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RESEARCH ARTICLE

Road Safety Notification System Using Internet of Things (IoT) for Mountain Road

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ABSTRACT

The prevention of traffic accidents is critical. Moving from one location to another is a part of our daily lives. Every year, numerous road accidents occur as a result of unsafe road conditions, road driver ethics, or a combination of both road conditions and driver ethics. Road safety must be followed in order to ensure the safety of vehicle operators, passengers, and pedestrians on the sidewalk. To avoid serious accidents and injuries, traffic rules and guidelines must be established and strictly enforced. The proposed project's main focus is on road safety in mountainous areas. The primary goal of this project is to create a user-friendly safety system while also reducing the number of road accidents by incorporating a system that is accessible at the tip of our fingers. The method connects the integrated circuit that has been designed in order to send notification to the user on the Blynk application via the method of using an integrated circuit as well as an app platform, Blynk. When driving at higher elevations, a lack of hydration can result in elevation infection, which can affect sharpness. The higher you go, the less oxygen you can see all around you. A few people may suffer from a minor illness such as a migraine, queasiness, or exhaustion. A few people may experience mild symptoms such as a migraine, queasiness, or exhaustion. Keep in mind that dehydration can precipitate the onset of high altitude side effects. This research has the potential to save thousands of lives by providing insight into how road safety affects our lives. It is possible to save lives by combining the use of a smartphone to send notification and an alert system in the form of a warning light.

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Introduction

For this project, the emphasis is on developing a system that is user-friendly on the road or in person. Its primary goal is to reduce the number of accidents on the road by constructing a system that can be accessed at the tip of one's fingers while also saving the lives of road users on mountain roads.

In Malaysia, road accidents are a severe concern. There were 373,047 road accidents in the year 2008 which resulted in 6,527 deaths. Since 2003, the number of road accident deaths in Malaysia has been steadily above 6,000, although the indices used for the road safety measure have shown only a minor decline over the years.

Because of this alarming statistic, the government launched the Road Safety Plan 2006-2010 in March 2006 with the goals of rising mortality rates by 2010 to 2 deaths per 10,000 registered vehicles, 10 deaths per 100,000 population and 10 deaths per billion kilometer of vehicles travelled (VKT) (Ministry of Transport, 2006). Since then, numerous efforts have been made by the government to improve road safety condition in order to achieve the target (Jarašūniene & Jakubauskas, 2017). This is overall statistics for road accidents in Malaysia.

To better understand the limitations of hill driving, the contrast of the hill roads with those in the plains needs to be conducted in depth. Topography is the key factor which distinguishes mountains from plains. The topography encourages rectilinear alignment of roads in plains while the

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mountain roads are sinuous, even without any gradient, as they have to negotiate topography of the ridge valley. Thus, the sinuosity of the mountain roads is a necessity put about by the terrain's topography and this aspect differentiates mountain roads from those in the plains (Jha & Sharma, 2020).

There are current method that is being used which is incorporated in India. This method involves the usage of GIS (Geographical Information System). This correspondence endeavors to advance a GIS-based technique for the distinguishing proof of the stretches of mountain streets that are generally progressively inclined to mishaps to set up an extensive mitigative system. Some trademark parameters must be recognized with the end goal of GIS-based examination from among the different components that make slope driving inclined to mishaps. Other than having a significant impact upon the event of mishaps, these parameters must be target and well quantifiable. Three parameters that qualify these conditions have been recognized with the end goal of examination under GIS condition. These include: sinuosity of the road; inclination of the road; and width of the road (Jha & Sharma, 2020).

In this research, the system consists of an ultrasonic sensor, a notification from an App as well as information that can alert the driver that there is incoming vehicle that is arriving from the other side of the mountain. The app serves as a reminder to the driver that there is an incoming vehicle that is arriving, and gives an alert to the driver to slow down. As for the sensors, it detects the presence of vehicles that is using that road. This system is crucial to be placed at a blind spot at mountain areas. The results that is expected to gain from this project is that the drivers are able to identify an incoming vehicle as well reducing accident risk in mountain areas in Malaysia.

