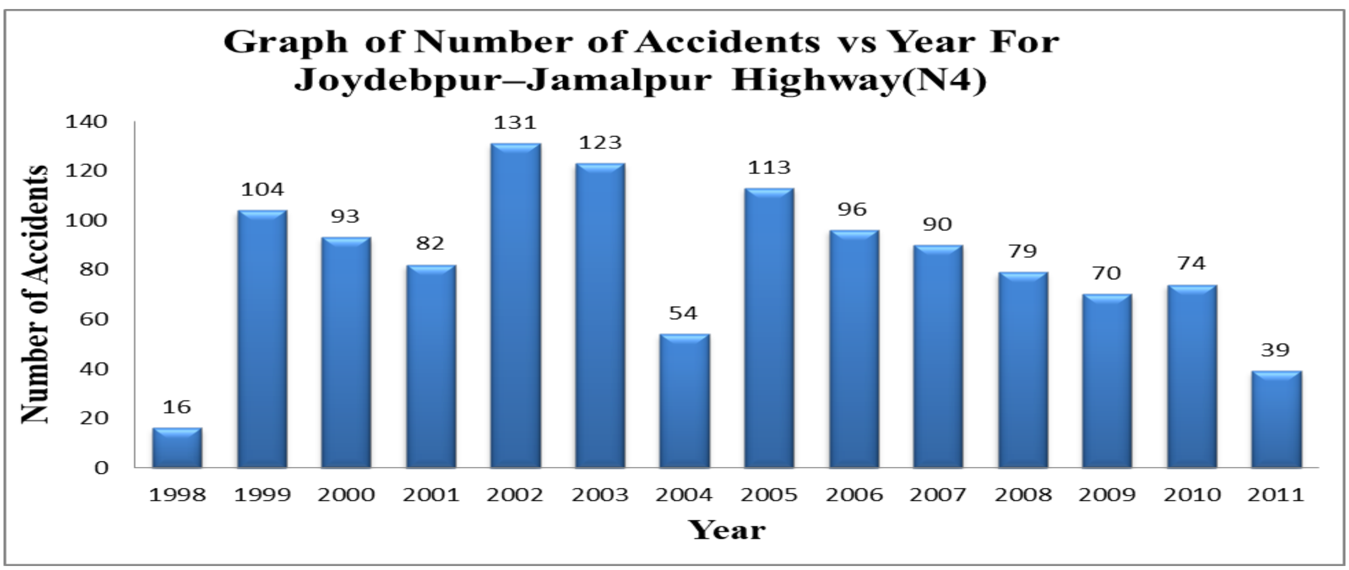


Figure 3.12: Graph of Number of Accidents vs year for Joydebpur-Jamalpur Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.12] shows the number of accidents in Joydebpur-Jamalpur Highway from the year 1998 to 2011

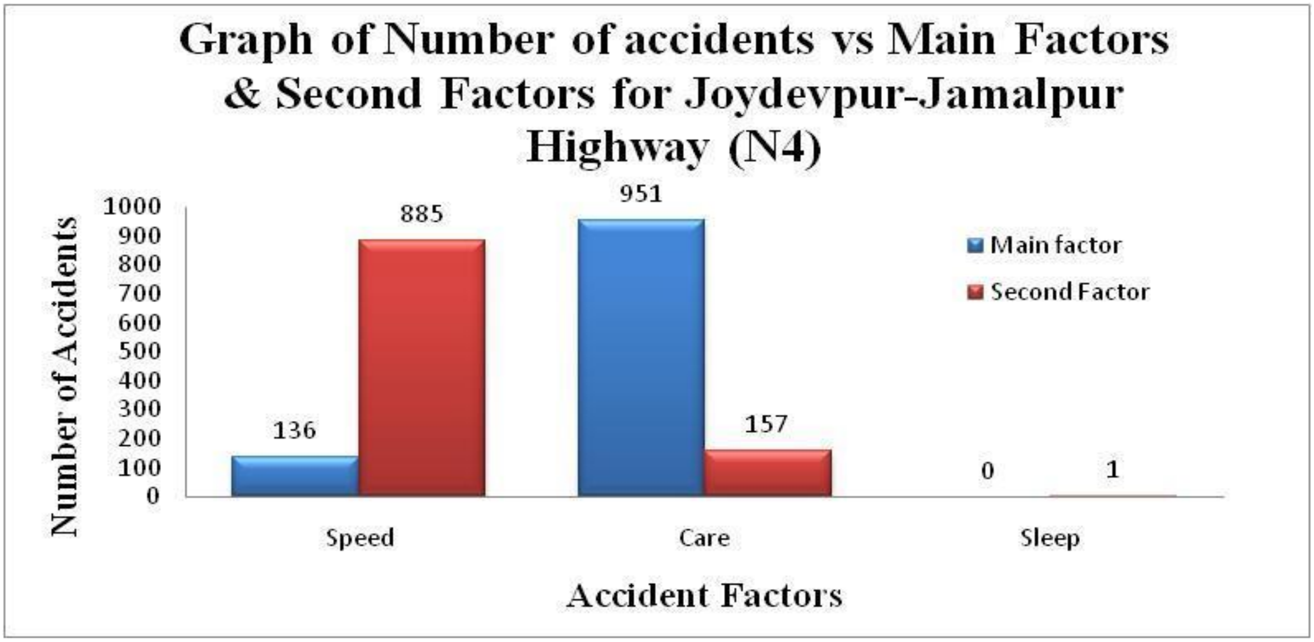


Figure 3.13: Graph of Number of Accidents vs Main factor and second factor for Joydebpur-Jamalpur Highway (Using the data collected from ARI, BUET)

This bar diagram shows the number of accidents due to main factor and second factor in Joydebpur-Jamalpur Highway from the year 1998 to 2011.

N5 (Dhaka–Banglabandha Highway):

The N5 is known as Dhaka–Banglabandha Highway road in Bangladesh. It links between the capital Dhaka and the town of Banglabandha on the Bangladesh-India border. The highway is approximately 507 km (315 mi) in length [11].

Figure 3.14: N5 Highway (Dhaka–Banglabandha Highway)

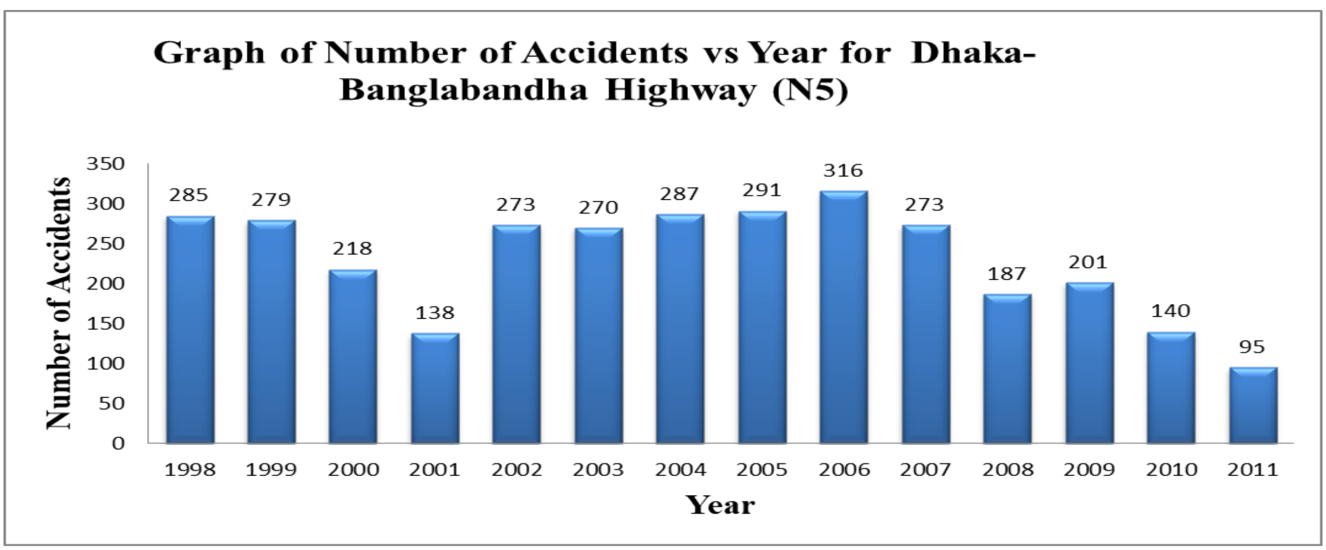


Figure 3.15: Graph of Number of Accidents vs year for Dhaka-Banglabandha Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.15] shows the number of accidents in Dhaka-Banglabandha Highway from the year 1998 to 2011.

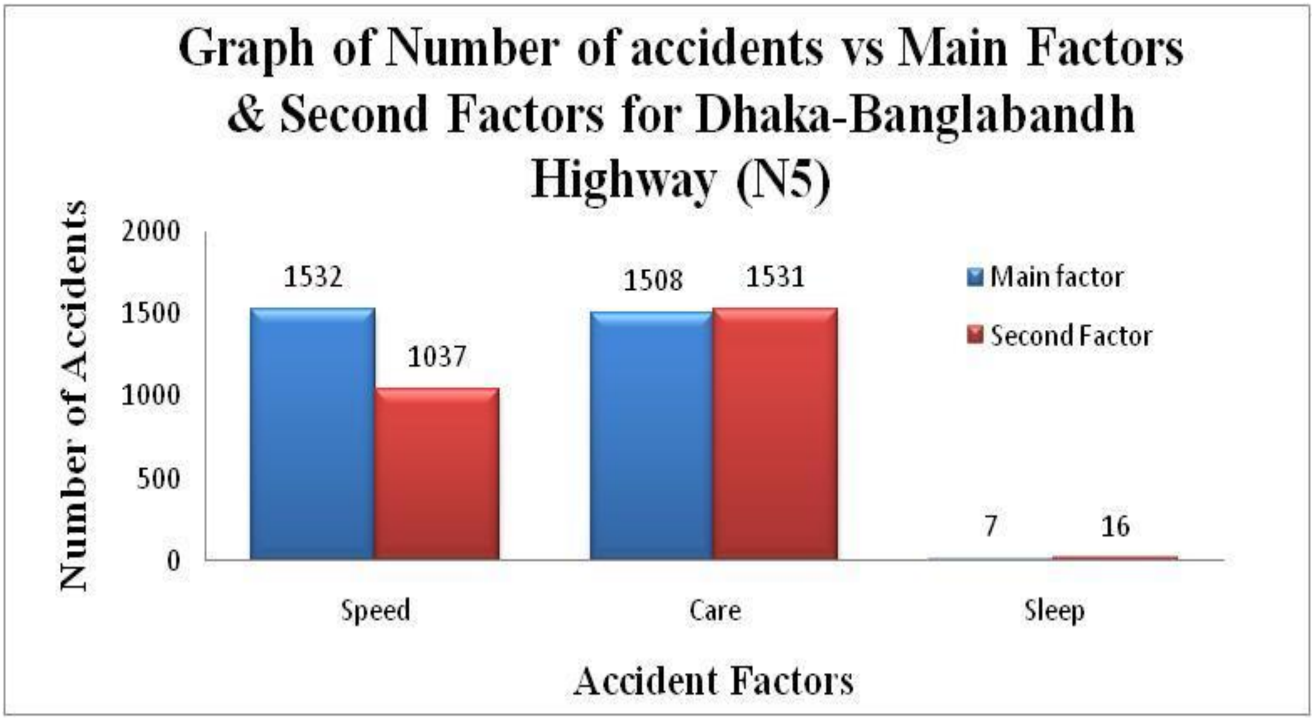


Figure 3.16: Graph of Number of Accidents vs Main factor and second factor for Dhaka-Banglabandha Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.16] shows the number of accidents due to main factor and second factor in Dhaka-Banglabandha Highway from the year 1998 to 2011.

