ICT Virtual Organization of ASEAN Institutes and NICT

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Call for Presentations

I. Traffic and Road Monitoring and Management System for Smart City Environment

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IV. Smart Society: ICT applications for community and environment (Smart City)

V. ABSTRACT

A. **IoT on Traffic Law Enforcement to Vehicles with the Use of Accurate Plate Recognition with Violation Checking and Recording System**

Traffic congestion causes a great deal of problems; it affects the economy [1] and the environment [2]. Vehicle idling creates carbon footprint, and is one of the sources of air pollution [2]. Germany had a value of fuel and time wasted total of 21,684 million US Dollars in 2013 due to traffic congestion [2]. One of the major causes of traffic congestion in the City of Manila is the godawful discipline of drivers. Public utility vehicle drivers' indiscriminate loading and unloading around the city is one example that causes major traffic build-ups. A considerable number of drivers in the city are not well-disciplined because of corrupt traffic enforcers who allow drivers to slip through the law with favour and money.

To address this kind of incidents and problems, the Philippines implemented a No-Contact Traffic Apprehension policy. High definition CCTVs were installed in major roads and highways. Captured videos, using the installed CCTVs, will be used to manually check all the vehicles who violate traffic laws. The plate number of the vehicle will be recorded manually with their corresponding violations caught thru the captured videos. The Metro Manila Development Authority (MMDA) is a government agency in the Philippines that is responsible for the traffic and transport management within Metro Manila. The database in MMDA, which contains all the plate number with corresponding violations, is available for access to the Land Transportation Office's (LTO). The LTO is a government agency responsible in issuing driver's licenses and registration to all vehicles in the Philippines. Through the existing website of MMDA, Filipinos can also check if they have an existing traffic violation by entering their plate number on a website. If a violation was committed, the driver will not be allowed to renew his/her driver's license nor renew the registration of their vehicle until they finish attending a seminar. This is the penalty in violating traffic laws, aside from paying dues.

To change the existing system into a smart environment, the existing manual recording and checking will be replaced by a system that will optically recognize the plate number of a vehicle. The paper proposes to achieve this feat with the use of image-processing, specifically optical

character recognition, to acquire the identity of the public vehicle using their plate numbers. Recognizing the issue, a study concerning plate number recognition was studied. One research was done in order to understand existing algorithms for plate number detection [3]. The actual experiment was divided into two parts: counting vehicles on the highway, and recording plate numbers on a crossroad. Their data sets were divided into a "Crossroad Data set" and a "Highway Data set" [3].

However, the previous study was conducted merely for detecting plate numbers, and no actions were done in order to actually enforce the law. The information that the Automatic Number Plate Recognition (ANPR) system can provide is only used to capture evidence. No algorithm was constructed in order to check if the vehicles detected are actually violating any laws. This paper will address the said problem. An algorithm is going to be developed in order to determine whether the detected vehicles are violating the law. If so, information regarding the violation and the vehicle would be uploaded into a database. The stored data in database may be used to reprimand and penalize all the owners of the vehicles who violated the traffic law, and drivers who likewise violate the law. The database then may help government agencies such as the LTO and the MMDA to ease their job in recoding the plate numbers and their respective violations, and hopefully avoid corruption within the traffic enforcers.

Overall, this study proposes to make use of the following components: an Infrared Projector, Monochrome and Color Cameras, and a Raspberry PI 3 Model B computer. The IR projector, along with the Monochrome Camera, will provide accurate identification of the plate numbers. The IR projector providing infrared signals thrown to the vehicles' plates increases the difference in the intensity of the plate with the actual plate numbers [3]. A Monochrome camera is used first for identification of the plate number because monochrome cameras produce a more accurate and higher-detailed images compared to Color Cameras [3]. The Color Camera will be used for evidence purposes. For example, tracking a certain vehicle with a certain color would be easier to find.

A. Overall Procedure

The ANPR system first feeds the images and information into the Raspberry Pi computer. This is done by combining the functions of an IR projector and a Monochrome Camera. The computer will then process the images provided by the ANPR system; it checks the images for any violations caused by a vehicle. If a violation is detected, the computer saves the information and records for a case of violation against the vehicle. If a violation occurs, the Colored Camera's images will be requested as evidence.