Through this research, more lives can be saved especially on mountain roads. The reason being is this research will impact a lot on road user. The roads played a vital role in connecting people all around the country. Therefore, if the number of road accidents can be reduced, it can guarantee the road users to be safe whenever they are driving on the road.

Literature Review

Problems such as traffic congestion, global warming and environmental sustainability are pushing us to review our long-term strategies for travel. Our mission must be to build and enhance the safety, protection and reliability of transport networks, based on investments made over the past decades, everywhere we can. We must expect and be ready for it at the same time (Jarašūniene & Jakubauskas, 2017). Road vehicles have much greater protection for the protection of as was the case a decade or perhaps many years earlier, their drivers and passengers. Nevertheless, in the case of incidents, there is still a lot to do to improve the safety of disabled persons. Intelligent Vehicle Safety Systems (IVSS) are modern automotive systems that incorporate mechanical, micro-electrical, communication and information technology that are targeted at dramatically minimizing the rate and effect of road injuries (Jarašūniene & Jakubauskas, 2017). The horn is generally used for this purpose. But the horn cannot be heard in the wet seasons. Some people don't use a horn on their own. Horn is not a suitable solution for solving this problem, thus. The key explanations for injuries are these. Thus, it is possible to developed a sensor-based crash avoidance system to eliminate these issues on curved roads (Jha & Sharma, 2020). The main aim of this paper is to develop a road safety scheme in order to minimize the number of road accidents caused by curvy and narrow roads. This scheme of indicators provides the cars an indicator that other vehicles are approaching from the other direction, so that they can only take safety precautions in advance (Saha, Mukherjee, Roy & Chatterjee, 2020; European Commission, 2016). At night time, collisions can occur due to headlight strength from the opposite side of vehicles. Both curved roads and mountain roads also face the challenge of light intensity; thousands of people risk their lives. Alerting the driver of the car approaching from the opposite side is the solution to this dilemma. This is achieved by keeping an ultrasonic sensor in one side of the road before the curve and keeping an LED light after the curve, so that if vehicle approaches from one end of the curve sensor senses and LED light glows at the other side (Yadav, Teli, Darvesh, Baraskar & Kumar, 2020). In the world, the dangerous roads are either mountainous roads, short roads with twists, or T roads. The mountain roads that are most dangerous are very narrow and they have many curves. For example: Bolivia's North Yungas Route, Three Level Zigzag Road in the Himalayas, China's 99-bend Road, Japan's Tsugaru Iwaki skyline, Chile's Los Caracoles, France's Lacets de Montvernier. In rural areas, there can also be openings for animals on the lane, which is also a big concern on hilly roads. The biggest problem with curve roads is that the driver cannot see the other end of the curve road due to obstacles such as trees or rocks in the middle that cause frequent crashes (Jha & Sharma, 2020). Accidents occur regularly in hilly terrain. They are caused by winding roads and mountain road speed breakers. Most roads for rock climbing have tight curves. Vehicles cannot be visible to the pilot from the other side. Millions of people risk their lives as a result of injuries. And a concept is suggested to prevent certain forms of crashes by introducing the crash sensing and alarm system during the advent of these circumstances (Nithya, Pooranam, Deepalakshmi, Aruna Rani & Anandha Swarna, 2020). 90% of road fatalities are estimated to be attributable to human error (for example, Treat et al. 1977). Since education and the availability of information have such a small impact on improving the behavior of people (see Wakefield, Loken and Hornik 2010), it is important that the road environment is built in such a way that it is adapted to the limits of human processing capacity (Theeuwes, 2012). Compared with roads in flatter areas, mountainous roads have complicated path geometry and minimal 'right of way'. Sloped surfaces are one of the most prevalent topographical traits of mountainous regions, making it impossible for planners and builders to create roads according to engineering requirements. Vertical and horizontal orientation combinations combined with dangerous roadside conditions, such as cliffs and embankments, allow driving in these areas are more

