DRIVER FATIGUE DETECTION AND ALARM SYSTEM

A MINOR PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report "DRIVER FATIGUE DETECTION AND ALARM SYSTEM "

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1. HRV- HEART RATE VARIABILITY
2. API - APPLICATION PROGRAMMING INTERFACE

ABSTRACT

A serious problem causing thousands of road accidents every year is "Driver Fatigue". According to "The Royal Society for The Prevention of Accidents", "driver fatigue may be a contributory factor in up to 20% of road accidents, and up to one quarter of fatal and serious accidents." Available at: https://www.rospa.com/road-safety/advice/drivers/fatigue/road-accidents/ .We aim to continuously monitor the driver's health parameters and make-up or prevent any loss of control over the vehicle. Nowadays, wrist wearables include a host of sensors like accelerometers, Sleep-monitor, Heart-rate modules that provide instantaneous health data. More precisely, these health parameters will be transferred to a processing unit and the changes taking place in these parameters with changing conditions, which would be externally triggered, will be monitored. We have witnessed significant development of mobile and wearable technologies to collect vital human health parameters and activities. Nowadays, wrist wearables that provide valuable data are widely available. This is the data that we are working with to detect sleep stages. More precisely, we would transfer these health parameters to a processor and we would monitor the changes taking place in these parameters with changing conditions which would be externally triggered.

CHAPTER 1

INTRODUCTION

1.1 AIM

To design a device prototype which will monitor the build-up of fatigue in drivers and accordingly take steps so that there is no loss of control over the vehicle due to the driver falling asleep at the wheels. This project's purpose is to review published journals regarding:

a) the scale of the sleep related road accident problem

b) to come up with solutions that minimise accidents due to the driver sleeping off at the wheel and design a suitable prototype which acts as a detection and alert system in real time.

1.2 OBJECTIVES

To Extract health-data from a wearable device, specifically the sleep data (pre-made by the "Fitbit API").

1.To process this data using a microcontroller and use the processed data to control the speed of a stepper motor, which is, analogous to the speed of an actual engine rotor.

2.To invoke an alarm system.

3.To activate direct speed control of the vehicle whenever alarm fails to alter the sleep state of the driver.

CHAPTER 2

LITERATURE REVIEW

2.1 SMART WEARABLES

The “Royal Society for the prevention of Accidents” (2015) states that “Driver fatigue has led to a majority of road accidents, for up to 20% of fatal accidents in Great Britain”. The Government’s initiative, “Tomorrow’s Roads: Safer for Everyone”, identifies driver fatigue as one of the significant problems that needs to be addressed to reduce sleep related accidents. The paper was concentrated on the following issues:

a) Cases of accidents due to the driver sleeping-off at the wheels

b) The causes of the driver fatigue

c) The paper has proposed solutions to reduce accidents due to driver fatigue. This literature review is part of a “DETR grant-in-aid project” to develop “a Journey Planner for Drivers and to investigate the feasibility of electronic route planners automatically prompting drivers to take rest stops on long journeys and, where possible, providing other safety-related information.” The paper also presents results on research conducted in road accidents. The inference is as expected: “The drivers sleeping-off at the wheel is one of the major cause of road accidents especially at later hours of the night.” To avoid such incidents this project undertakes an alarm system for alerting a semi-asleep driver, to prevent the loss of control over the wheel. Moreover, direct speed control is done to reduce the maximum speed of the vehicle.

2.2 AN IN-DEPTH ANALYSIS OF WEARABLE DEVICES FOR BIOMETRIC ACQUISITION OF DRIVERS

According to Marko Kos and Iztok Kramberger (2017) Faculty of Electrical Engineering and Computer science, University of Maribor, Maribor 2000, Slovenia their prototype offers a device for “detecting and recording the movement and biometric information of a user during sport activities”. The wearable device can be worn on a wrist to various parameters like skin temperature and pulse rate. Also, it detects arm movement to detect gestures using what he describes as “inertial measurement unit”. It’s small form factor allows it to be especially appropriate for sports, where any extra weight would hinder performance of the athletes. “Basic signal processing is performed directly on the wearable device but for more complex signal analysis, the data can be uploaded via the Internet to a cloud service, where it can be processed by a dedicated application.” The exponential growth of such wearable device sales and popularity as seen in Fig 1.1 is the reason why this paper pursues using a FitBit wearable device to acquire biometric data of drivers.

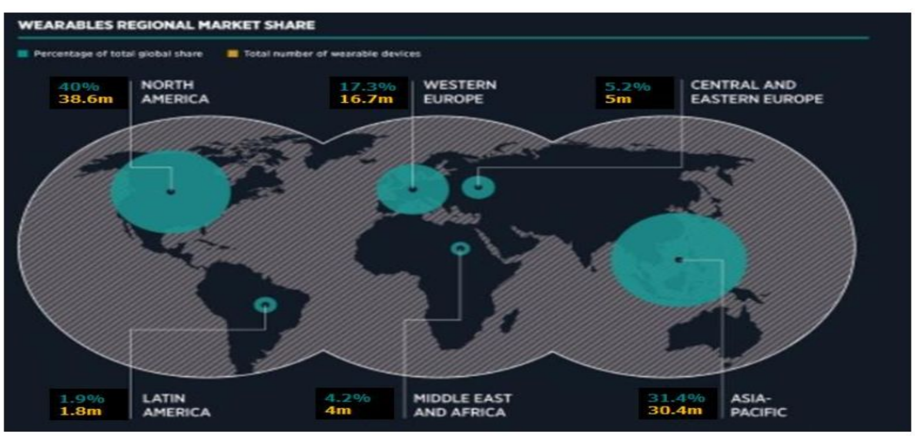

Fig 1.1: Regional wearable devices growth(Credit: Cisco 2016)

2.3 A REVIEW ON THE PREVIOUS ATTEMPTS USING IMAGE PROCESSING

According to: Matthew Sacco, Reuben A. Farrugia. (2012) “DRIVER FATIGUE MONITORING SYSTEM USING SUPPORT VECTOR MACHINES”, Proceedings of the 5th International Symposium on Communications, Control and Signal Processing: Fast object detection method on the basis of the “face and facial feature detection approach” was used in this work. Instead of “pixel by pixel image analysis” to determine corresponding RGB values, this method uses “Haar-like features”, which resemble the “Haar wavelets”. They are using OpenCV based image recognition systems to detect signs of fatigue on the face of a driver as shown in Fig 1.2. This requires a camera to be set on the front dashboard of the vehicle.According to the authors: The “computer vision approach adopted was very successful in classifying the visual appearance of the driver, achieving an average recognition rate of 95.2%”. The results further show the case of deploying “non-intrusive fatigue monitoring systems for commercial applications” at the cost of accuracy.