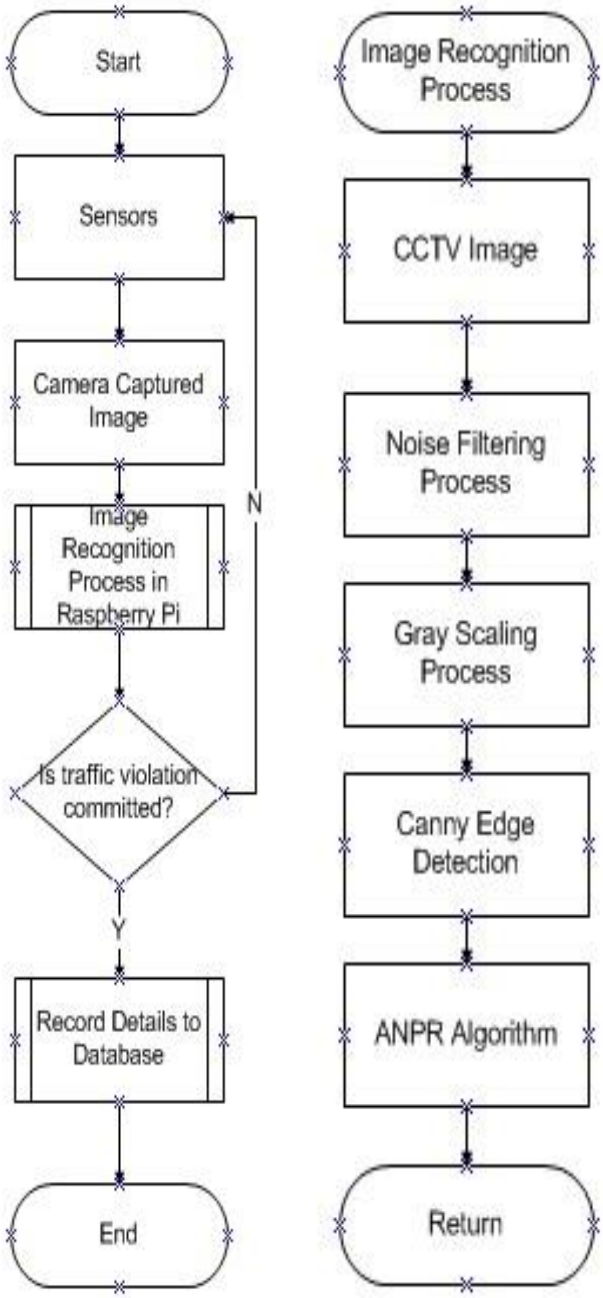
B. Programming Language

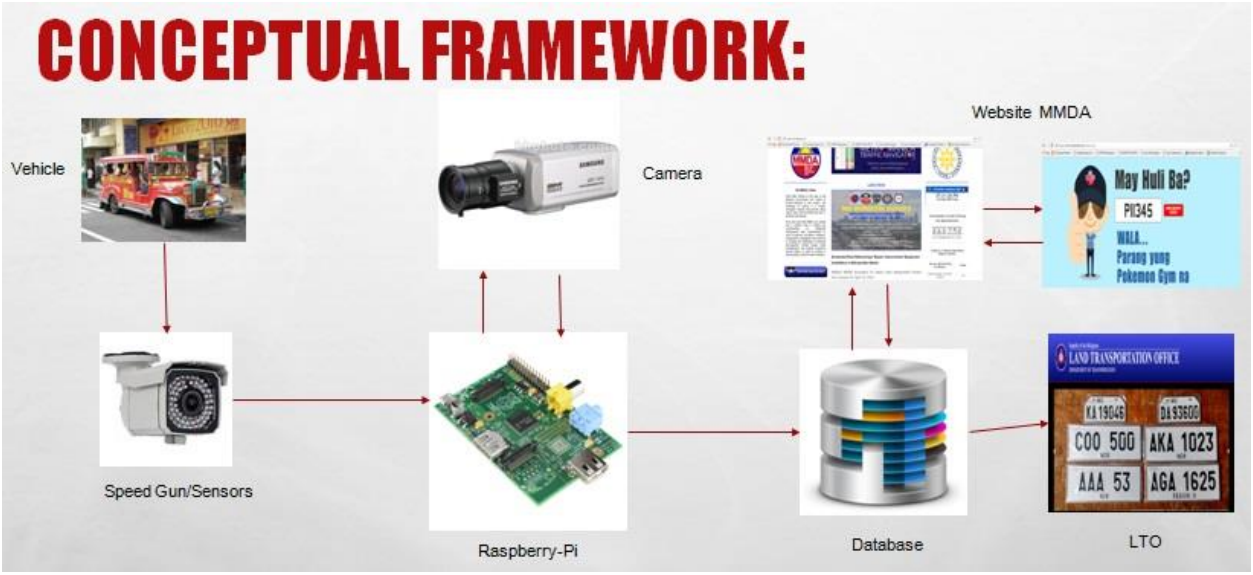
The programming language to be used in constructing the violation detection algorithm will be C++, which will be used by the Raspberry Pi computer in order to process the data provided by the ANPR system.