N6 (Kashinathpur-Rajshahi Highway):

The N6 is known as Kashinathpur–Rajshahi Highway road in Bangladesh. It is the national highway connecting Rajshahi and Kashinathpur in the Bangladeshi Division of Rajshahi. The highway is approximately 150 kilometers (93 miles) in length [11].

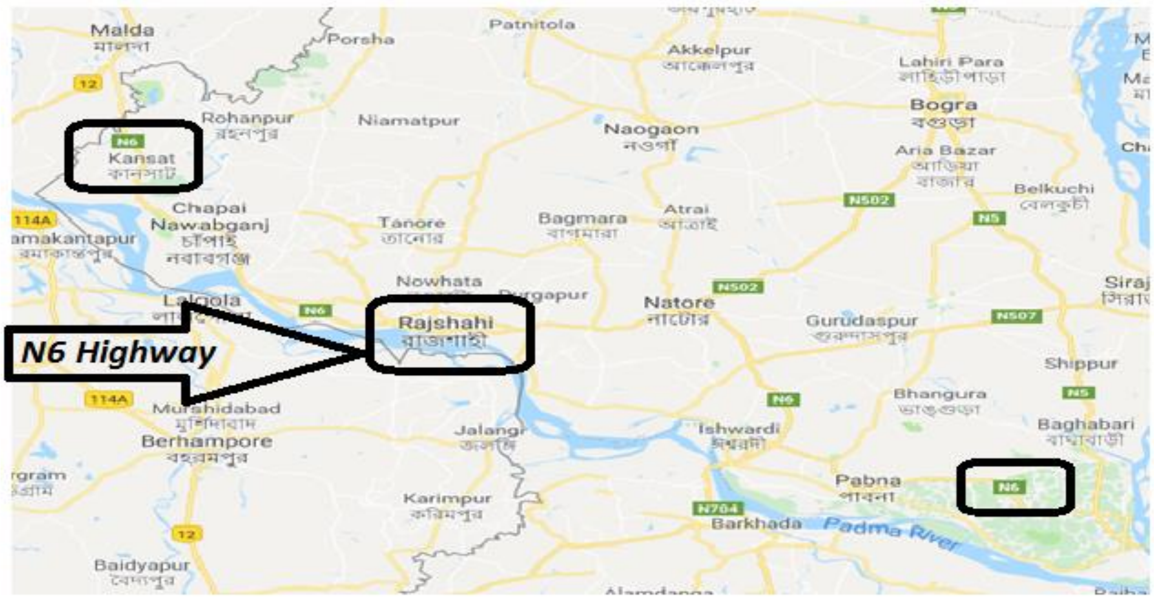


Figure 3.17: N6 Highway (Kashinathpur-Rajshahi Highway)

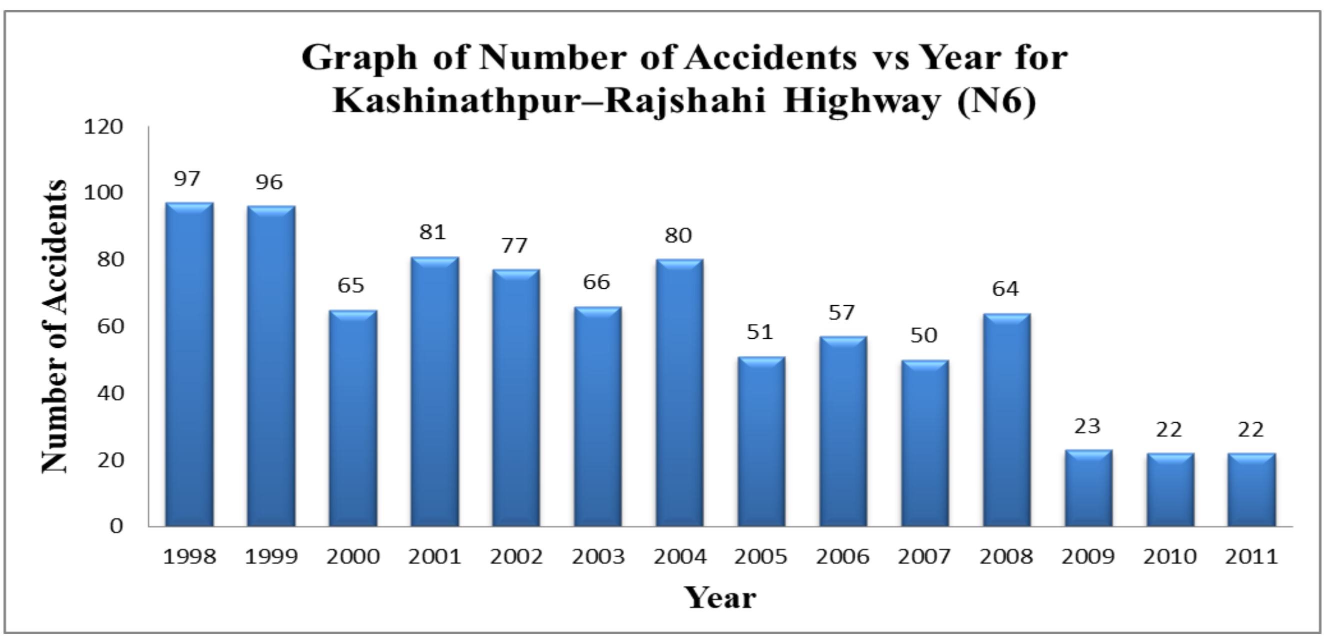


Figure 3.18: Graph of Number of Accidents vs year for Kashinathpur-Rajshahi Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.18] shows the number of accidents in Kashinathpur-Rajshahi highway from the year 1998 to 2011.

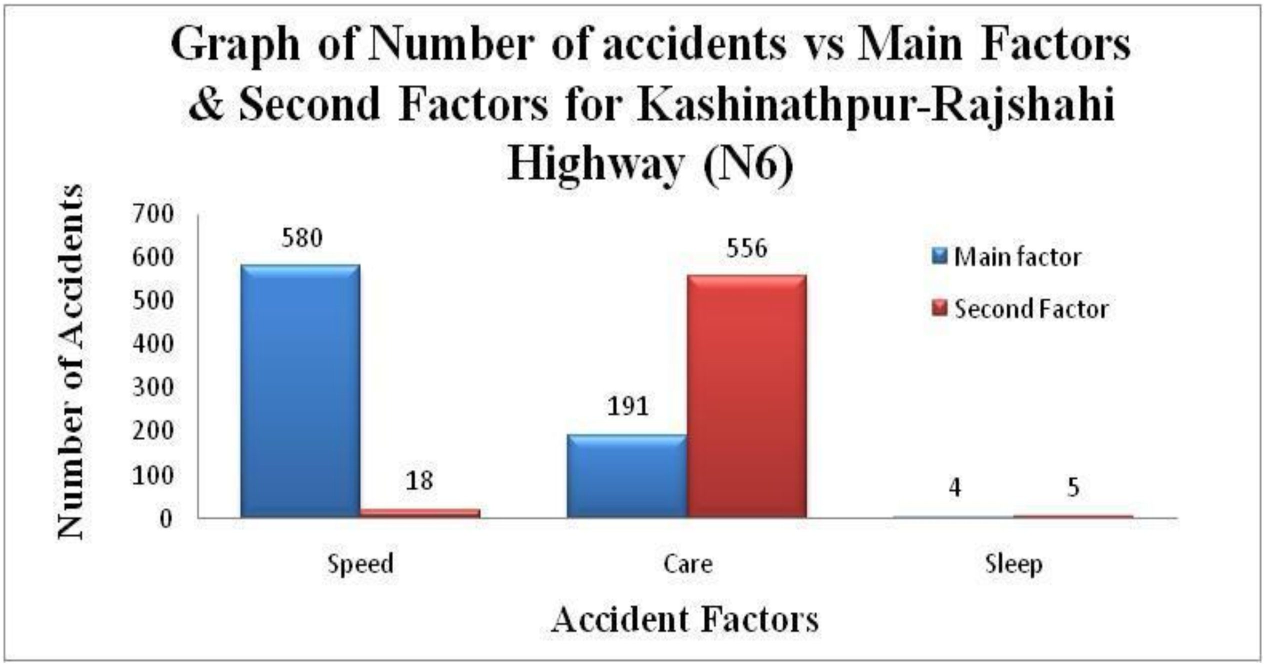


Figure 3.19: Graph of Number of Accidents vs Main factor and second factor for Kashinathpur-Rajshahi Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.19] shows the number of accidents due to main factor and second factor in Kashinathpur-Rajshahi Highway from the year 1998 to 2011.

N7 (Dhaka-Khulna Highway):

The N7 is known as Dhaka-Khulna Highway road in Bangladesh. It links between the Daulatdia Ferry Terminal, on the south bank of the Padma River near the Bangladeshi capital Dhaka, with the Port of Mongla in Bagerhat District. The highway is known along various stretches as the Dhaka–Khulna Highway, the Jessore-Khulna Highway, and the Khulna-Mongla Highway. The highway is approximately 252 kilometers (157 miles) in length [11].

Figure 3.20: N7 Highway (Dhaka - Khulna Highway)

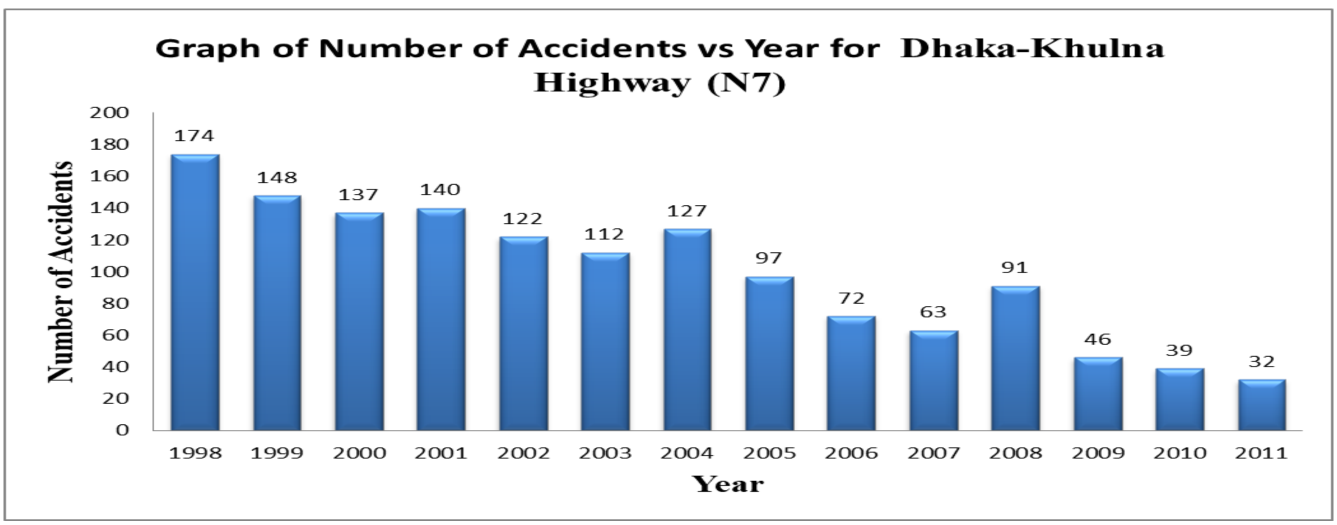


Figure 3.21: Graph of Number of Accidents vs year for Dhaka - Khulna Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.21] shows the number of accidents in Dhaka - Khulna Highway from the year 1998 to 2011.