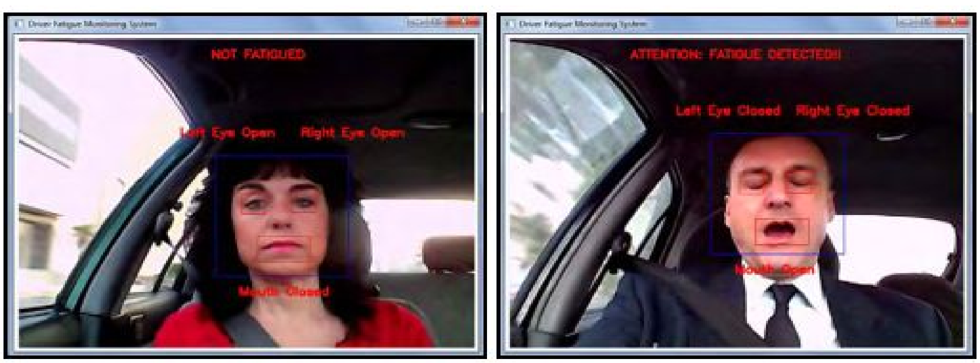

Fig 1.2:Fatigued and non-fatigued classifications in real-time.

(Credit:Matthew Sacco, Reuben A. Farrugia. 2012)

2.4 INNOVATION

Here,in Fig 1.3, the wearable unit is made totally wireless and it is controlled by data from sensors which is processed by a processing unit. An ESP8266 based framework can be adopted to make the setup wireless. The data processing is done by a window based remote pc. The sensor signal processing is done by Arduino Uno Rev 3 microcontroller. Sensor is essentially the Fitbit tracker used in this project.

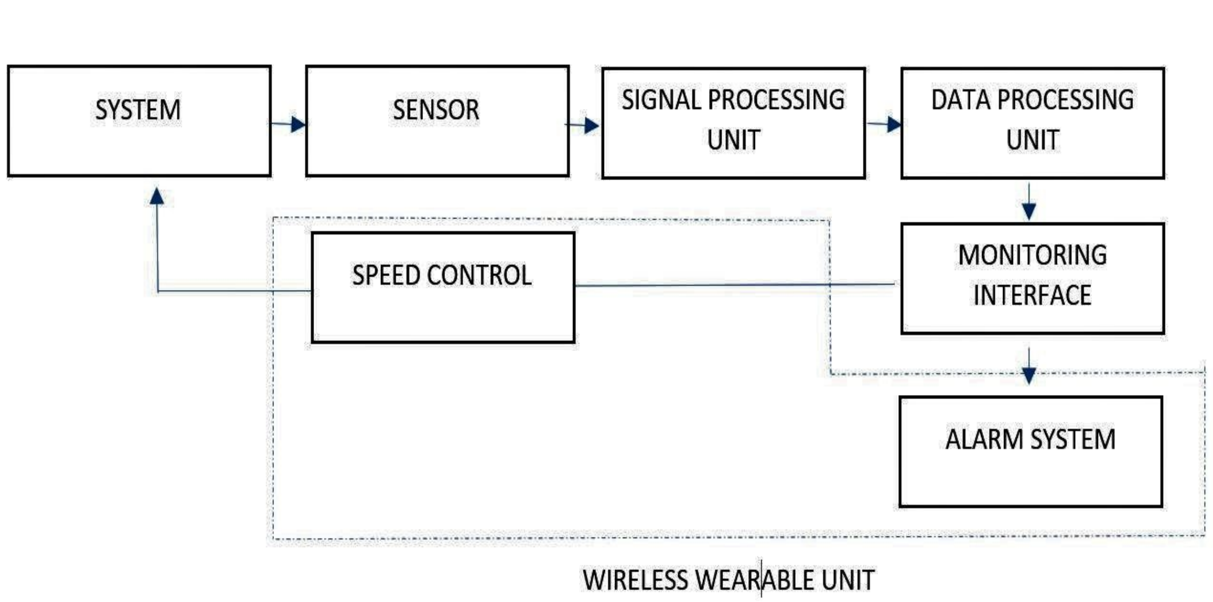

Fig 1.3 : Block Diagram for implementation

The dotted part is the wireless wearable unit which is enclosed in a hardened plastic case and attached to a elastic arm band. The ground unit is no enclosed, however, because the motor which is analogous to the vehicle wheels needs to be visible.

Devices for detecting driver-fatigue and accordingly device an alarm system to alert them of the risk, or even control vehicle speed, have been a matter of much interest lately. There were various approaches: detecting heart-rate and pulse and facial data. Detection of changes in vehicle trajectory, such as drifting out of lane, were also regarded. However, there remains concerns regarding the dependability of such devices. Drivers may rely on them to warn them in time. Thus, this project aims to improve road safety by ensuring no driver falls asleep at the wheel. Rigorous sleep detection system with an alarm consisting of sound and haptic keeps the driver awake at all times of the drive.The loss or disruption of sleep results in sleepiness during periods when the person would usually be fully awake. The loss of even one night's sleep can lead to extreme short term sleepiness, and continual disrupted sleep leading chronic sleepiness. The only effective way to reduce sleepiness is to take adequate rest. Sleeping less than four hours per night impairs performance. The effects of sleep loss are cumulative, and regularly losing one or two hours of sleep a night can lead to chronic sleepiness over time. Sleepiness reduces reaction time which is a critical element of safe driving. It also reduces vigilance, alertness and concentration so that the ability to perform attention-based activities such as driving in particular is impaired. The speed at which information is processed is also reduced by sleepiness. The quality of decision-making may also be affected consequently. An analysis of road accidents between 1990 and 1992 was done in North Carolina and it was found that 5,104 accidents occurred due the driver falling asleep at the wheels and even studies prove that men are twice more likely to fall asleep compared to women.