C. ANPR System's Positioning

The three main parts of the ANPR system are the Monochrome and Color Camera, and the IR projector. These three would be fixed to be as close as possible to achieve a good synchronization between the three devices. In order to prevent the weather from damaging the devices, a case suitable for weather conditions in the Philippines will be utilized. The ANPR

system will be placed next to existing CCTV cameras that are installed within the major roads and highways.





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B. **Road Condition System with Vehicle Velocity and Weather Considerations using Smartphone GIS/GPS Application for Recording, Analysis and Assessment.**

The Philippines is no doubt very prone to devastating natural disasters such as tropical cyclones, earthquakes, and landslides which often alters the country's geological structure. Given that land travel across cities and provinces is the most popular means among travellers and tourists, the intercity roads serve as a great factor when it comes to the safety of the people. Since some of the roads are situated at mountainous regions or remote places, accidents are most likely to happen due to road problems, over speeding, bad weather, lack of road signs and illumination or street lights during the night. According to some road traffic/accident figures by Department of Transportation and Communications (DOTC), out of the 36,000 road fatalities every year in the Philippines, 10% is caused by bad road conditions and ill-maintained roads. This makes road accidents as the fourth leading cause of death in the Philippines [1]

Geographic information system, or GIS, is being utilized to capture and store information related to locations around the world. In the modern day, the majority of the population is adept in using today's smartphones. Since the capabilities of today's mobile phones and Personal Digital Assistants (PDA) gives possibilities of integrating designs and applications for GIS. However, these modern devices can be considered as constrains since their capabilities are far inferior compared against that of desktop computers, because the latter can process, load, and store information much faster [2]. Since the information stored on today's GIS mainly focuses on major routes and roads, the condition and information for remote locations should still be addressed.

Information about road conditions for land travel should also consider natural phenomena such as rain, fog, or any unexpected changes in the weather. The risk of travelling under the said conditions rises, especially when the road ahead is barely accessed or is in a bad condition. A notable example would be the infamous Halsema Highway, which stretches from Baguio City to the mountain province in Bontoc. However, these are not the only factors to be considered; the structure of the road ahead is important as well. Accident-prone areas such as sudden tight curves, uphill/downhill blind spots, combined with faults of drivers such as over speeding increases the risk even more. Simple banked roads should not be underestimated when driving at high speeds, since the banking angle would greatly affect the maximum velocity of the vehicle [3].

In this research, modern technology would allow the utilization of the capability of modern smartphones to develop an application that would make use of GIS/GPS technology to further improve the safety of all road travellers. As the information on intercity road conditions are stored into the GIS, the application would guide the driver on the best route to take using a GPS-guided map, considering the weather conditions on that specific location. For the case of roads located at mountainous regions, the angle of inclination of the road ahead should be considered, as it greatly affects the vehicle's velocity. The application would warn the user if in case the vehicle's velocity is too high when approaching a banked turn, a descent, a sharp curve, and it could even warn the user when a severe thunderstorm is within proximity. It would then display a suggested maximum velocity (in kilometres per hour) to guide the user until the constraint ahead is passed by.