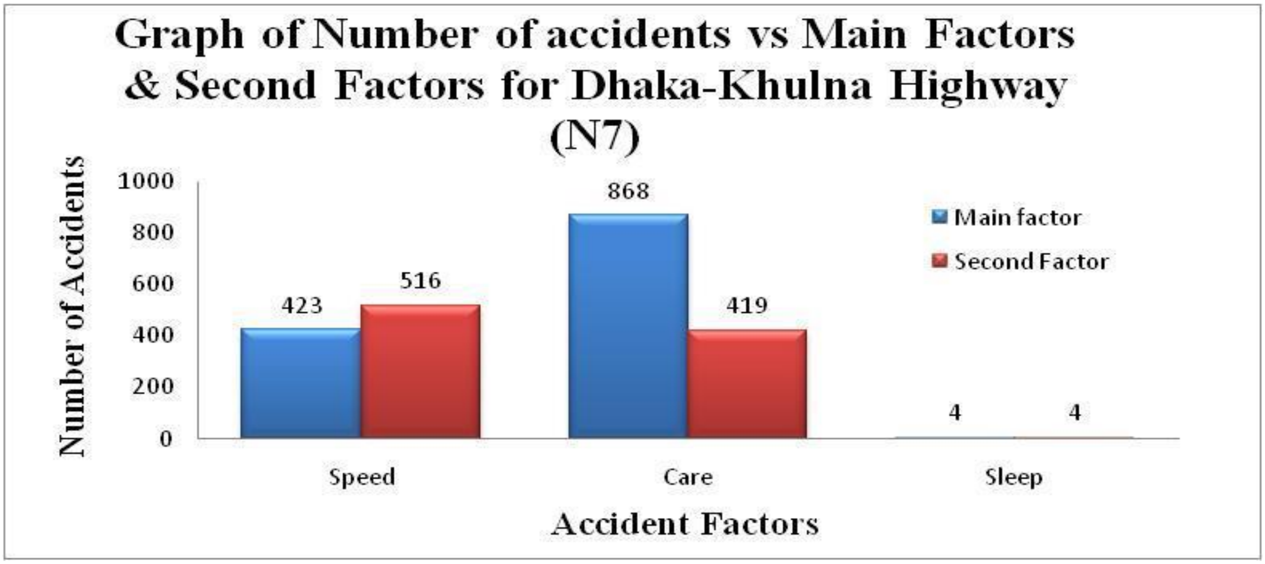


Figure 3.22: Graph of Number of Accidents vs Main factor and second factor for Dhaka - Khulna Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.22] shows the number of accidents due to main factor and second factor in Dhaka - Khulna Highway from the year 1998 to 2011.

N8 (Dhaka–Patuakhali Highway):

The N8 is known as Dhaka–Patuakhali Highway road in Bangladesh. It links between the capital Dhaka and Patuakhali. The highway is approximately 191 kilometers (119 miles) in length [11].

Figure 3.23: N8 Highway (Dhaka–Patuakhali Highway)

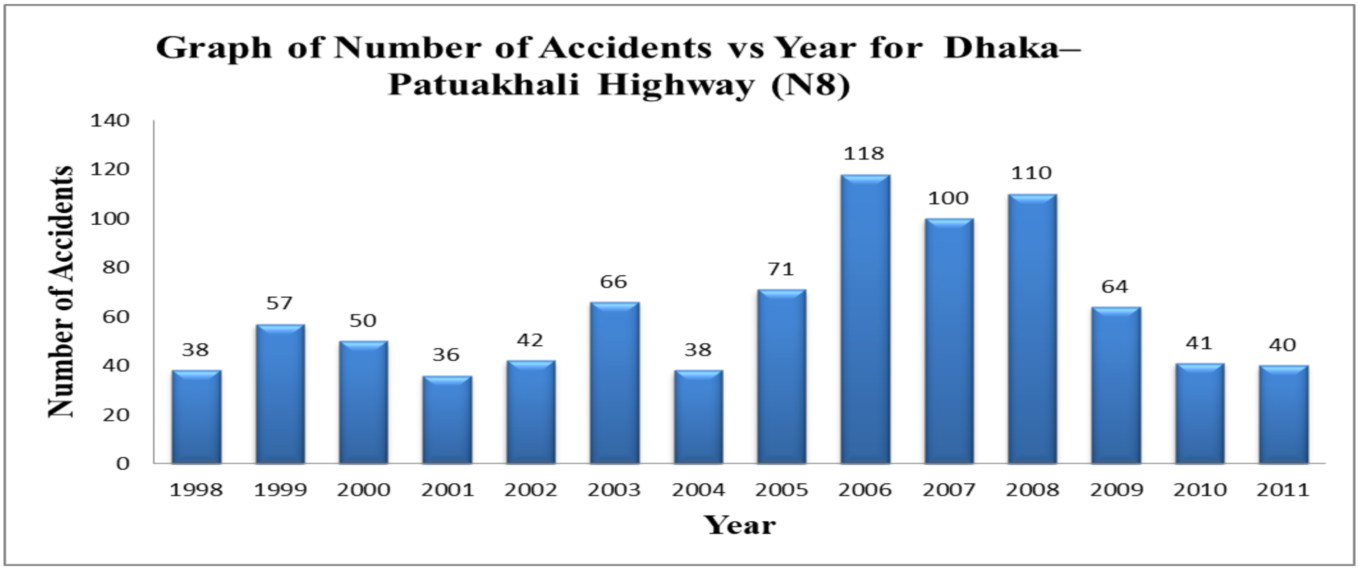


Figure 3.24: Graph of Number of Accidents vs year for Dhaka-Patuakhali Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.24] shows the number of accidents in Dhaka-Patuakhali Highway from the year 1998 to 2011

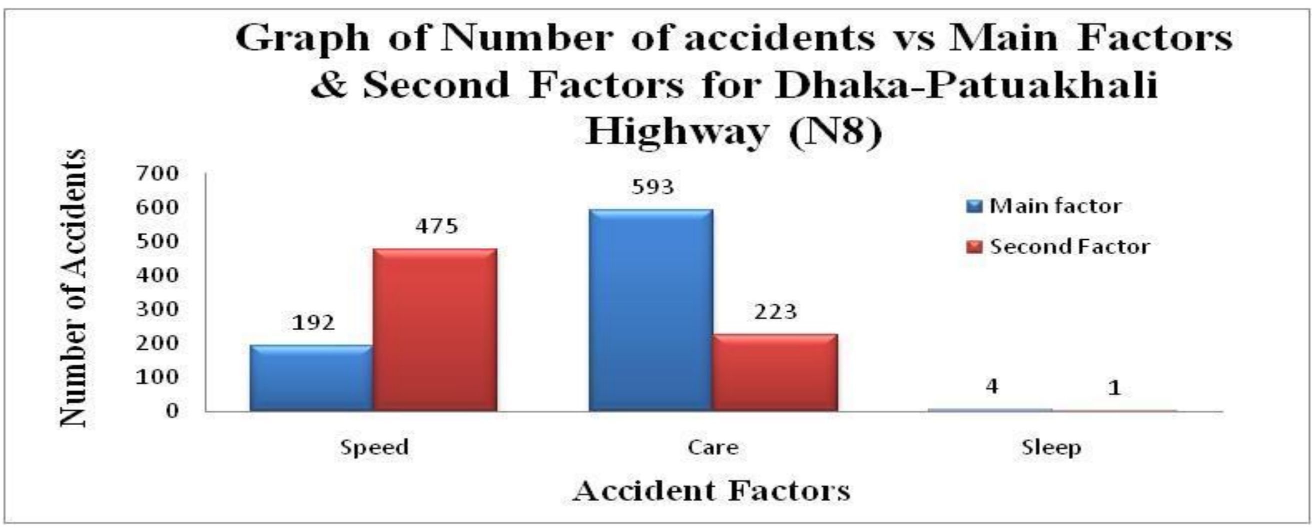


Figure 3.25: Graph of Number of Accidents vs Main factor and second factor for Dhaka-Patuakhali Highway (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.25] shows the number of accidents due to main factor and second factor in Dhaka-Patuakhali Highway from the year 1998 to 2011.

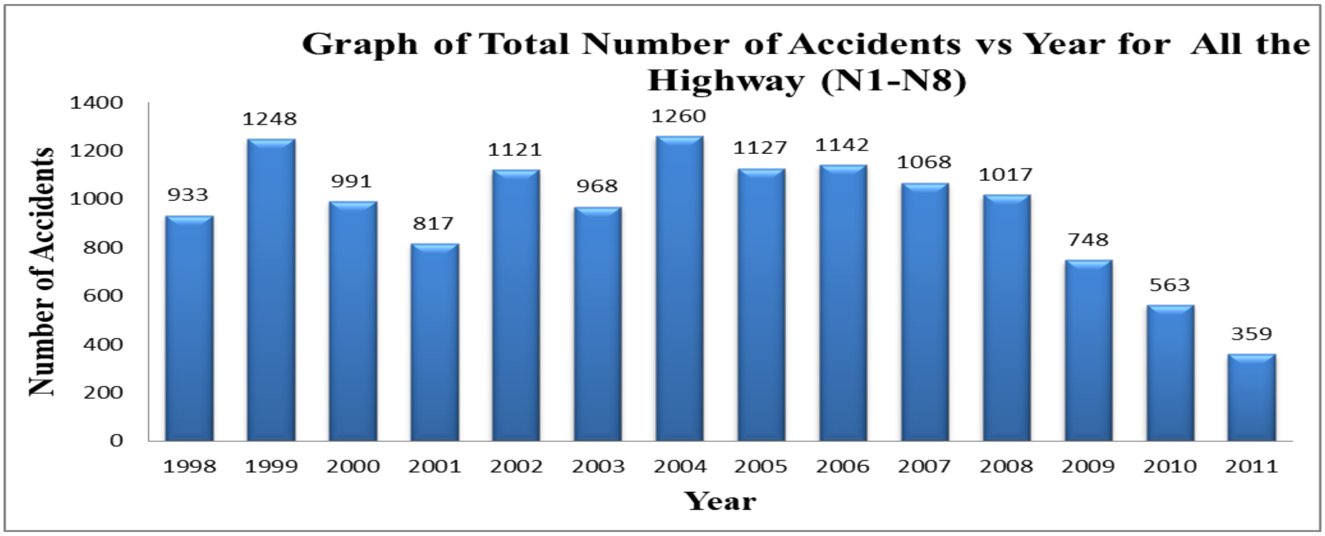


Figure 3.26: Graph of Number of Accidents vs year for all the Highways (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.26] shows the number of accidents occurred per year in the Highways from the year 1998 to 2011.