challenging (Rusli, Haque, King & Voon, 2015; Communication from the Commission to European Parliament, 2016; Intelligent Transport Systems and Services, 2019). The three major causes of traffic collisions are negligence, overtaking and driver-related alcohol consumption. The predominant explanation for driving drunk is that not every vehicle can be searched by the police and the police can be easily bribed even though they find someone (Bhumkar, Deotare & Babar, 2012). Thus, mountain paths cannot always be matched with contours and varying altitudes must be negotiated. This makes these roads especially steep for certain stretches. Another physical parameter that is distinct from the hill roads. is steepness or the gradient of the lane, which along with the sinuosity, it makes hill driving vulnerable to hazards (Rautela & Shikher Pant, 2007). Drivers must therefore better interpret and appreciate driving safety in order to guarantee driving safety. Interpret and consider the related items and elements of the actual traffic condition in the preparation and regulation of their behavior (Kochan, Bellemans, Janssens & Wets, 2012; Definition and scope of ECTRI's long-term strategy, 2017; GRAFU, 2015).

Methodology

There are several methods that are being used that involved the use of software such as Arduino's IDE and Blynk application. The method that is being used is mainly based on simulation, as well as sending notifications to smartphones. The use of these methods is vital and contributes a great deal to the success of the research. Figure 1 show that the system architecture for this project.