The objective of this paper is to increase drivers' awareness and safety when driving through unknown road conditions, especially along mountain passes and remote locations. Furthermore, it aims to decrease the risk of driving under light to severe weather conditions, when the driver may tend to over speed.

This research will address the problem about road fatalities in the Philippines, with the specific cause of driving along bad road conditions in either city driving or remote locations. It will also address the accidents due to the driver's carelessness when driving in these cases.

As vehicular accidents tend to occur with road condition and weather as a factor, these would serve as the coverage of this research. It would only focus on the safety of driving along city and intercity roads under foreseeable weather changes such as low pressure areas, thunderstorms, or tropical cyclones. It would not consider unpredictable natural phenomena such as sudden earthquakes and landslides.

The methodology of this research is to utilize the GPS capability of today's smartphones and develop an application that would fetch information about the route and road conditions until the driver's destination. This research will include the proposed flowchart on how the application functions.

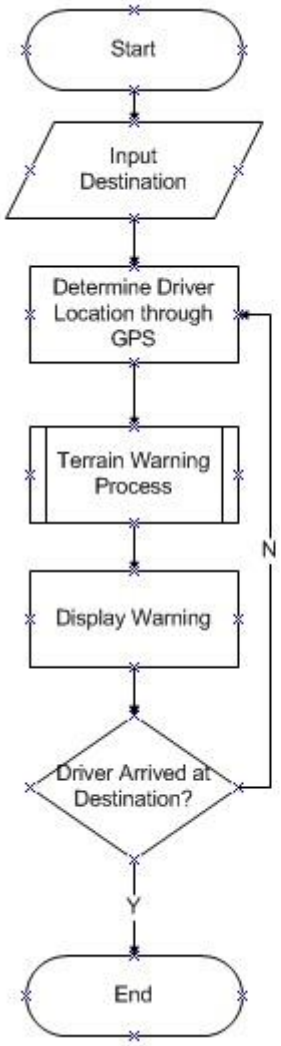
A. *Procedures and Concept*

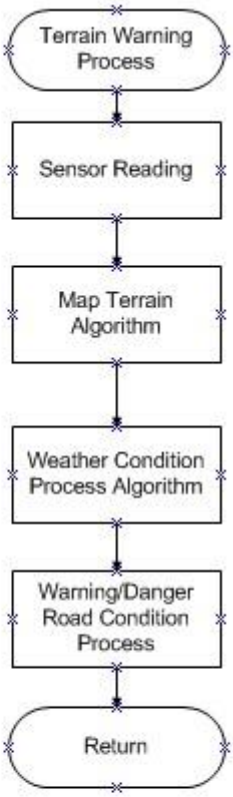
The application would initialize and require the driver to input a destination. Then, the driver's location would be determined by the phone's GPS. Next, both weather conditions (rain, thunderstorms) and road hazards (sharp curve, banked road, descent blind spots) would be fetched using the application's GIS feature. Depending on the data acquired, if the vehicle is approaching a road hazard, the app would output a suggested speed reduction. This case also applies when a weather condition like a thunderstorm is within close proximity.

However, if both occurrences were acquired, then the suggested speed reduction would be greater, since the risk would also increase. Thereafter, whenever the driver has not reached his destination yet, the application continues to loop itself back to the constant GPS monitoring until the destination point has been reached

B. *Proposed Flowchart of the System*

Included in the methodology is the proposed flowchart which would illustrate the procedures and concept, i.e. how the application would function.