Drivers generally when they are feeling sleepy, and therefore make a conscious decision about whether to stop and rest or to continue driving while combating with sleepiness and stay awake. Laboratory studies have shown that if people are woken within a few minutes of falling asleep, they will have no knowledge of having fallen asleep. However, even if drivers are genuinely unaware that they have fallen asleep, they get to know before dozing off. Most of the things that drivers do to fight off sleepiness when driving are barely effective. The only measures that have an effect in reducing sleepiness when driving, as per a study shows that taking a nap of around 15 minutes and taking at least 150 mg of caffeine can make a person feel somewhat comfortable. However, these measures are no substitute for sleep and there is an added concern that drivers may use these tactics to enable themselves to continue driving when they should really stop. The number of incidents increased as drivers grew more sleepy, and all the major incidents involved cases when the driver was trying to keep himself up all throughout the drive. Much of the research into driver fatigue has identified that long drive, dull and monotonous roads lead to more number of accidents in comparison to other physical and topographic conditions.Unfortunately, it is beyond our scope to design roads, instead we need to come up with something that makes the driver cautious when he is about to fall asleep while driving.However, there are some highway design and engineering measures that have been implemented successfully in a few cities. This developed model incorporates both speed control and alarm system which is an effective way to minimise road accidents and ensure safe driving.

CHAPTER 3

IMPLEMENTATION

3.1 BASIC WORKING

1. The synced data of an individual from a Fitbit device has been successfully extracted in CSV format as shown in Fig 1.4
2. The data synchronises with Fitbit servers every minute and returns three Integer values: 1,2,3.
3. State 1: The subject is in the highest state of consciousness. “Very Awake”
4. State 2: Noticeable Fatigue which will/might be followed by loss of consciousness. “Awake”
5. State 3: Complete Loss of consciousness. “Asleep”
6. Installation of haptic feedback using vibration motors.
7. Forced Stop of Motor using special parameters from the extracted data.

A	B	C	D
13:59	109		
14:14	108		
14:29	108		
14:34	90		
14:44	89		
14:54	87		
14:59	86		
15:04	84		
15:09	81		
15:14	80		
15:19	83		
15:24	82		
15:29	81		
15:34	75		
15:39	87		
15:44	89		
15:49	87		
15:54	77		
15:59	74		

	A	B	C
1	Time	State	Interpreted
2	23:14:00	3	Very Awake
3	23:15:00	3	Very Awake
4	23:16:00	3	Very Awake
5	23:17:00	3	Very Awake
6	23:18:00	3	Very Awake
7	23:19:00	3	Very Awake
8	23:20:00	3	Very Awake
9	23:21:00	3	Very Awake
10	23:22:00	3	Very Awake
11	23:23:00	3	Very Awake
12	23:24:00	3	Very Awake
13	23:25:00	3	Very Awake
14	23:26:00	3	Very Awake
15	23:27:00	3	Very Awake
16	23:28:00	3	Very Awake
17	23:29:00	3	Very Awake
18	23:30:00	3	Very Awake
19	23:31:00	3	Very Awake
20	23:32:00	3	Very Awake
21	23:33:00	2	Awake
22	23:34:00	2	Awake
23	23:35:00	2	Awake
24	23:36:00	2	Awake
25	23:37:00	2	Awake
26	23:38:00	2	Awake
27	23:39:00	2	Awake

Fig 1.4: CSV data obtained from Fitbit servers

3.2 BASED ON VARIABLE HEART RATE DATA

According to the Fitbit website: "Fitbit estimates your sleep stages using a combination of your movement and heart-rate patterns. When the person has not moved for about an hour, the tracker or watch assumes asleep state. Additional data—such as the length of time your movements are indicative of sleep behaviour (such as rolling over, etc.)—help confirm that you're asleep." Available at: https://help.fitbit.com/articles/en_US/Help_article/1314. While sleeping, the tech tracks "the beat-to-beat changes in heart rate, known as heart rate variability (HRV)", which changes due to transition between the various sleep stages. A data sync is set up to retrieve sleep data from the previous night.

3.3 TYPES OF SLEEP STAGES

3.3.1 LIGHT SLEEP

Light sleep is the point at which sleep sets in at each night as the body slowly goes into sleep and slows down. Typically, beginning with the onset of few minutes of falling asleep. A person might continuously shift between sleep and awake conditions during this stage. A person might be vaguely alert of the surroundings and thus, can be easily awoken. "Breathing and heart rate typically decrease slightly during this stage." Is what medical research has to say on this issue.This stage, being the intermediate between deep sleep and completely awake stages, is crucial to the process of alerting the driver using the proposed alarm system.

Indicated by stage 2: "AWAKE"

3.3.2 DEEP SLEEP

The first few hours of sleep where a person sleeps comfortably is the deep sleep stage. Solid deep sleeps can help in a refreshed feeling the next morning. Deep sleep shuts down the body to outside stimuli and thus a person becomes unresponsive to outside disturbances. It is noted that breathing becomes gentler and muscles relax due to a much-reduced heart-rate. The deep sleep periods vary with age and thus the onset of fatigue is different in different people of the age group.

Deep sleep is essential for physical recovery and memory and learning. Immune system largely depends on the time of deep sleep.

Indicated by stage 1: ASLEEP"

3.4 SETUP OF THE PROJECT

3.4.1 PYTHON MODULE TO FETCH DATA FROM SERVERS

A python module was developed to fetch data from Fitbit servers. This module fetches "sleep" and "heart" data according to some defined parameters and stores them locally for processing. This fetching takes place every minute for sleep and every 10 seconds for heart. The official Fitbit API used for this project is open source. The technical details and code is presented in the appendix. The other libraries used are:

1. Pandas: "Pandas is an open-source, BSD-licensed Python library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language." Pandas is used for a variety of tasks like academics, statistics, creating easy dataframes. In this project, we have

mainly used it for creating data tables and exporting them to a CSV file format.