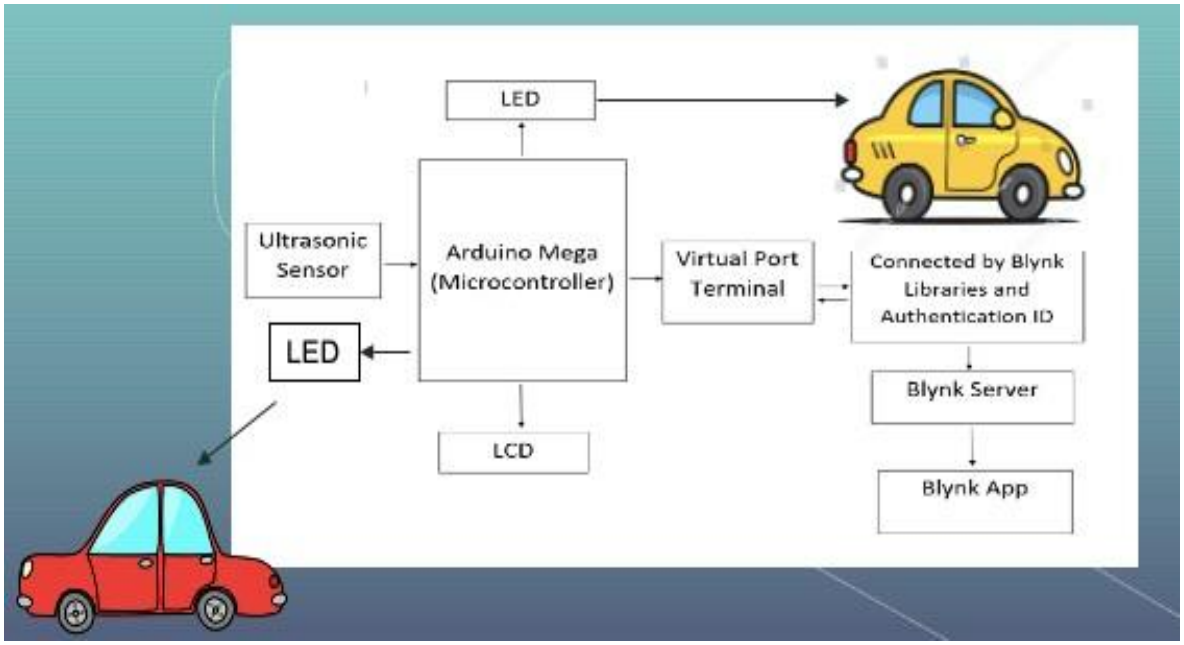

Figure 1. System Architecture

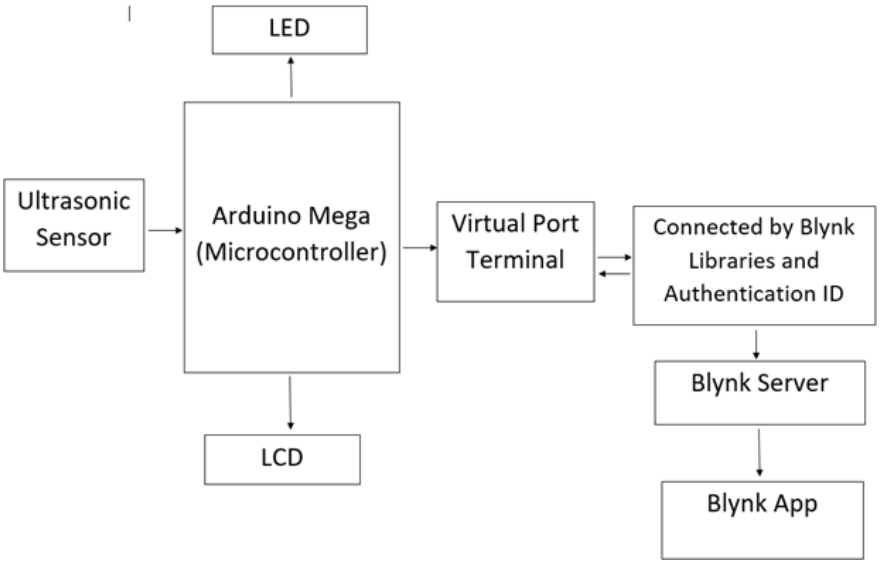

Figure 2. Block Diagram of the System

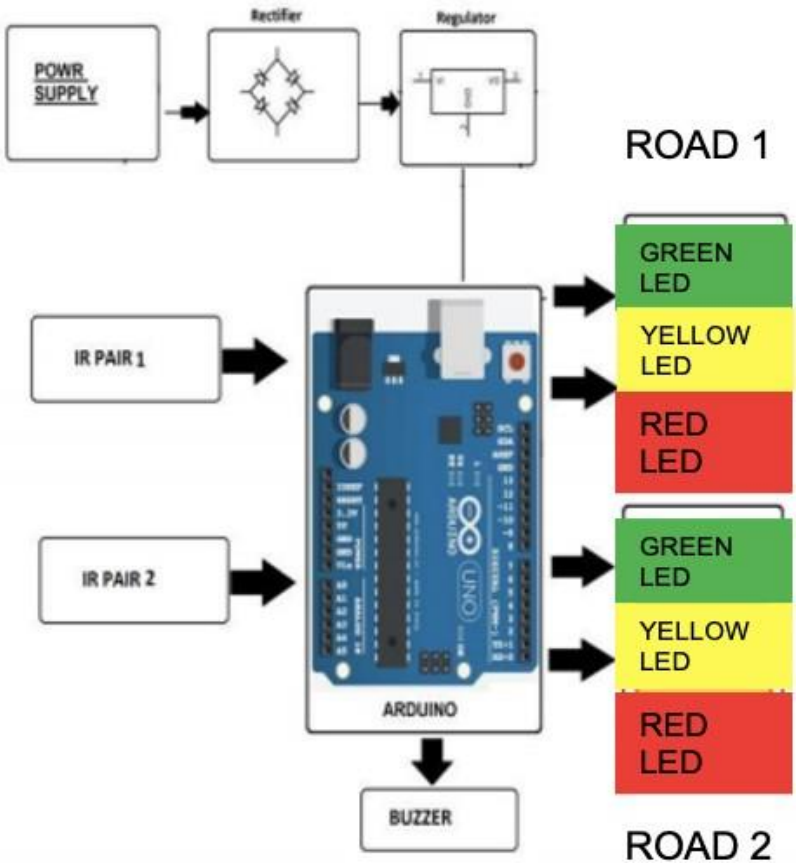

Figure 3. Component Diagram

System Design

Figure 3 shows that there are a four component that are being used for the design of the research. The components that are being used are ultrasonic sensor, LEDs, LCD and a virtual port terminal that are being used due to limitations due to the current pandemic that we are currently experiencing in our country. Therefore, the design of this software is mainly based on simulation based on Proteus software platform, in order to simulate the design of the system in which is used in real-time application.