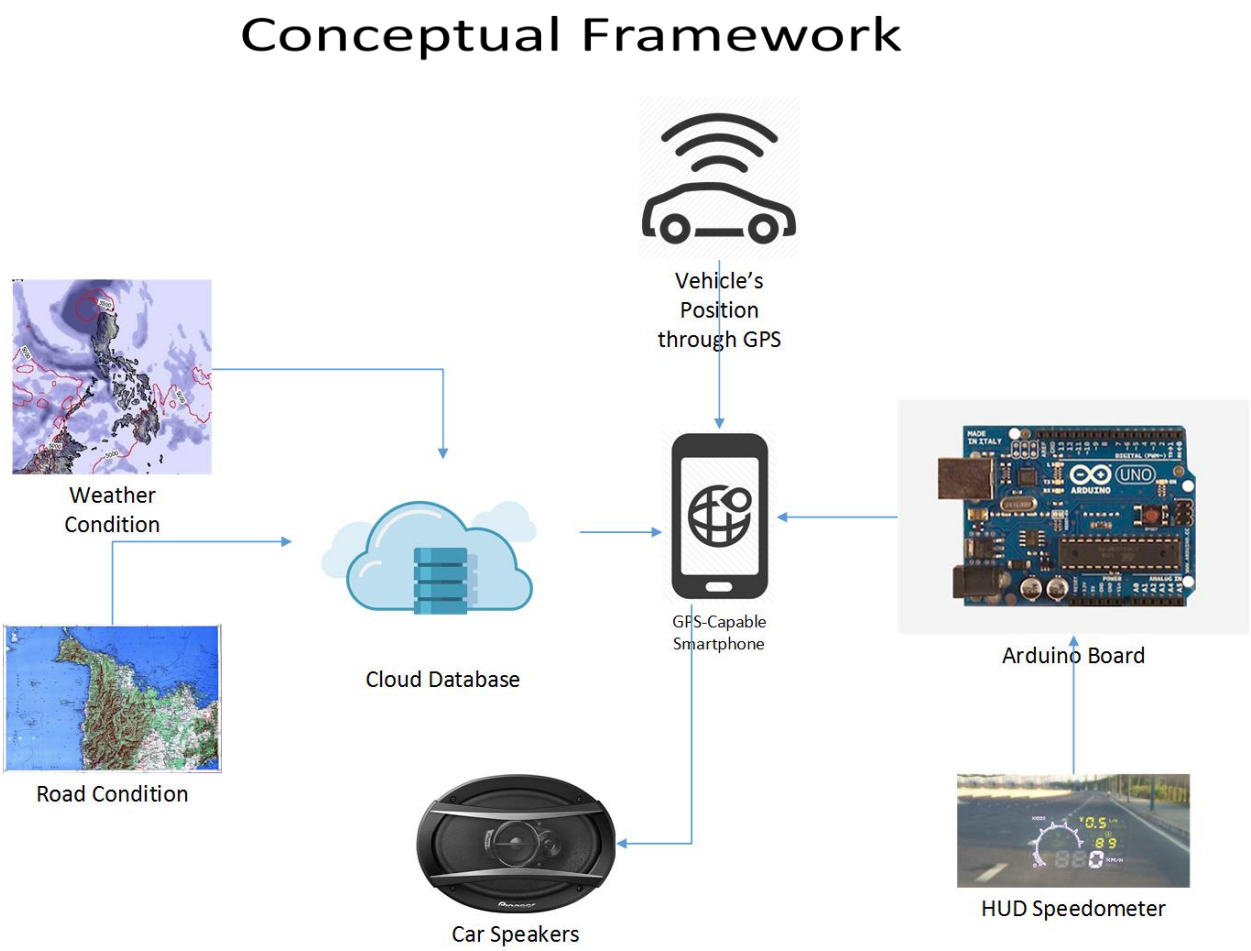




INPUT
Sensor Reading
Map Terrain
Weather Condition

PROCESS
Map Terrain Algorithm
Weather Condition Algorithm

OUTPUT
Processed Terrain Map
Warning



C. **Non-invasive Drowsiness Detection using Face and Eyes Image Processing with Smartphone GPS Reporting and Recording System**

In driving cars, safety is one of the most important factors to be considered since the lives of the driver and/or passenger is at stake. One of the factors is the ability of the driver to maintain focus while driving to watch out for other cars, staying in the proper lane, and following speed limits. Vehicular accidents are then caused by out-of-focus drivers due to fatigue and exhaustion, or sometimes due to drunk driving.

In a survey done in 2007 in the United states of America, it was found that 18% of accidents are caused by fatigue, while the value was in 20% in Britain [1-2]. On the other hand, drunk driving causes 50% of all the accidents occurring based on a statistic by a U.S State department [3]. When a person is intoxicated, driving performance worsens which leads to a higher risk in accidents when driving vehicles. The cognitive and neurological functions are affected as the higher amount of alcohol is absorbed by the system of the driver [4]. Reaction time of the driver, depth perception and following distance judgement is then reduced drastically and leads to a higher risk when certain decisions need to be made while driving on the road [5].