2. Datetime: Python does not have native date-as-a variable support. However, we do have a datetime library which can create a modifiable date variable. Here, in this project we have used it to create file-names for fetching and saving data.

3.4.2 PLX-DAQ

Parallax Data Acquisition tool is a Visual Basic Application developed by an "Parallax Inc." It acts a plug-in for Microsoft Excel which is used to send and receive data from/to an arduino based microcontroller system. Here, it is used to send the control words to the arduino to control the alarm and stepper motor,as shown in Fig 1.5. Information securing or Data Acquisition is the way toward examining signals that measure genuine physical conditions and changing over the subsequent examples into advanced numeric qualities that can be controlled by a PC. Information securing frameworks, abridged by the acronyms DAS or DAQ, regularly convert simple waveforms into computerized esteems for handling. The parts of information securing frameworks include:

- Sensors, to change over physical parameters to electrical signs.
- Flag molding hardware, to change over sensor signals into a shape that can be changed over to advanced qualities.
- Simple to-computerized converters, to change over adapted sensor signs to advanced qualities.
- An endpoint software application to manage the data.

Information securing applications are typically controlled by programming programs created utilizing different universally useful programming dialects, for example, Assembly, BASIC, C, C++, C#, Fortran, Java, LabVIEW, Lisp, Pascal, and so forth. Remain solitary information procurement frameworks are frequently called data loggers.Information procurement starts with the physical marvel or physical property to be estimated. Models of this incorporate temperature, light power, gas weight, liquid stream, and power. Notwithstanding the sort of physical property to be estimated, the physical express that will be estimated should initially be changed into a bound together frame that can be inspected by an information obtaining framework. The errand of performing such changes falls on gadgets called sensors.

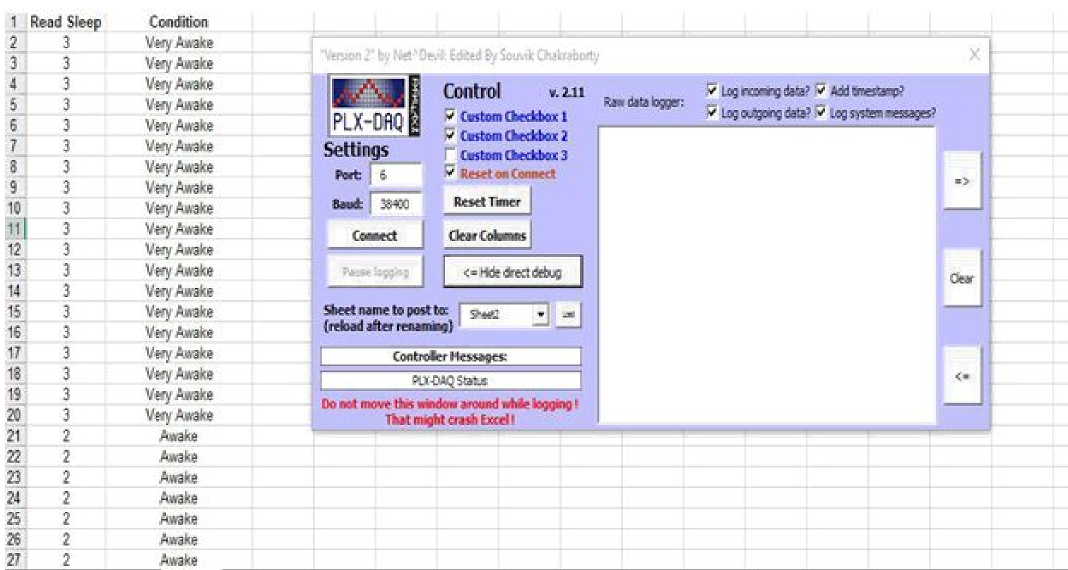

Fig 1.5: PLX-DAQ system to send data from CSV to Arduino

3.4.3 ARDUINO UNO REV 3

The Arduino Uno is a microcontroller board dependent on the ATmega328 (datasheet). It has 14 computerized input/output pins (of which 6 can be utilized as

PWM outputs), 6 analog inputs, a 16 MHz clay resonator, a USB association, a power jack, an ICSP header, and a reset catch as shown in Fig 1.6. It contains everything expected to help the microcontroller; basically interface it to a PC with a USB link or power it with an AC-to-DC connector or battery to begin.

The libraries used are:

1. AccelStepper: This is a community developed library for stepper control which provides easy to use functions to control a stepper speed, direction, run etc.
2. Servo: The native arduino library used for servo control. Here the servo library has very minimal use as the servo has been configured to work as just a vibration device.

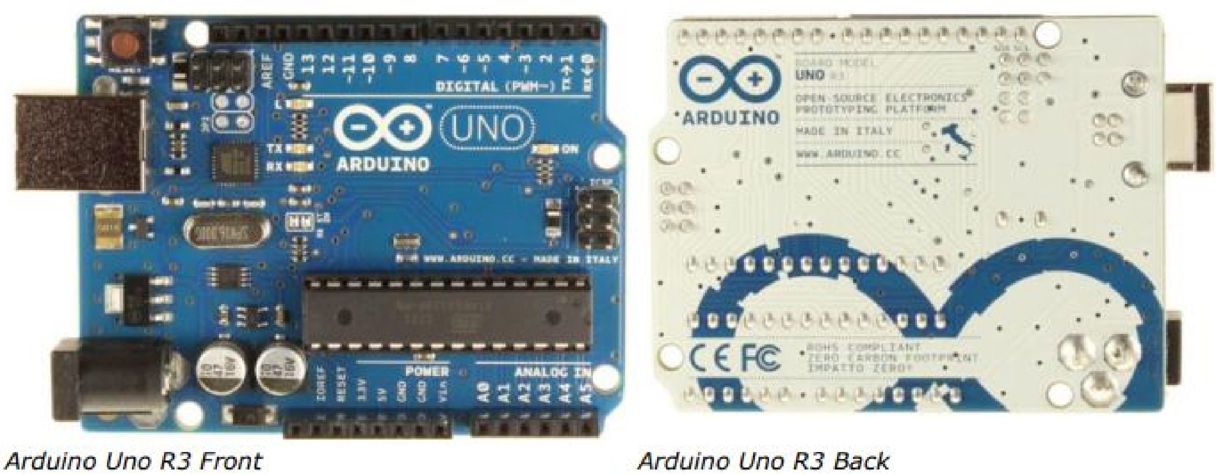

Fig 1.6: Front and back of an Arduino UNO R3(Credit: Farnell.com)