1. Arduino Mega 2560 Microcontroller

The microcontroller for this project that is being chosen is Arduino Mega. Using SRAM, Arduino boards (Static Random-Access Memory), with 8 kB, the Mega 2560 has the most SRAM space, which is 4 times more than the Uno and 3.2 times more than the Micro. The Arduino has more room to build and control variables as it runs, with more SRAM space. Therefore, Arduino Mega acts as the main brain for this system.

2. LED

The LED functions as a three-colour system in which it serves by sending an alert to the user of the road. The LED will change colour in accordance to the system of the ultrasonic sensor that have been set in the coding. As the vehicle travels and passes through the sensor, it will change the colour from green, to yellow to red with respect to the distance of the vehicle.

Ultrasonic Sensor

As in accordance to the LED as stated above, the ultrasonic sensor serves as a system in which it determined the colour of the LED in which the distance of the vehicle are taken into account. For the LED to function well, the ultrasonic sensor will determine the colour of the LED, for the red LED, the distance of the vehicles is determine to be less than 50 meters from the cornering or blind spot of the mountain areas. For yellow LED, the distance is set to be at 50 to 100 meters from the cornering or blind spot. For green LED, it is save to state that the distance of the vehicle from the cornering or the blind spot of the mountain is more than 100 meters.

$$\text{Distance} = \text{Time} * \text{sound speed} / 2 \quad (1)$$

Where Time = the time between an ultrasonic wave is received and transmitted.

LCD

As for the LCD, it represents an interactive billboard on the mountain areas in which it alerts an incoming vehicle that is coming from the opposite direction. The LCD system is connected to the ultrasonic sensors, in which it will show a detailed distance of incoming vehicle. The purposed of this LCD is to notify an incoming vehicle due to its larger size in which it is an interactive billboard on real time application, it can alert the incoming driver during day or night due to its brightness and large size.

Virtual Port Terminal

The port serves as a virtual connector to connect the system to the smartphone via Wi- Fi. This port is crucial because without the port, it will not be able to be connected to the smartphone and to Wi-Fi, where it sends the notification for incoming vehicle. Figure 4 shows that the overall process involved in the project.