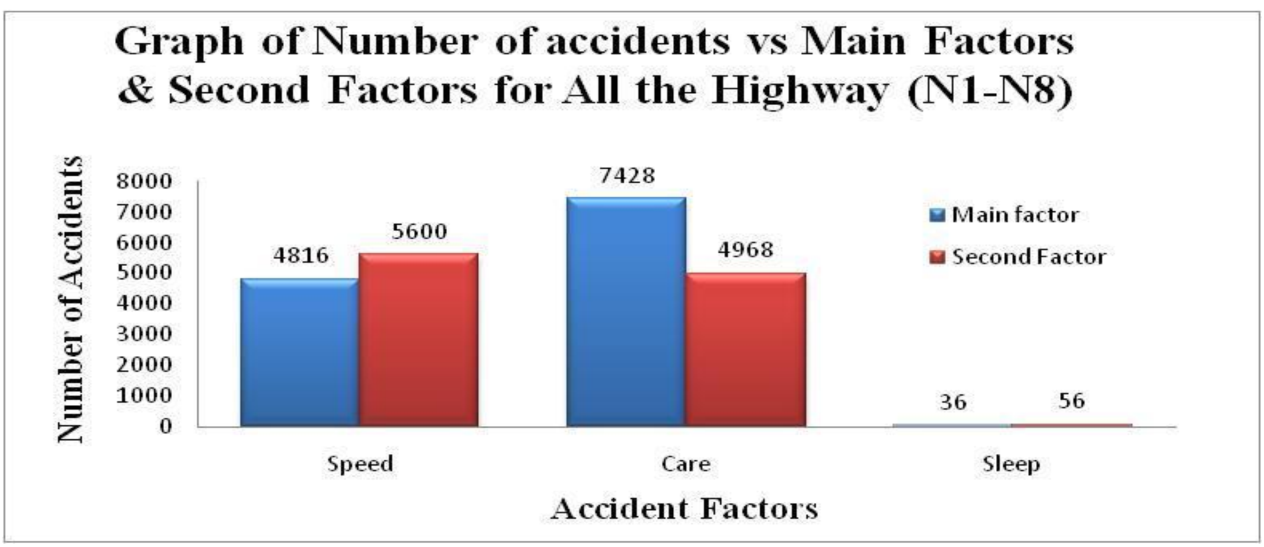


Figure 3.27: Graph of Number of Accidents vs Main factor and second factor for all the Highways (Using the data collected from ARI, BUET)

This bar diagram [Figure 3.27] shows the number of accidents due to main factor and second factor in the Highways from the year 1998 to 2011.

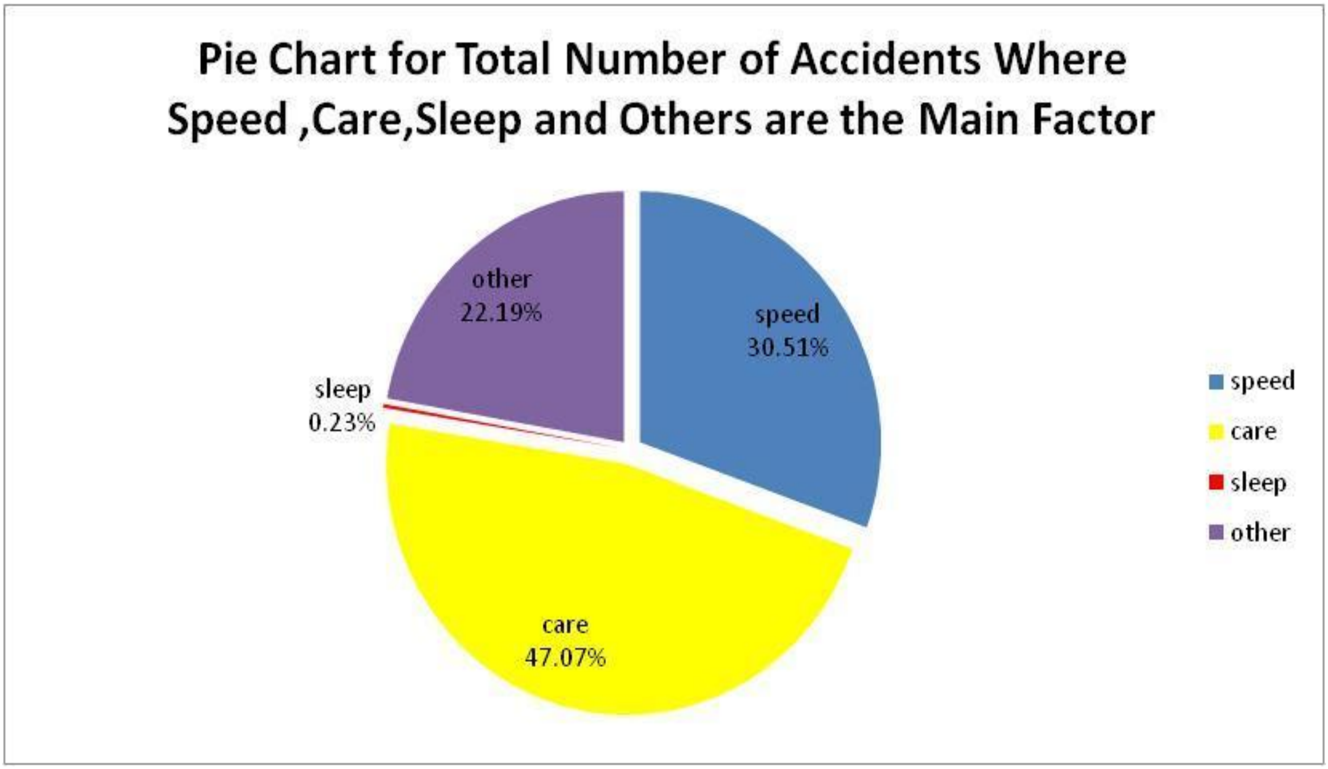


Figure 3.28: Pie Chart showing the percentage of accidents occurred due to Speed, Care, Sleep and others as the main factor (Using the data collected from ARI, BUET)

Here [Figure 3.28] the total number of accidents occurred due to over speed as a main factor is 4816 from the year 1998 to 2011 which is 30.51% of the total accidents. Besides the number of total accidents occurred due to lack of carefulness as a main factor is 7428 from the year 1998 to 2011 which is 47.07% of the total accidents. Again the number of total accidents occurred due to sleep while driving as a main factor is 36 from the year 1998 to 2011 which is 0.23% of the total accidents. The number of accidents that occurred to some other reason (Close contact, breaking the signal or giving wrong signal, overtaking, overturning, drink and drive, pedestrian, passenger, road condition, road factor, weather, vehicle defect, over load, tire burst, animal and others) is 3502 from the year 1998 to 2011which is 22.19% of the total number of accidents.

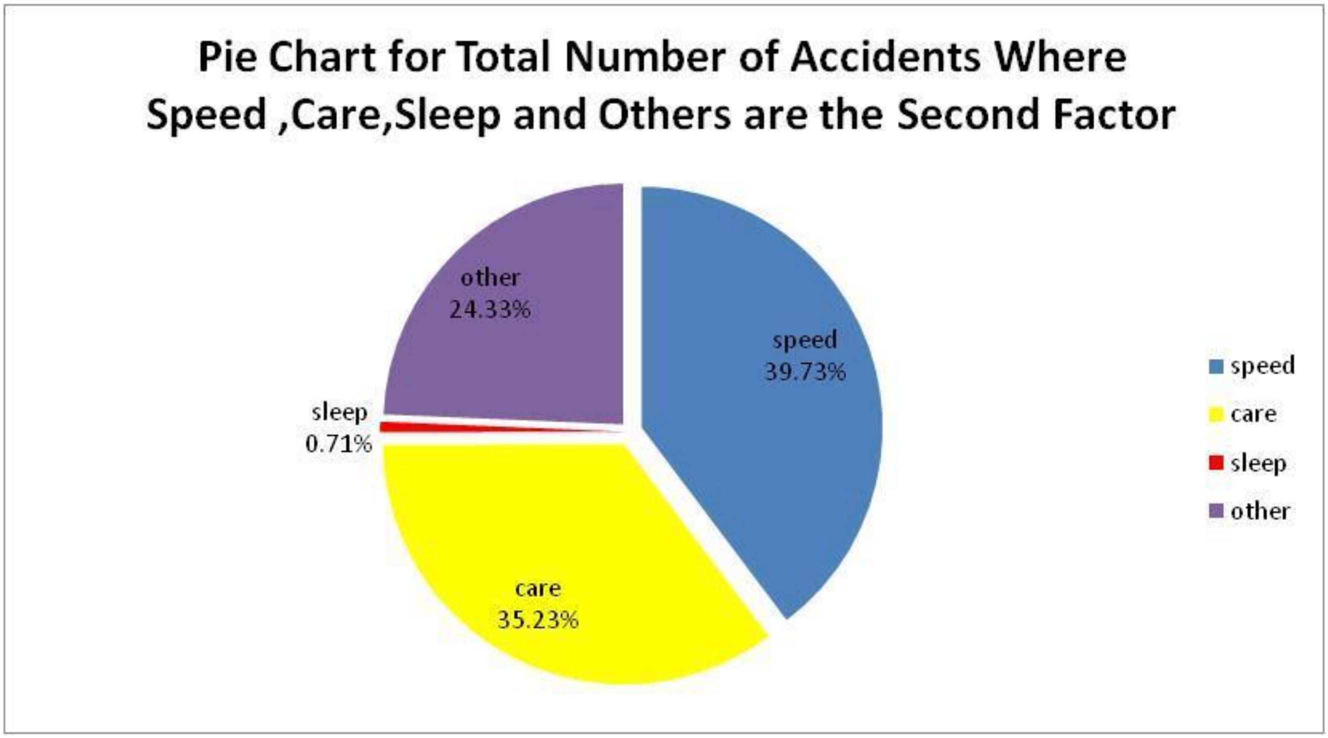


Figure 3.29: Pie Chart showing the percentage of accidents occurred due to Speed, Care, Sleep and others as the second factor (Using the data collected from ARI, BUET)

Here [Figure 3.29] the total number of accidents occurred due to over speed as a second factor is 5601 from the year 1998 to 2011 which is 39.73% of the total accidents. Besides the number of total accidents occurred due to lack of carefulness as a second factor is 4968 from the year 1998 to 2011 which is 35.23% of the total accidents. Again the number of total accidents occurred due to sleep while driving as a second factor is 100 from the year 1998 to 2011 which is 0.71% of the total accidents. The number of accidents that occurred to some other reasons (Close contact, breaking the signal or giving wrong signal, over taking, overturning, drink and drive, pedestrian, passenger, road condition, road factor, weather, vehicle defect, over load, tire burst, animal and others) as a second factor is 3431 from the year 1998 to 2011which is 24.33% of the total number of accidents.