CHAPTER 4

RESULTS

4.1 NOVELTY OF THE PROPOSED WORK

1. During this development, we have identified interoperability challenges related to the collection and processing of data from wearable devices. We have already developed a python module which is compatible with Fitbit's Operating System.
2. Instead of using image processing we will be using sensors to monitor individual's health parameter changes during onset of fatigue.

4.2 DELIVERABLES

1. The project can significantly help in road accident prevention.
2. It is an alternative to image processing-based detection systems.
3. Given the lost-cost resources to build a wearable health monitor and extremely low power requirements for such a setup, enables us to install it in any kind of utility vehicle.
4. Smart wearable technology is used in various scenarios for biometric and health data acquisition. Sports like golf, tennis, baseball, basketball, boxing, soccer, swimming, rowing, etc. readily require athletes to wear these. As there is already a presence of these wearables in the market, integration would be easier.
5. Easy integration with any Fitbit device makes it ready to use for FitBit users.

4.3 DATA SAMPLE TABLES AND ANALYSIS

Table 1.1: A sample of HRV data obtained.

Time	Heart Rate	Time	Heart Rate
00:00:04	76	00:02:56	77
00:00:19	87	00:03:01	71
00:00:24	89	00:03:06	70
00:00:34	69	00:03:11	72
00:00:39	69	00:03:16	75
00:00:44	65	00:03:21	78
00:00:49	65	00:03:26	80
00:00:54	67	00:03:31	79
00:00:59	71	00:03:36	78
00:01:04	72	00:03:41	73
00:01:09	71	00:03:46	68
00:01:19	73	00:03:51	69
00:01:24	75	00:03:56	71
00:01:34	72	00:04:01	74
00:01:39	71	00:04:06	74
00:01:46	70	00:04:12	75
00:01:51	72	00:04:17	76
00:02:06	72	00:04:22	75
00:02:11	84	00:04:27	74

Table 1.2: A sample of HRV data obtained.(continued)

Time	Heart Rate	Time	Heart Rate
00:04:57	74	00:07:34	66
00:05:02	76	00:07:39	70
00:05:07	78	00:07:44	72
00:05:12	77	00:07:49	69
00:05:27	77	00:07:54	68
00:05:42	76	00:07:59	65
00:05:57	76	00:08:04	66
00:06:02	69	00:08:09	68
00:06:07	68	00:08:19	69
00:06:12	66	00:08:29	70
00:06:17	69	00:08:34	74
00:06:22	68	00:08:39	75
00:06:32	72	00:08:54	75
00:06:47	72	00:08:59	77
00:06:52	74	00:09:04	77
00:07:02	75	00:09:09	76
00:07:07	76	00:09:19	76
00:07:22	73	00:09:29	70
00:07:27	70	00:09:34	69

Table 1.3: A sample of HRV data obtained.(continued)

Time	Heart Rate	Time	Heart Rate
00:09:39	73	00:11:15	76
00:09:44	70	00:11:20	77
00:09:49	69	00:11:25	76
00:09:54	70	00:11:30	77
00:09:59	73	00:11:35	73
00:10:04	74	00:11:40	75
00:10:09	74	00:11:45	73
00:10:14	75	00:11:50	75
00:10:20	75	00:11:55	80
00:10:25	77	00:12:00	74
00:10:30	82	00:12:05	73
00:10:35	73	00:12:10	84
00:10:40	70	00:12:15	85
00:10:50	71	00:12:20	73
00:10:55	72	00:12:26	72
00:11:00	73	00:12:31	72
00:11:05	75	00:12:36	71
00:11:10	75	00:12:41	74

We have seen that with various actions performed, HRV has changed phenomenally. HRV is just a proportion of the variety in time between every heartbeat as depicted by Table 1.1,1.2,1.3. This variety is controlled by a crude piece of the sensory system called the autonomic sensory system (ANS). It works paying little mind to our longing and manages, in addition to other things, our pulse, circulatory strain, breathing, and absorption. The ANS is subdivided into two vast parts, the thoughtful and the parasympathetic sensory system, otherwise called the battle or-flight instrument and the unwinding reaction.

The cerebrum is always preparing data in an area called the nerve center. The nerve center, through the ANS, sends signs to whatever is left of the body either to invigorate or to loosen up various capacities. It reacts not exclusively to a poor night of rest, or that sharp communication with your supervisor, yet in addition to the energizing news that you got ready for marriage, or to that flavorful solid dinner you had for lunch. Our body handles a wide range of improvements and life goes on. Be that as it may, in the event that we have tireless instigators, for example, push, poor rest, undesirable eating regimen, useless connections, disengagement or isolation, and absence of activity, this parity might be upset, and your battle or-flight reaction can move into overdrive. HRV is an intriguing and noninvasive approach to distinguish these ANS awkward nature. In the event that a man's framework is in all the more a battle or-flight mode, the variety between ensuing pulses is low. On the off chance that one is in a more loosened up express, the variety between beats is high. As such, the more advantageous the ANS the quicker you can shift gears, demonstrating more versatility and adaptability. In the course of recent decades, look into has demonstrated a connection between low HRV and compounding sorrow or nervousness. A low HRV is even connected with an expanded danger of death and cardiovascular malady. Individuals who have a high HRV may have more prominent cardiovascular wellness and be stronger to push. HRV may likewise give individual input about your way of life and help inspire the individuals who are thinking about stepping toward a more advantageous life. It is interesting to perceive how HRV changes as you consolidate more care, reflection, rest, and particularly physical movement into your life. For the individuals who love information and numbers, this can be a pleasant method to track how your sensory system is responding not exclusively to the earth, yet in addition to your feelings, contemplations, and sentiments. Here, we use HRV to track changes in sleep and awake patterns. However, HRV alone cannot provide proper sleep detection data. Thus we use a special function of the fitbit devices to get "sleep data." Pulse Variability is a measure which demonstrates how much variety there is in your pulses inside a particular time period. The unit of estimation is milliseconds (ms).