When intoxicated, a breathalyzer could be used to know if the alcohol in a person's blood is above dangerous levels and to determine if the person is in a dangerous state to drive. Drowsiness is the feeling of falling asleep at inappropriate times which could be caused by fatigue and drunk driving [6]. Fatigue could be caused by long work times or boredom in working conditions. Drunk driving is operating a motorized vehicle while excessive alcohol is in the blood.

Previous researches regarding drowsiness detection were classified in to three categories by behaviour-based approach, by physiological approach or by the vehicle-based approach [78]. Behavior-based approach pertains to monitoring the driver through the eyes, head to shoulders and body. Physiological approach utilizes invasive methods to accurately detect signals such as the heart rate, brain activity and eye movement [9]. Being invasive however makes the approach risky since it might hinder the driver in being vigilant. Lastly, there is the vehicle-based approach where the car's movements, braking, accelerating and steering are recorded. It is the most convenient among the methods since the system is embedded onto the car during production, it comes with the car. However, this is found to be too slow to detect the drowsiness of the driver [7]. A camera was used in previous researches, albeit, the lighting and the angle of how the driver is seen are the most problems encountered.

This paper intends to create a system that is non-invasive but would still be able to use the physiological approach of measuring the heart rate of the driver.

The objectives of this paper are to:

- Monitor the heart rate and the eye movement of the driver
- Allow communication between the device and the government agency like Pilipinas 911 to provide assistance to the driver in case of drowsiness.
- Prevent road accidents from happening due to drowsy drivers.
- Notify the driver with recommended speed

The Materials needed for the proposed system are a microcontroller, a camera, an accelerometer, a pulse rate sensor and a buzzer. Open CV would be used for the image processing since it has already functions that can detect the Eyes [10]. The microcontroller will process all the information. The camera would record the driver in normal lighting and lowlight conditions. The accelerometer is used to measure the velocity of the vehicle and ensure the driving speed is safe enough. Lastly, the buzzer will be used to notify the driverif the system detected drowsiness. A cloud database will store information like inputted cell phone number of the driver and warnings from the system. The database will have a connection to the website of Pilipinas 911 for emergency response and for verification of the status of the driver.

Using the Coordinates found, the Open CV Face detection Algorithm is used with improvements so that the face could still be seen even in an oblique manner or when the driver is slightly looking away from the camera [11]. After finding the face, the eyes are then scanned to detect whether the driver has his eyes closed or not, by looking at the whiteness in the eyes aside from the retina. Improvements to the eye detection are placed where in the event of the lighting is insufficient. The image is converted into

greyscale where the parts of the image the eye is noticeable could stand out more. Determining the state of the eye is further improved by using the Percentage of Eye Closure (PERCLOS) [11].

If the PERCLOS is determined to be high or around 80% eye closed and above, the system counts it as one count of having the eyes closed from being drowsy (Drowsy Count). The other method is to check whether the BPM of the Driver is low enough to be considered drowsy. In the event that the threshold is met, the system would emit a beeping alarm sound that is loud enough for the driver to be more aware and notify the driver to the park the car in the nearest stop available. The System would shut down only when the accelerometer detects that the car had stopped.

Authorized officials would be then notified that the driver requires assistance along with the Location.