3.3 Experimental analysis

As we analyzed the accident data and we found that there are mainly three factors such as (1) the health condition (2) the body movement and (3) the head movement. If we can utilize these three factors then the number of accident can be reduced more than 50% because sleep is a health issue as well as the carelessness is reflected through the body and head movement. That’s why we have constructed a device that will analyze these three factors and will give alarm if it finds any of the three factors sign. Sleep will be detected through pulse sensor using BPM (beats per minute) rate. Body movement is detected by PIR sensor (motion sensor) and the head movement will be detected by the gyro sensor.

The number of contractions of the heart or the number of times a person's heart beats per minute is called heart rate or heart pulse. It is different for different person, but the normal range for adults is 60 to 100 beats per minute, according to the Mayo Clinic (medical practice and medical research group).

The normal heart rate depends on the individual’s age, body size and heart conditions. Besides the movement such as whether the person is sitting or moving, medication use and even air temperature can change the heart rate. Moreover emotions can affect the heart rate; for example, getting scared or excited can increase the heart rate. The heart rate of fit people is low and it increases the efficiency of the heart muscles. A well-trained athlete may have a heart rate of 40 to 60 beats per minute, according to the American Heart Association (AHA).

Dr. Mary Ann Bauman who is an internist at Integris Baptist Medical Center in Oklahoma City said "Your heart is a muscle and just like strengthening other muscles by doing activities; you can do the same thing with your heart"[14].

Anyone can monitor his fitness level using the Knowledge about his heart rate. Besides it can help him to identify the development of health problems if he is experiencing other symptoms

Normally while taking rest the heart beat goes down. It is usual to have 60 BPM for a normal person while taking rest. But a sleeping person heart beat rate is 55 to 40 BPM. While driving the driver need to have some movement and careful about the driving. His mind and body will work so hardly he will have the BPM lower than 60. He will have lower than 55 BPM when he is drowsy. For this reason in our device we want to alarm a person before sleep. So we have used a condition that if the BPM is lowers than 55and find no movement of the driver than the system will generate alarm. The heart rate sensor device will be inappropriate for the well trained athlete as there heart rate is lower than normal people. For the athletes the standard sleeping heart rate value should be updated in the code of the processor.

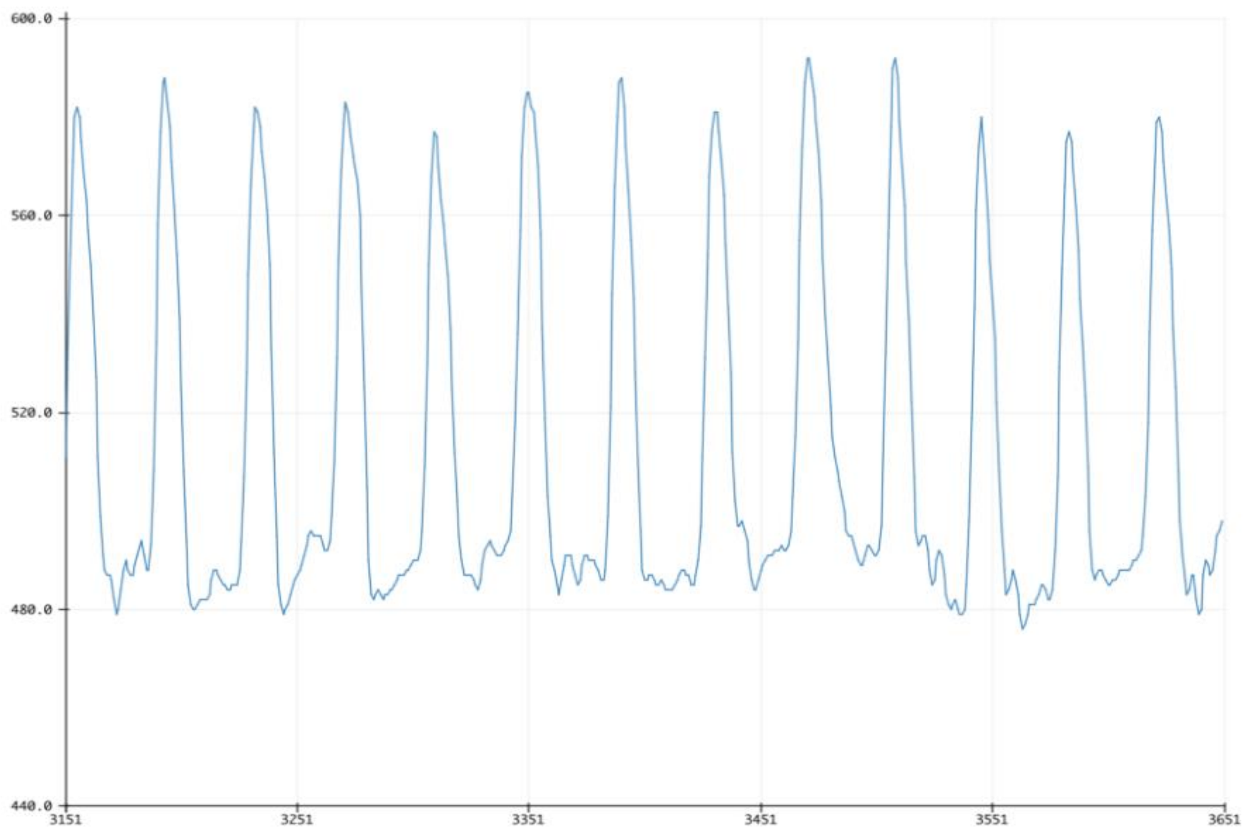


Figure 3.30: Pulse waveform of human (Sample)

Depending on the placement of the pulse sensor, the signal of the pulse sensor change. The change may occur due to the noise or the poor amplification for the sensor. In our case we want to use pulse sensor on the finger. If the pulse sensor is not placed properly then in most of the case we are getting more noise or wrong BPM rate. So it is important to place the finger and sensor perfectly. In the figure 3.30, a sample feedback from the pulse sensor is shown.

It is important to understand the difference between the blood pressure and the BPM. Few people become confuse with high blood pressure and the high heart rate. The measurement of the force of the blood against the walls of arteries is known as Blood pressure , while pulse rate is the number of times one’s heart beats per minute.

There is no direct correlation between blood pressure and heart rate. The high blood pressure which is also known as hypertension does not necessarily result in a high pulse rate, and vice versa. For example, heart rate may increase during strenuous activity but a vigorous workout may just increase the blood pressure modestly [14].

Sleep represents the unconscious resting time for one's body and mind. The heart rate normally slows due to complex regulatory mechanisms during sleep. Normal sleeping heart rate depends on some factors such as his/her resting heart rate while awake, which varies person to person. Certain medical conditions can also affect the sleeping heart rate. Average heart rate during sleep decreases by roughly 24 beats per minute in adults, as reported in a March 2009 "New England Journal of Medicine" article [15].

Table 01: Good pulse for different age while resting or normal activity [16].

Age	18-25	26-35	36-45	46-55	56-65	65+
Athlete	49-55	49-54	50-56	50-57	51-56	50-55
Excellent	56-61	55-61	57-62	58-63	57-61	56-61
Good	62-65	62-65	63-66	64-67	62-67	62-65
Above Average	66-69	66-70	67-70	68-71	68-71	66-69
Average	70-73	71-74	71-75	72-76	72-75	70-73
Below Average	74-81	75-81	76-82	77-83	76-81	74-79
Poor	82+	82+	83+	84+	82+	80+

Here we have considered a pick value of BPM which is 55 for drowsy condition of a driver as we found through the analysis that approximately 90.31% (following the data from ARI, BUET) who faced the accident were aged from 21 to 45 years.

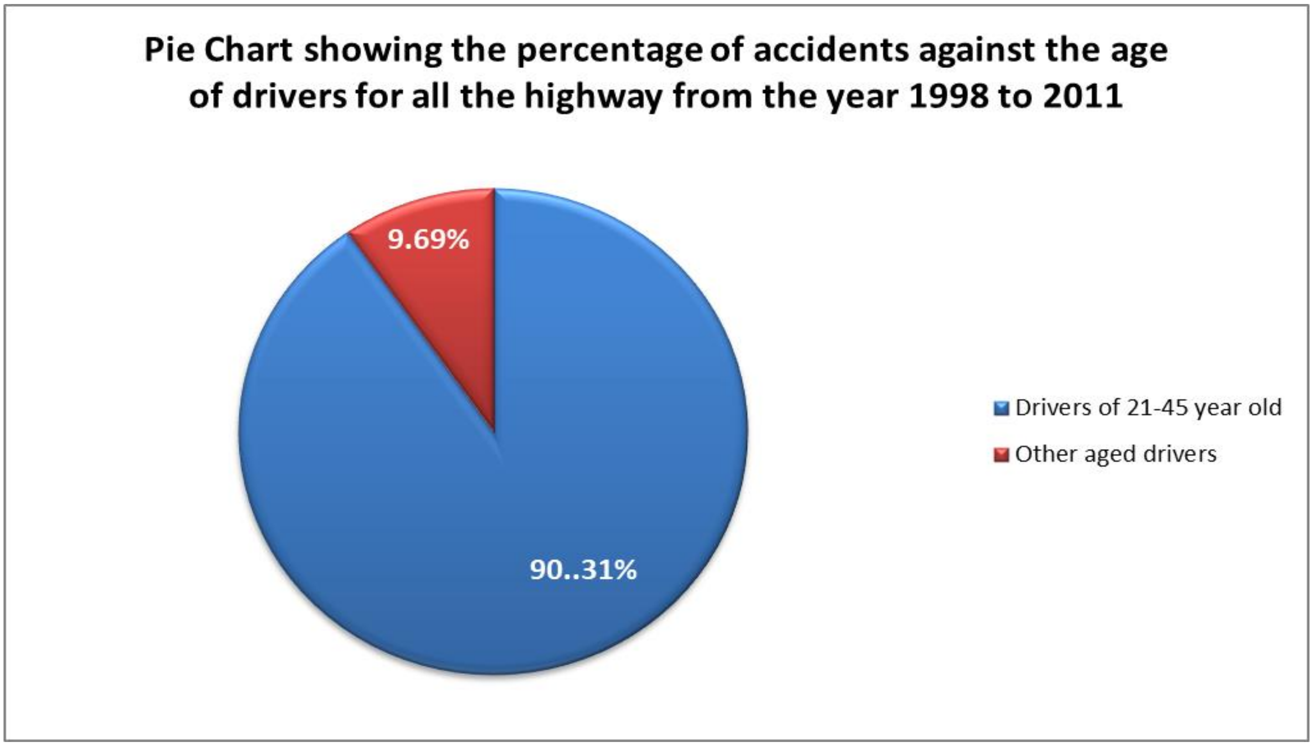


Figure 3.31: Pie chart showing the percentage of accidents against the age of the drivers for the highways from the year 1998 to 2011 [using collected data from ARI, BUET]

Besides when people feel drowsy or sleepy, the movements of the person's body decreases or stop. While driving a car usually driver may have movement as he has to control the steering and the gear. But at the time of sleeping he can't control those things as he will be unconscious about the surroundings. Besides yawning is one of the common movements while feeling drowsy. Repeated yawning is commonly a sign of drowsiness or sign of boredom [17].