- On the off chance that the interims between your pulses are somewhat steady, your HRV is low.
- On the off chance that their length variates, your HRV is high.

There are diverse approaches to figure HRV, however they all need to do with the measure of variety in the interims between pulses. Set up these together and we can figure a standard that when the rest-related parasympathetic branch is dynamic and the thoughtful branch is dormant, your pulse is lower and HRV higher. Factors, for example, stress can prompt the withdrawal of parasympathetic action, or actuation of thoughtful branch notwithstanding when you are resting, both prompting raised pulse and brought down HRV.

Table 1.4: A sample of sleep data obtained.

Time	State	Interpreted	Time	State	Interpreted
23:14:00	3	Very Awake	23:26:00	1	Asleep
23:15:00	3	Very Awake	23:27:00	1	Asleep
23:16:00	3	Very Awake	23:28:00	1	Asleep
23:17:00	3	Very Awake	23:29:00	1	Asleep
23:18:00	3	Very Awake	23:34:00	1	Asleep
23:19:00	2	Awake	23:35:00	1	Asleep
23:20:00	1	Asleep	23:36:00	1	Asleep
23:21:00	1	Asleep	23:37:00	1	Asleep
23:22:00	1	Asleep	23:38:00	1	Asleep
23:23:00	1	Asleep	23:39:00	1	Asleep
23:24:00	1	Asleep	23:40:00	1	Asleep
23:25:00	1	Asleep	23:41:00	1	Asleep

Table 1.5: A sample of sleep data obtained.(continued)

Time	State	Interpreted	Time	State	Interpreted
23:42:00	1	Asleep	23:54:00	1	Asleep
23:43:00	1	Asleep	23:55:00	1	Asleep
23:44:00	1	Asleep	23:56:00	1	Asleep
23:45:00	1	Asleep	23:57:00	2	Awake
23:46:00	1	Asleep	23:58:00	2	Awake
23:47:00	1	Asleep	23:59:00	2	Awake
23:48:00	1	Asleep	00:00:00	2	Awake
23:49:00	1	Asleep	00:01:00	2	Awake
23:50:00	1	Asleep	00:02:00	2	Awake
23:51:00	1	Asleep	00:03:00	2	Awake
23:52:00	1	Asleep	00:04:00	2	Awake
23:53:00	1	Asleep	00:05:00	1	Asleep

Table 1.6: A sample of sleep data obtained.(continued)

Time	State	Interpreted	Time	State	Interpreted
00:08:00	1	Asleep	00:20:00	1	Asleep
00:09:00	1	Asleep	00:21:00	1	Asleep
00:10:00	1	Asleep	00:22:00	1	Asleep
00:11:00	1	Asleep	00:23:00	1	Asleep
00:12:00	1	Asleep	00:24:00	1	Asleep
00:13:00	1	Asleep	00:25:00	1	Asleep
00:14:00	1	Asleep	00:26:00	1	Asleep
00:15:00	1	Asleep	00:27:00	1	Asleep
00:16:00	1	Asleep	00:28:00	1	Asleep
00:17:00	1	Asleep	00:29:00	1	Asleep
00:18:00	1	Asleep	00:30:00	1	Asleep
00:19:00	1	Asleep	00:31:00	1	Asleep

Rest stages are generally estimated in a lab utilizing an electroencephalogram to recognize cerebrum action alongside different frameworks to screen eye and muscle movement. While this strategy is the highest quality level for estimating rest stages (source), your gadget can assess your rest organizes in a more agreeable, advantageous way. Fitbit gauges rest stages utilizing a blend of development and pulse designs. When you haven't moved for around 60 minutes, your tracker or watch expect that you're snoozing. Extra information, for example, the timeframe your developments are characteristic of rest conduct, (for example, moving over, and so on.)— help affirm that you're snoozing. While you're dozing, your gadget tracks the beat-to-pulsate changes in your pulse, known as pulse inconstancy (HRV), which vacillate as you progress between light rest, profound rest, and REM rest stages, as shown in Tables 1.4,1.5,1.6. When the user adjusts the gadget toward the beginning of the day, the sensors utilize their development and pulse examples to appraise the rest cycles from the earlier night.One of the most genuine outcomes of inadequate rest is car crashes because of lazy driving. An ongoing report by the American Automobile Association (AAA) assesses that "one out of each six (16.5%) dangerous car crashes, and one out of eight (12.5%) crashes requiring hospitalization of auto drivers or travelers is because of sluggish driving." (AAA, 2010). Experts speculate that even these exasperatingly high figures think little of the quantity of mischances or close miss mishaps because of languid driving due to drivers being uninformed or not conceding they were lazy at the season of the mischance, or police not gaining that data. The common risk of tired driving is underlined by the quantity of lazy drivers that overviews uncover are still out and about. An ongoing AAA review found that two out of each five drivers (41%) confessed to having nodded off at the worst possible time sooner or later, with one out of ten drivers (10%) announcing they did as such inside the previous year.Studies have connected lethargy and exhaustion to diminishes in cautiousness, response time, memory, psychomotor coordination, data handling, and basic leadership, which are all required for safe driving. (Lyznicki et al, 1998) Sleepiness can disable driving execution to such an extent or more so than liquor, considers appear. The impacts of tiredness on driving execution are likened to that of a blood liquor fixation near that of as far as possible in many states in a very much refreshed individual. (Dawson and Reid, 1997; Powell, 2001) as such, driving tired resembles driving alcoholic. Languor not just aims individuals to nod off at the worst possible time, yet in addition triggers redundant head drops because of microsleeps of a couple of moments in term. (Powell and Chau, 2010). Research has uncovered a couple of markers of sleepiness and tired driving. (Papadelis et al, 2007; Mathis and Hess, 2009). These include:

- Visit flickering, longer length squints and head gesturing
- Experiencing difficulty keeping one's eyes open and centered
- Memory passes or staring off into space
- Floating from one's driving path or off the street.