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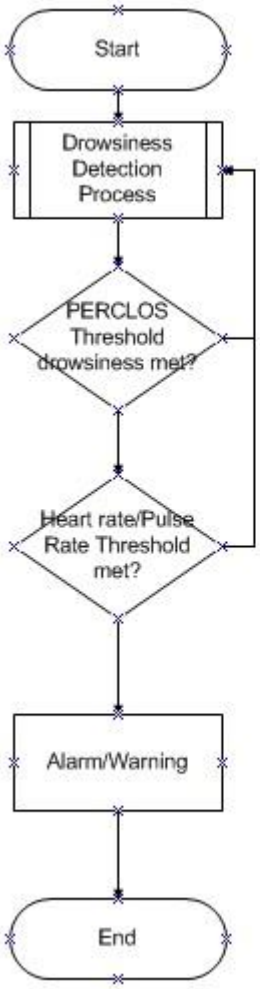
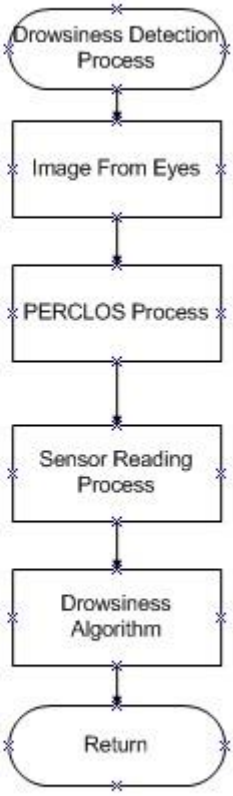
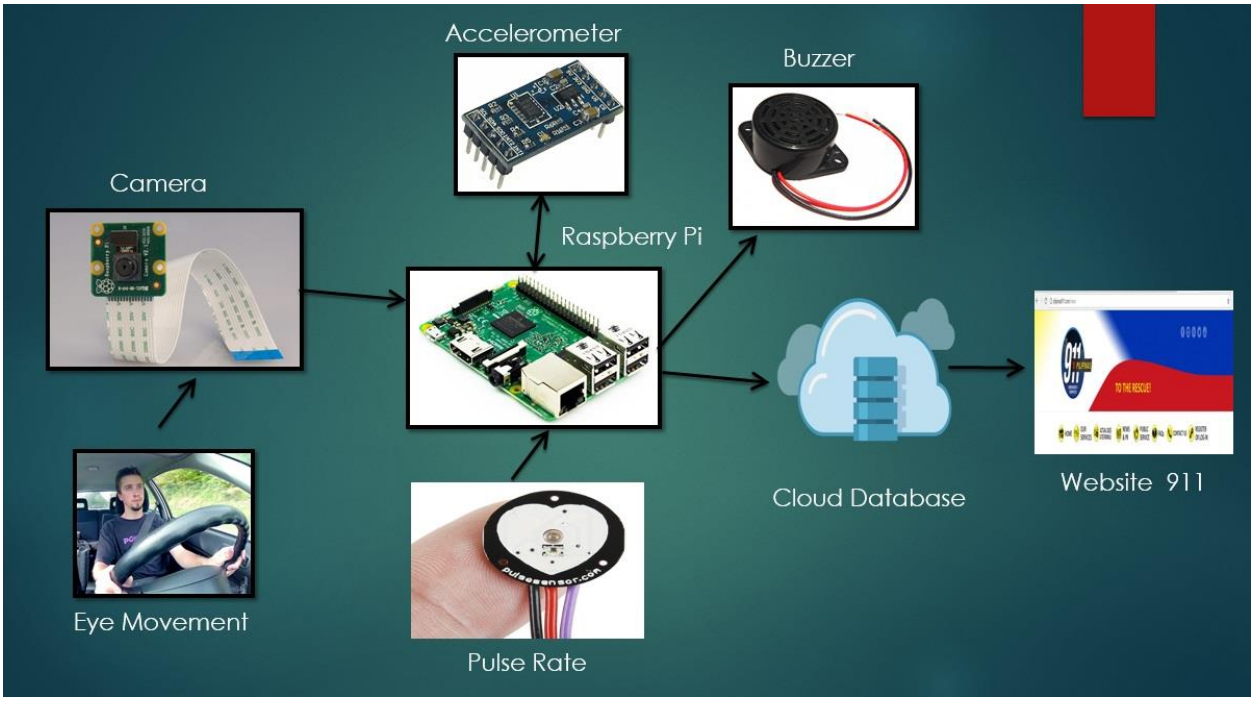

Start
Drowsiness Detection Process
PERCLOS Threshold drowsiness met?
Heart rate/Pulse Rate Threshold met?
Alarm/Warning
End


Drowsiness Detection Process
Image From Eyes
PERCLOS Process
Sensor Reading Process
Drowsiness Algorithm
Return


INPUT
Image from Eyes
Pulse Rate
INPUT
PERCLOS Algorithm
Drowsiness Algorithm
INPUT
Buzzer
Database
Warning to 911

Conceptual Framework



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