Driver can also be careless while he is awake. Usually at the time of driving driver will turn their face towards the looking glass. For this the movement will be slow and little. But if someone is looking any shocking things at left/right side, he/she will turn his/her face towards those things and this face movement will be faster compared to the looking at looking glass. We will consider two types of movements, one is normal movement while driving and another is unusual movement while driving. For example, lets a driver is driving a car and his/her mobile phone fall down from his hand. Then he/she may try to pick up the phone. At this time his/her head will have a downward movement. So this is an abnormal movement while driving.

CHAPTER 4: DETECTION PROCESS

4.1 Block Diagram of the System

Our system has two devices. One device will detect BPM and body motion and another device will detect the head movement. The block diagram of the total system is shown in the figure 4.1 and 4.2. This is the proposed block diagram of the system.

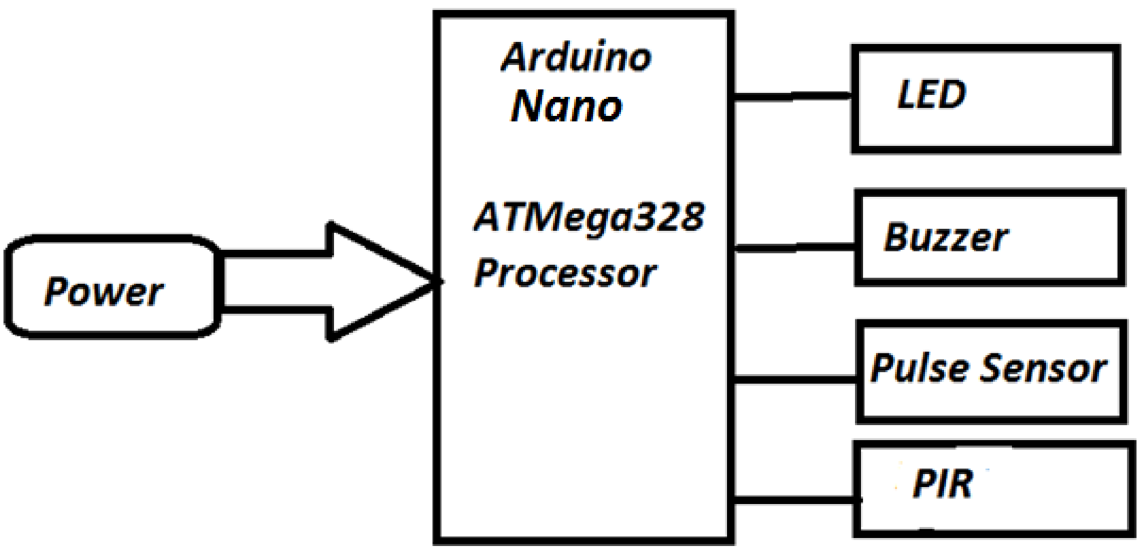


Figure 4.1: Block diagram of the BPM and body motion device

Arduino Nano AT Mega 328 series is used as the processor of the Health condition detection Device. Pulse sensor, PIR (Passive Infrared) sensor, LED and Buzzer module are connected with the Arduino Nano. The pulse sensor measures the pulse and the PIR sensor sense movement data and sends to the Arduino Nano. The Arduino Nano decides the output and sends the output to the LED or the Buzzer. DC Power is supplied to the Arduino through two 1000mah 5V battery.

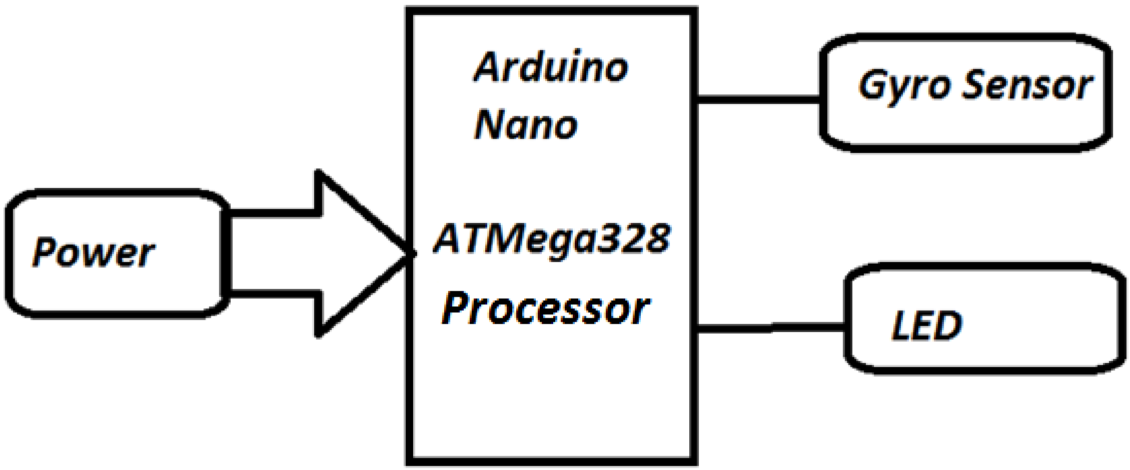


Figure 4.2: Block diagram of the Head movement device

Arduino Nano AT Mega 328 series is also used as the processor in the Head movement detection device. The Gyro sensor and the LED module are connected with the Arduino Nano. Gyro sensor monitors the drivers head movement and sends the data to the Arduino Nano. The Arduino Nano sends the output to the LED.DC Power is supplied to the Arduino through two 1000mah 5V battery.

4.2 Algorithm

BPM and body motion device algorithm:

1. Take a BPM value from user/driver
2. Take 50 body motion sample in a row
3. If: BPM < 55 || Motion sample == 0

   Then: LED Blinks
4. If: BPM < 55 && Motion Sample == 0

   Then: Buzzer sound
5. Else: No LED Blinks, No Buzzer sound.

Head movement device Algorithm:

1. First 10-20 seconds Gyro sensor calibration
2. Take the three axes (x,y,z) sample rate
3. If: sample rate > safe range

   Then: LED Blinks three times
4. Else: No LED Blinks

4.3 Working Principle

BPM and body motion device:

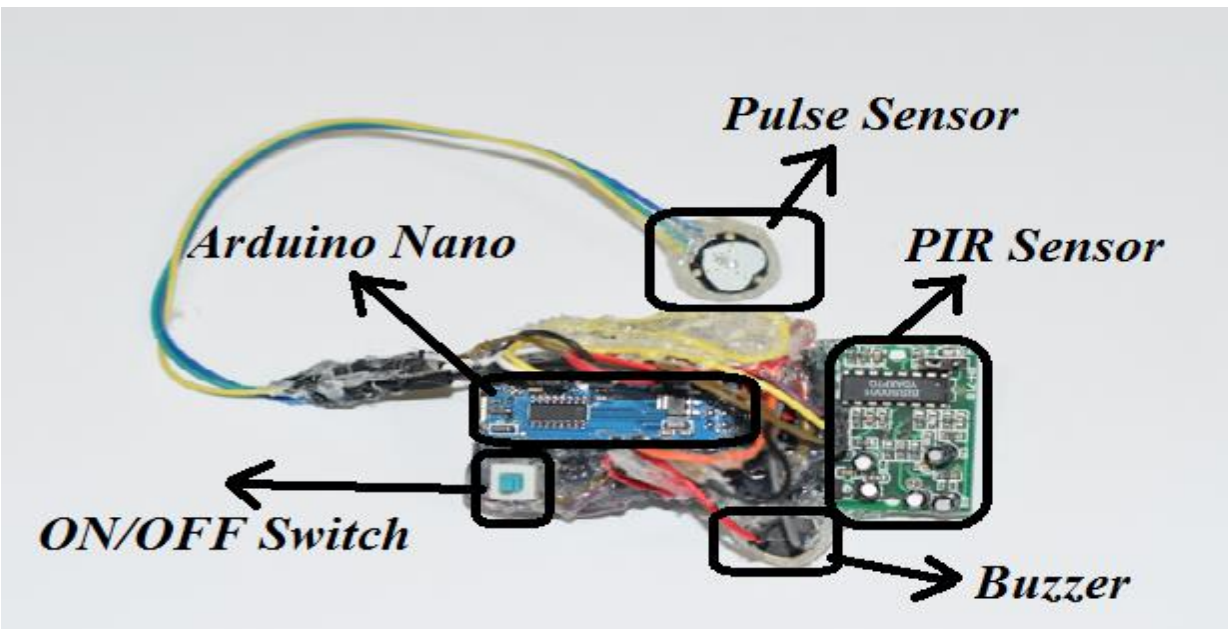


Figure 4.3: BPM and body motion device (Arduino Nano, pulse sensor, PIR sensor and Buzzer)

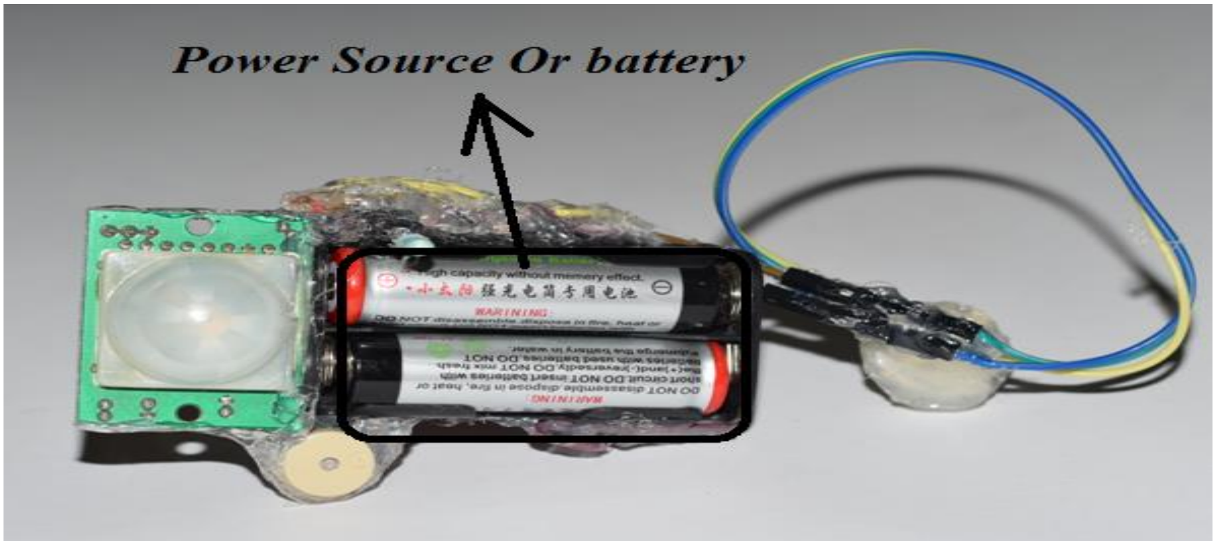


Figure 4.4: BPM and body motion device (Power Source or Battery)

If finger is placed on the pulse sensor and the device is switched on then the pulse sensor will start to collect the data. The pulse sensor will send the data to the processor and the processor will check whether there is movement of the driver or not at the 61^{th} second. After checking the motion data found from the PIR sensor, the processor will process the data and compare with the pulse sensor data. After comparing those data the processor will decide whether it will give an alarm or not. If it needs to give an alarm then it will compare which type of alarm it should give, light alarm or sound alarm. Then the device will repeat the process simultaneously.