As of now, there is no conclusive physiologic test or recognition framework for sluggishness equal to the breath analyzers used to identify alcoholic driving. Our setup intends to overcome this issue, while maintaining utmost accuracy. Specialists concur that there is not a viable alternative for rest, and drivers ought to guarantee they are very much rested to forestall crashes. (Nguyen et al, 1998) Awareness of the indications of sluggishness may be useful, however just if drivers take care of those signs by pulling off the street and getting adequate rest. On the off chance that that isn't conceivable, thinks about propose two intercessions that are useful: taking a short, 20-minute rest, and additionally drinking some espresso or other proportionally charged refreshments. Caffeine will enhance sharpness just for a brief timeframe. Thus an alert system is necessary for a prolonged period of time. In no way can it replace sleep, but a disaster can be averted with an alert. Although people who fall asleep for more than a few minutes are often aware of those lapses in wakefulness, drivers may not be aware of shorter lapses and microsleeps, which can also have serious consequences when a quick reaction is needed to avoid high-speed crashes. (Powell and Chau, 2010). Most people also are not aware of how drowsiness affects their driving performance, even without falling asleep. Sluggishness can disable driving execution to such an extent or more so than liquor, thinks about show. The impacts of tiredness on driving execution are likened to that of a blood liquor fixation near that of as far as possible in many states in an all around rested individual.Albeit certain fragments of the populace are more inclined to lazy driving, for example, business truck drivers, move laborers, young fellows, individuals taking steadying prescriptions, or those with rest issue, tired driving is such a predominant condition, to the point that "as a rule it is the normal 'driver nearby' who simply happens to put in additional hours at work, acclimating to another child in the family unit, remaining out late for a gathering, or endeavoring to make it back home after an away trek," noted one gathering of scientists. (Stutts, et al, 1999). Fortunately, tired driving is both preventable and treatable with certain fitting measures, which will be examined in this paper.

4.4 WORKING MODEL

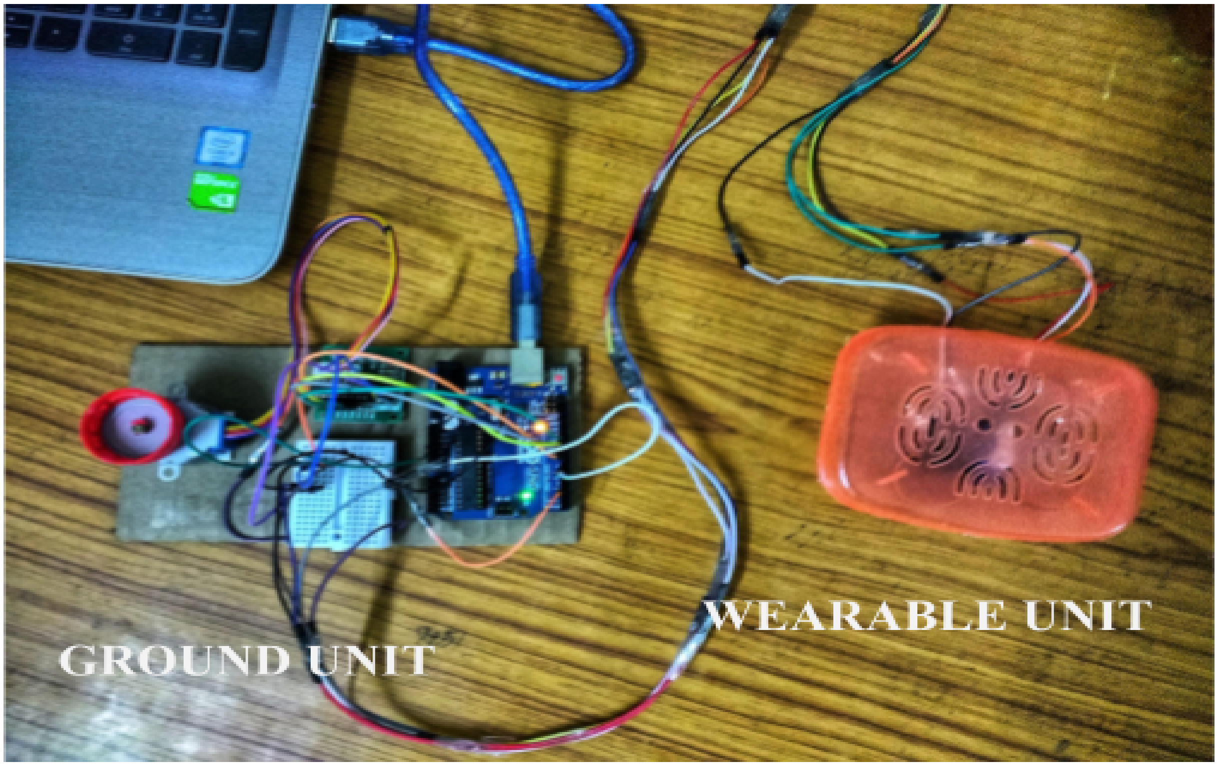

Fig 1.7 Working Model

The ground unit consists of:-

- Stepper Motor
- Motor Driver
- Microcontroller
- Microprocessor for DAQ

The wearable unit consists of:-

- A servo configured as a vibration device
- An active buzzer for alarm
- A plastic encasing to hold the devices to a strap

CONCLUSION

Detection and alert providing devices which track the driver's behaviour and vehicle movement are currently the areas of interest for research and development. Few of them monitor the driver attributes and detect behavioural changes in blink rates or head position. Others detect changes such as the vehicle drift. There are concerns on the reliability of such devices and the extent to which drivers can rely on them to take suitable actions when the situation becomes particularly dangerous. Thus, this project aims to improve road safety by ensuring a steep decline of sleep related accidents. Rigorous sleep detection system with an alarm consisting of sound and haptic keeps the driver awake at all times of the drive.