There can be four cases for giving alarm. They are as follows:

Case 1:
If the pulse sensor get less than 55 BPM and find no movement through the motion sensor then the device will assume that the driver is sleeping. For this reason it will give an alarm through the buzzer.

Case 2:
If the pulse sensor get more than 55 BPM and find movement through the motion sensor then the device will assume that the driver is awake. For this reason it will give no alarm and restart the measurement process again.

Case 3:

If the pulse sensor gets more than 55 BPM but do not get any movement through the motion sensor then it will not be confirmed with the user activity. There is 50-50 chance that the driver is sleeping or awake. For this reason it will blink the LED light.

Case 4:

If the pulse sensor get less than 55 BPM but find movement through the motion sensor then the device will not be confirmed with the user activity. There is 50-50 chance that the driver is sleeping or awake. For this reason it will blink the LED light.

Head movement device:

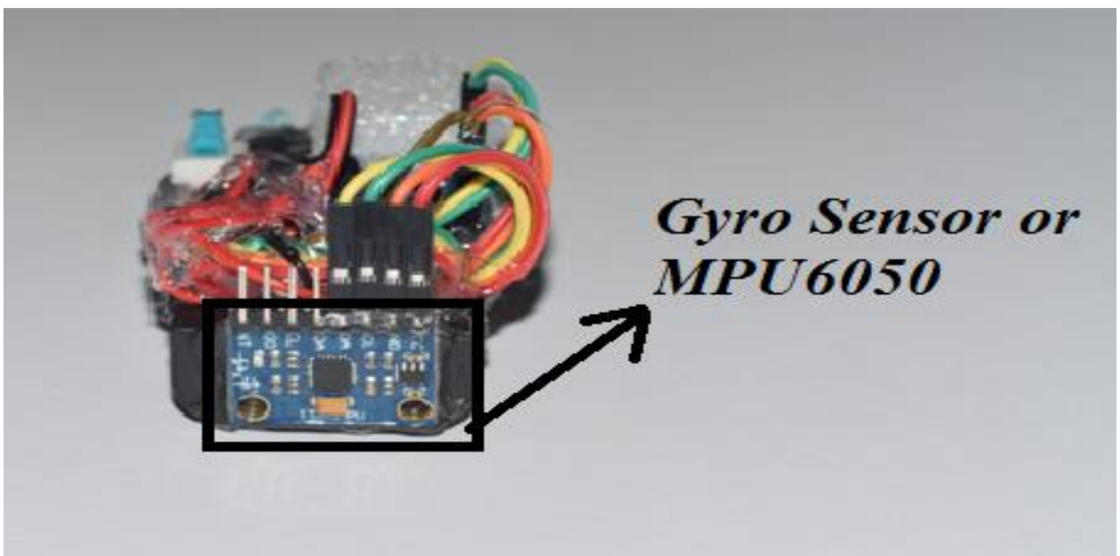


Figure 4.5: Head movement device (Gyro sensor).

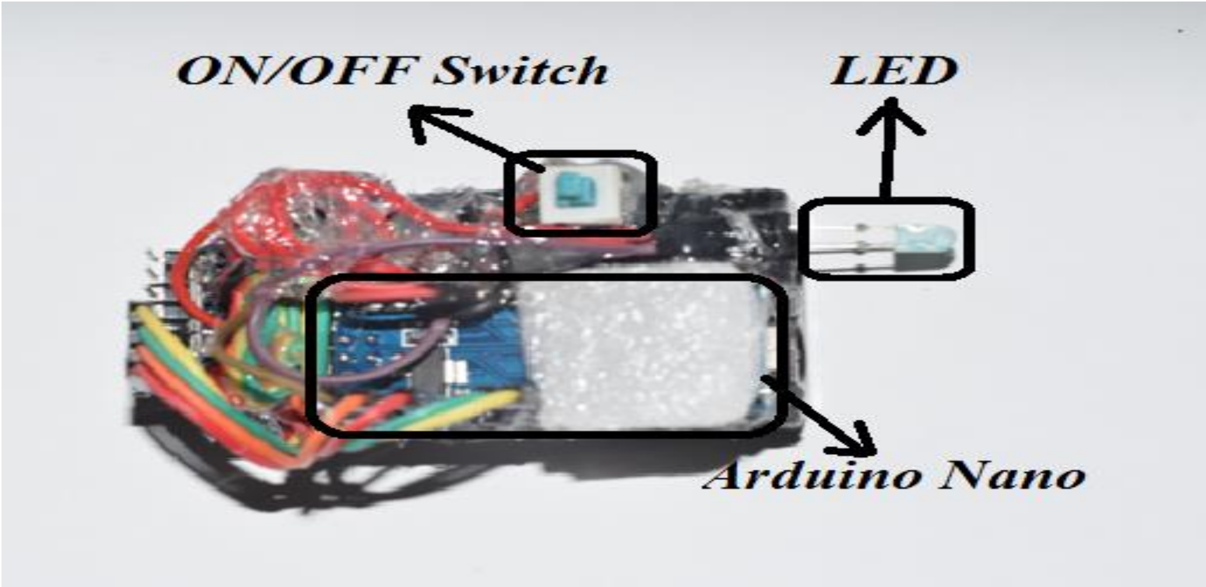


Figure 4.6: Head movement device (Arduino Nano, LED and Switch).

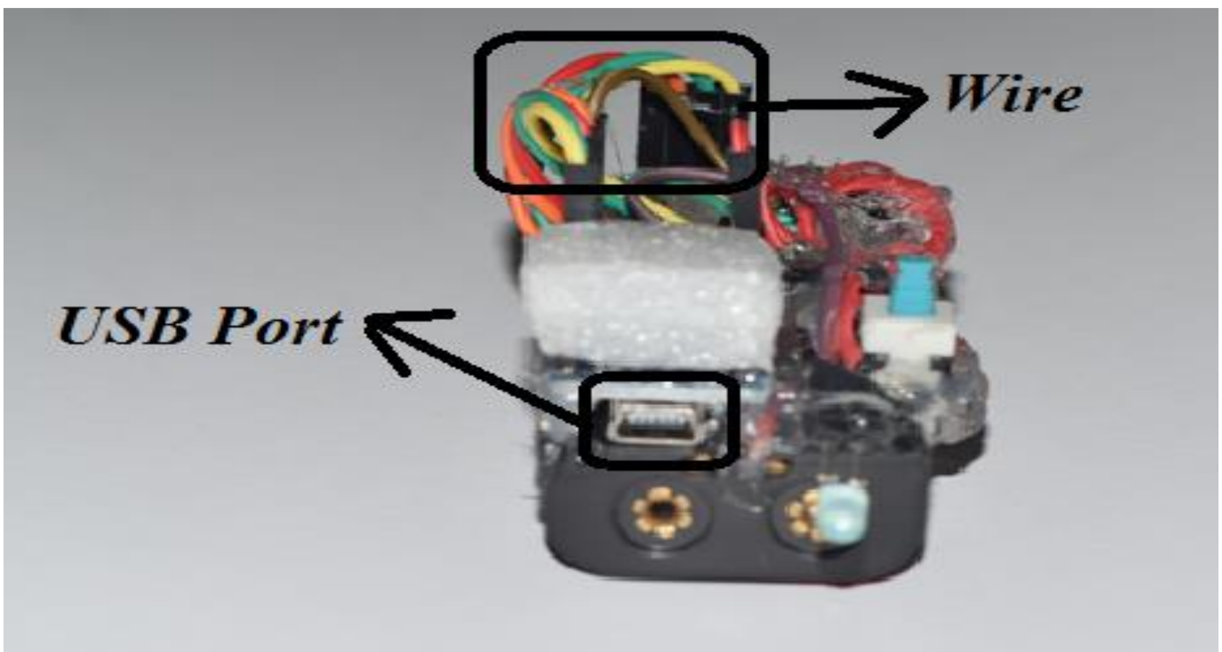


Figure 4.7: Head movement device (USB port and Wire).

Figure 4.8: Head movement device (Power supply or Battery)

After switching the device on at first for 10-20 seconds the head device will calibrate with its surroundings. The gyro sensor will detect head movement. If there is no abnormal head turn in any 3 axis [Figure 4.9] then there will be no alarm signal. But if it detect any abnormal head turn then it will give an alarm signal to the user through led blinking.

We analyzed the head turn when a person is driving a vehicle. Depending on that, we found some pattern from where we can check that if this is normal or abnormal head turn. The normal head turn means when a person drives his/her vehicle, he/she looks around his surroundings as usual and for this reason the signal generated by the sensor we call it safe signal. And if we find any unusual signal generated by the sensor then that signal is called unsafe signal.

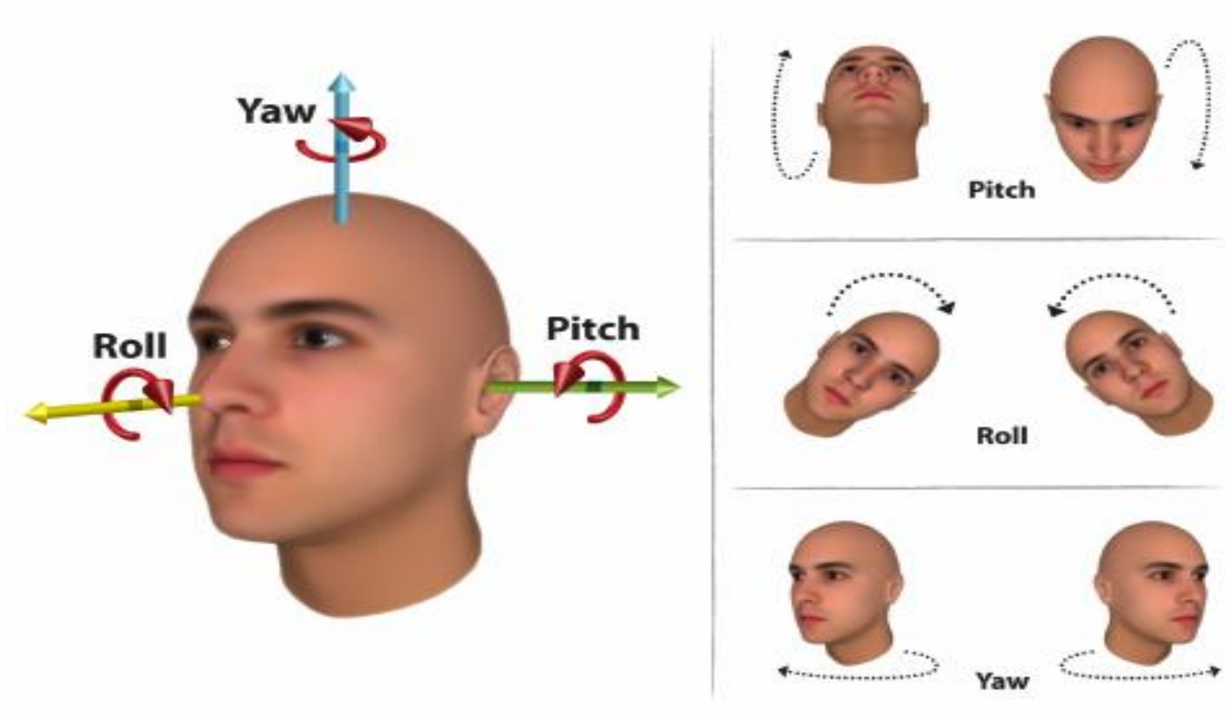


Figure 4.9: Pitch, Roll, Yaw direction of gyro [18]

Once we get any unusual signal, immediately give an alarm by blinking led three times at a row.
We assume that, this is enough reminders for a person to get back his/her concentration on driving.