REFERENCES:

1. Marko Kos And Iztok Kramberger, "A Wearable Device and System for Movement and Biometric Data Acquisition for Sports Applications," IEEE Acc, 2017

2. Matthew Sacco, Reuben A. Farrugia (2012) 'Driver Fatigue Monitoring System Using Support Vector Machines', ISCCSP 2012, 2-4 May, 2012.

3. Jim Horne and Louise Reyner, "Sleep Related Vehicle Accidents" in Sleep Research Laboratory, Loughborough University, 2007

APPENDIX

PYTHON SOURCE CODE TO FETCH DATA FROM FITBIT SERVERS:

```
#using fitbit unoffical API
import fitbit
import gather_keys_oauth2 as Oauth2
import pandas as pd
import datetime
CLIENT_ID = '22CZR5'
CLIENT_SECRET = '25b7c8d16f68ba7feb9d6f03897608c4'
server = Oauth2.OAuth2Server(CLIENT_ID, CLIENT_SECRET)
server.browser_authorize()
ACCESS_TOKEN = str(server.fitbit.client.session.token['access_token'])
REFRESH_TOKEN = str(server.fitbit.client.session.token['refresh_token'])
auth2_client = fitbit.Fitbit(CLIENT_ID, CLIENT_SECRET, Oauth2=True,
access_token=ACCESS_TOKEN, refresh_token=REFRESH_TOKEN)
yesterday = str((datetime.datetime.now() -
datetime.timedelta(days=1)).strftime("%Y%m%d"))
yesterday2 = str((datetime.datetime.now() -
datetime.timedelta(days=1)).strftime("%Y-%m-%d"))
today = str(datetime.datetime.now().strftime("%Y%m%d"))
today2 = str(datetime.datetime.now().strftime("%Y-%m-%d"))
fit_statsHR = auth2_client.intraday_time_series('activities/heart',
base_date=today2, detail_level='1sec')
time_list = []
val_list = []
for i in fit_statsHR['activities-heart-intraday']['dataset']:
   val_list.append(i['value'])
   time_list.append(i['time'])
heartdf = pd.DataFrame({'Heart Rate':val_list,'Time':time_list})
heartdf.to_csv('/Users/Souvik/Documents/classes/PROJECT/data/heart'+ \
            today2+'.csv', \
            columns=['Time','Heart Rate'], header=True, index = False)
fit_statsSl = auth2_client.sleep(date='today')     #has to be today;data synced with
server every 1 minute...that's the server pre-defined
print(fit_statsSl)
stime_list = []
sval_list = []
```

```
for i in fit_statsSl['sleep'][0]['minuteData']:
    stime_list.append(i['dateTime'])
    sval_list.append(i['value'])

sleepdf = pd.DataFrame({'State':sval_list,
                        'Time':stime_list})
sleepdf['Interpreted'] = sleepdf['State'].map({'2':'Awake','3':'Very
Awake','1':'Asleep'})
print(sleepdf)
sleepdf.to_csv('/Users/Souvik/Documents/classes/PROJECT/data/sleep' + \
               today+'.csv', \
               columns = ['Time','State','Interpreted'],header=True,
               index = False)
```

ARDUINO CODE TO CONTROL MOTOR SPEED, ALARM AND VIBRATION MOTORS:

```
#include <AccelStepper.h>
#include <Servo.h>
#define HALFSTEP 8
#define mtrPin1  8
#define mtrPin2  9
#define mtrPin3  10
#define mtrPin4  11
Servo serv;
int flag=0;
AccelStepper stepper1(HALFSTEP, mtrPin1, mtrPin3, mtrPin2, mtrPin4);
int readSleep;
int c;
int k;
int s;
int bzpin=3;
void setup() {

 Serial.begin(38400);
 serv.attach(6);
 serv.write(0);
```

```
 stepper1.setMaxSpeed(1000.0);
 Serial.println("CLEARDATA");
 Serial.println("LABEL,Read Sleep,Condition");
 c=2;
 stepper1.setSpeed(1000);
 stepper1.runSpeed();
 pinMode(bzpin,OUTPUT);


}
void callServo()
{
  digitalWrite(bzpin,HIGH);

  serv.write(0);
  stepper1.runSpeed();

  serv.write(90);
  stepper1.runSpeed();

  serv.write(180);
  stepper1.runSpeed();

  stepper1.runSpeed();

}

void loop() {
  Serial.println( (String) "CELL,GET,FROMSHEET,Sheet1,B,"+c);
  readSleep = Serial.readStringUntil(10).toInt();
  if(readSleep==0)
  {
  Serial.println("PAUSELOGGING");
  while(true)
  {}
  }
  else if(readSleep==1)
  {
    stepper1.setSpeed(100);
```

```
 }
else if(readSleep==2)
{
  stepper1.setSpeed(300);

}
else if(readSleep==3)
{
  stepper1.setSpeed(1000);
  digitalWrite(bzpin,LOW);

}

 Serial.print("DATA");
 Serial.print(",");
 Serial.print(readSleep);
 Serial.print(",");
 if(readSleep==3)
 {
 Serial.println("Very Awake");
 flag=0;
 }
 else if(readSleep==2)
 {
 flag=1;
 Serial.println("Awake");
 }
 else if(readSleep==1)
 {
 Serial.println("Asleep");
 flag=1;
 }


 c++;
  uint32_t period = 1 * 1000L;  //to keep as 1 minute to sync with data from #fitbit
servers.
 for( uint32_t tStart = millis();  (millis()-tStart) < period;  )
```

```
{
stepper1.runSpeed();
if(flag==1)
{
  pinMode(bzpin,HIGH);

callServo();
}
}

}
```

==