We did not fix the head device with any wearable things because we give the user flexibility so that he/she can use this device with any of his/her head wearable cloths, cap, head band or with any things comfortable.

CHAPTER 5: CONCLUSION

The system has a lot of feature. The device is user friendly and has easy to use interface. Besides the system has multiple detection and alarm layer. So the device is secured to use .During this project we have faced various types of challenges. We tried to minimize the problems. Since this was a prototype our focus was to build a model, which can minimize the accidents.

5.1 Features

There are a lot of features in the system. Those are as follow:

1. The system is very flexible.
2. The system can be used in any type of vehicle.
3. Head device is used for the safety purpose and even a cyclist can also use the device.
4. In the project head device is very interesting part because by using the head device drivers driving quality can be measured as a rough driver’s body and vehicle movement will be more than a gentle and conscious driver.
5. The head device can be used anywhere in the vehicle.
6. The DC power supply of the system is easy and it can be done by using battery or USB cable.
7. The system is portable.
8. The power consumption of the system is very low.

5.2 Drawback

The quality of the sensors is very low as we have used prototype sensors. This is the only drawback of the project.

5.3 Future Work

As we have the data we will build an AI model and that will be uploaded to the server. Device will communicate data and take efficient decision through Artificial Intelligence (AI) program. The device will send the data to the user and this will make the system more effective.

5.4 Discussion

However a device can’t completely shut down an accident if the driver is not well trained. Owners of motor vehicles should ensure that employed drivers have genuine licenses, properly trained and drive with responsibility. Besides as citizens, we all have some role to play in ensuring road safety. Passengers should protest and stop speeding and reckless driving by bus and taxi drivers.

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APPENDIX -I

Code of BPM and Body motion device:

```
#define USE_ARDUINO_INTERRUPTS true    // Set-up low-level interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>     // Includes the PulseSensorPlayground Library.

//  Variables
 int myBPM;                  // "myBPM" hold this BPM value
const int PulseWire = 0;       // PulseSensor PURPLE WIRE connected to ANALOG PIN A0
const int LED13 = 13;          // The on-board Arduino LED, close to PIN 13.
int Threshold = 550;           // Determine which Signal to "count as a beat" and which to ignore.
                               // Use the "Gettting Started Project" to fine-tune Threshold Value beyond default setting.
                               // Otherwise leave the default "550" value.

PulseSensorPlayground pulseSensor;  // Creates an instance of the PulseSensorPlayground object called "pulseSensor"


//for PIR senosr variable
unsigned long currentMillis;
long previousMillis = 0;

int PIR = A1; // PIR sensor connected pin A1
int pirState;

//For alarm
int LED=2; // an alarm led is connected
int sound=4;// a alarm buzzer is connected


void setup() {

  Serial.begin(9600);

  // Configure the PulseSensor object, by assigning our variables to it.
  pulseSensor.analogInput(PulseWire);
  pulseSensor.blinkOnPulse(LED13);       //auto-magically blink Arduino's LED with heartbeat.
```

```
  pulseSensor.setThreshold(Threshold);

  // Double-check the "pulseSensor" object was created and "began" seeing a signal.
   if (pulseSensor.begin()) {
    Serial.println("ok");  //This prints one time at Arduino power-up,  or on Arduino reset.
  }

 //for PIR sensor initializaiton
  pinMode(PIR, INPUT);
  pinMode(LED, OUTPUT);
  pinMode(sound, OUTPUT);
}



void loop() {

  myBPM = pulseSensor.getBeatsPerMinute();  // Calls function on our pulseSensor object that returns BPM as an "int".
                                               // "myBPM" hold this BPM value now.
//for PIR sensor
  currentMillis = millis();
  //Serial.println(currentMillis);
  if(currentMillis - previousMillis >61000)   //after every 61 seconds alarm(); funciton will be activated
  {
     previousMillis = currentMillis;
    alarm();
  }

}

int alarm(){
  for(int i=0; i<100; i++){
    pirState += digitalRead(PIR);
     Serial.println(pirState);

      }
```

```
  if(pirState==0 && myBPM<55) // if there is no movement of the driver or the the preson is in sleeping mood(when a person
is in sleep his/her BPM is 50-40
                              // we try to detech before the sleep, that is why we use BPM 65 in condition
                              //This conditon menas the driver definetly going to sleep
  {
        for(int i=0; i<20; i++){
          digitalWrite(sound, HIGH);
          delay(150);
          digitalWrite(sound, LOW);
          delay(50);
          }
      }
 if(pirState==0 || myBPM<55)  //// if there is no movement of the driver or the the preson is in sleeping mood(when a person
is in sleep his/her BPM is 50-40
                                  //// we try to detech before the sleep, that is why we use BPM 65 in condition
                                  // this conditon means that may be dirver is going to sleep(since when a person try sleep he try to stop
body movement)
  {
    for(int i=0; i<10; i++){
          digitalWrite(LED, HIGH);
          delay(150);
          digitalWrite(LED, LOW);
          delay(50);
          }
    }
    else{
          digitalWrite(LED, LOW);
          digitalWrite(sound, LOW);
    }
          pirState=0;


  }
```

Code of Head movement device:

```
////////////////////////////////////////////////////////////////////////////////////////
/*Terms of use
Gyro - Arduino pro mini
VCC  -  5V
GND  -  GND
SDA  -  A4
SCL  -  A5

LCD  - Arduino pro mini
VCC  -  5V
GND  -  GND
SDA  -  A4
SCL  -  A5
*////////////////////////////////////////////////////////////////////////////////////////

//Include LCD and I2C library

#include <Wire.h>

int ap,ar,ay;

//Declaring some global variables
int gyro_x, gyro_y, gyro_z;
int temperature;
long gyro_x_cal, gyro_y_cal, gyro_z_cal;
long loop_timer;
int lcd_loop_counter;
float angle_pitch, angle_roll,angle_yaw;
boolean set_gyro_angles;
int led=2;

void setup() {
  Wire.begin();                                            //Start I2C as master
  Serial.begin(9600);                                      //Use only for debugging
```

```
  setup_mpu_6050_registers();                                   //Setup the registers of the MPU-6050 (500dfs / +/-8g) and start the
gyro


  Serial.println("  MPU-6050 IMU");                                   //Print text to screen

  delay(1500);                                            //Delay 1.5 second to display the text

  Serial.println("Calibrating gyro");                                 //Print text to screen

  for (int cal_int = 0; cal_int < 2000 ; cal_int ++){                  //Run this code 2000 times
    if(cal_int % 125 == 0)
    Serial.print(".");                          //Print a dot on the LCD every 125 readings
    read_mpu_6050_data();                                        //Read the raw acc and gyro data from the MPU-6050
    gyro_x_cal += gyro_x;                                        //Add the gyro x-axis offset to the gyro_x_cal variable
    gyro_y_cal += gyro_y;                                        //Add the gyro y-axis offset to the gyro_y_cal variable
    gyro_z_cal += gyro_z;                                        //Add the gyro z-axis offset to the gyro_z_cal variable
    delay(3);                                             //Delay 3us to simulate the 250Hz program loop
  }
  gyro_x_cal /= 2000;                                          //Divide the gyro_x_cal variable by 2000 to get the avarage offset
  gyro_y_cal /= 2000;                                          //Divide the gyro_y_cal variable by 2000 to get the avarage offset
  gyro_z_cal /= 2000;                                          //Divide the gyro_z_cal variable by 2000 to get the avarage offset

pinMode(led, OUTPUT);
digitalWrite(led, LOW);
}

void loop(){

  read_mpu_6050_data();                                        //Read the raw acc and gyro data from the MPU-6050

  gyro_x -= gyro_x_cal;                                        //Subtract the offset calibration value from the raw gyro_x value
  gyro_y -= gyro_y_cal;                                        //Subtract the offset calibration value from the raw gyro_y value
  gyro_z -= gyro_z_cal;                                        //Subtract the offset calibration value from the raw gyro_z value

/*
```

```
  Serial.print("angle_pitch_output    ");
  Serial.println(abs(gyro_y));
   Serial.print("angle_roll_output   ");
  Serial.println(abs(gyro_x));
  */
  //Gyro angle calculations
  //0.01526717557 = 1 / ( 65.5)
  angle_pitch = gyro_y * 0.01526717557  ;                              //Calculate the traveled pitch angle and add this to the
angle_pitch variable
  angle_roll = gyro_x * 0.01526717557;                                //Calculate the traveled roll angle and add this to the angle_roll
variable
  angle_yaw   = gyro_z*0.01526717557;
  /*
  Serial.print("angle_pitch_output    ");
  Serial.println(abs(angle_pitch));
   Serial.print("angle_roll_output   ");
  Serial.println(abs(angle_roll));
  Serial.print("angle_Yaw_output   ");
  Serial.println(abs(angle_yaw));
*/

ap=abs(angle_pitch);
ar=abs(angle_roll);
ay=abs(angle_yaw);

Serial.print(ap);
   Serial.print(" ");
  Serial.print(ar);
  Serial.print(" ");
  Serial.println(ay);

  //alarm thereshold limit,for incrise the sensitivity low the value(230 to 100)
  //for decrise sensitivity incrise the value(230 to 500)
  if(ap>230 || ar>230 || ay>230){
  for(int i=0;i<3;i++){
   digitalWrite(led, HIGH);
  delay(200);
```

```
  digitalWrite(led, LOW);
  delay(50);
    }
    }
}


void read_mpu_6050_data(){                                        //Subroutine for reading the raw gyro and accelerometer data
  Wire.beginTransmission(0x68);                                   //Start communicating with the MPU-6050
  Wire.write(0x41);                                               //Send the requested starting register
  Wire.endTransmission();                                         //End the transmission
  Wire.requestFrom(0x68,8);                                       //Request 14 bytes from the MPU-6050
  while(Wire.available() < 8);                                    //Wait until all the bytes are received
  temperature = Wire.read()<<8|Wire.read();                       //Add the low and high byte to the temperature variable
  gyro_x = Wire.read()<<8|Wire.read();                            //Add the low and high byte to the gyro_x variable
  gyro_y = Wire.read()<<8|Wire.read();                            //Add the low and high byte to the gyro_y variable
  gyro_z = Wire.read()<<8|Wire.read();                            //Add the low and high byte to the gyro_z variable
}


void setup_mpu_6050_registers(){
  //Activate the MPU-6050
  Wire.beginTransmission(0x68);                                   //Start communicating with the MPU-6050
  Wire.write(0x6B);                                               //Send the requested starting register
  Wire.write(0x00);                                               //Set the requested starting register
  Wire.endTransmission();                                         //End the transmission
  //Configure the gyro (500dps full scale)
  Wire.beginTransmission(0x68);                                   //Start communicating with the MPU-6050
  Wire.write(0x1B);                                               //Send the requested starting register
  Wire.write(0x08);                                               //Set the requested starting register
  Wire.endTransmission();                                         //End the transmission
}
```