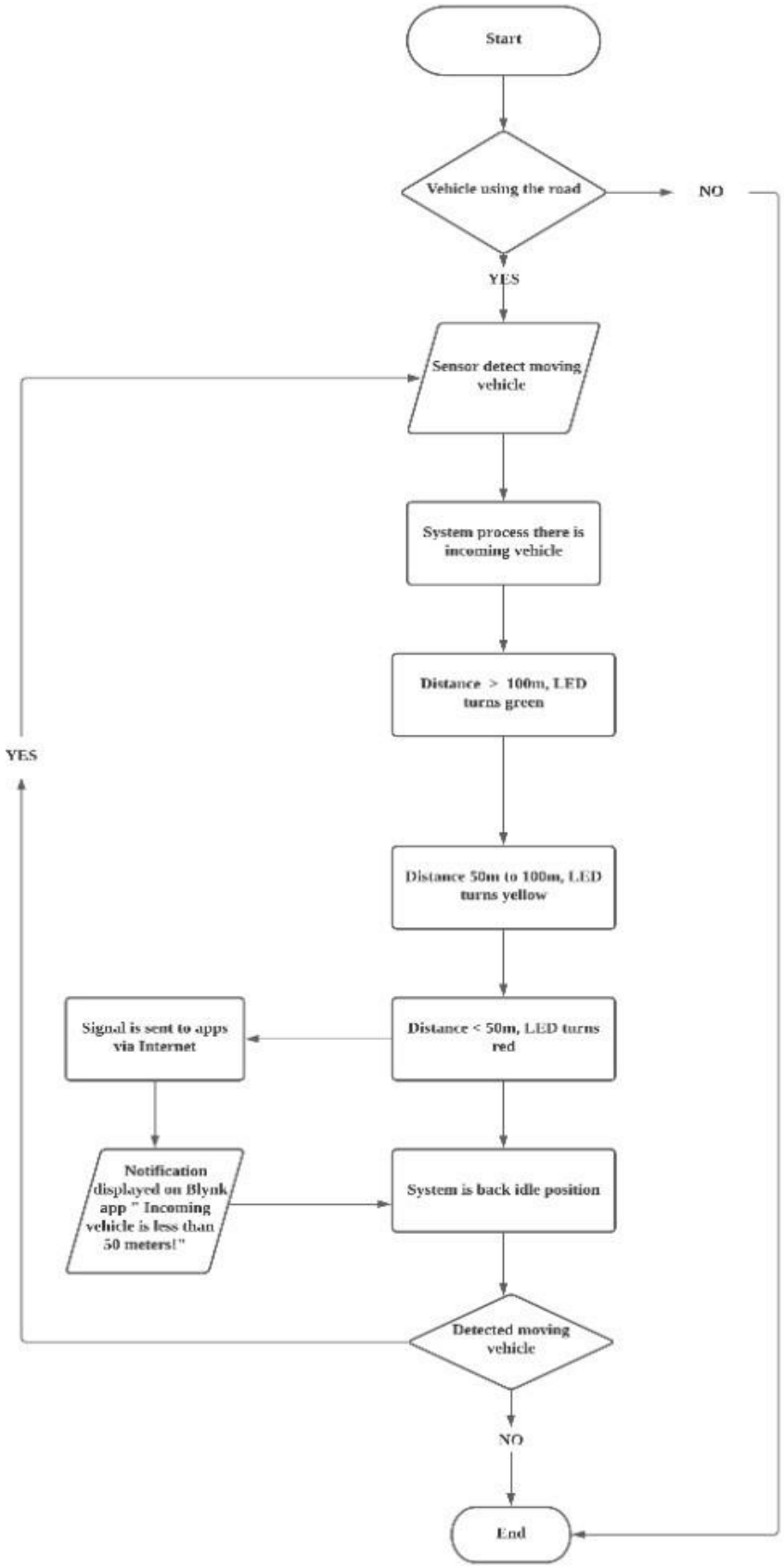

Figure 4. Flowchart of the System

Software Design

As for the software design, a few software are being put to used. The software that are being used are Arduino IDE and Proteus. The usage of both software that are being used play a vital role for this project. Different software serves their own purpose in this project.

i. Proteus

The Proteus plays a vital role because this is where the simulation occurs. The components that are being put to use in such LED, LED, ultrasonic sensor and microcontroller, Arduino Mega. After combining all of these components, the simulation can occur in which how it is perceived in real world application where it is placed on mountain roads.

The main coding for this project, in which it is placed inside the microcontroller is built through coding in this software. The integration of coding for the whole project are simultaneously combined in Arduino IDE. It is then loaded into the microcontroller, Arduino Mega and simulated in the Proteus software.

ii. Blynk App

The app is being used to notify the user of the apps, in this project is which is the user of the road. The app is being interfaced with Proteus software after the coding has been loaded into the microcontroller, Arduino Mega 2560. The app is crucial in the project because it helps in notifying the user of the on the incoming vehicles.

Discussion

After doing this project, there are a few aspects that can be taken into account while implementing this project onto a real-world application. This project entitled Road Safety System for Mountain Roads can be utilized not only on mountain area, but also in the area where accidents occurs the most. The reason being is because the system application used can also be used at those areas where accident occurs the most by placing it on areas where blind spot is present. Moreover, it can be placed also at areas where the roads are hazards for example slippery roads or roads that has a lot of heavy vehicles such as lorry and truck. In term of sustainability, the system itself can be upgrade in such that it helps in preventing road accidents from happening. The implementation of this system nowadays are quite relevant with the current issue that involves road safety and road accidents.

In the worst case scenario, an accident in which is unavoidable normally occurs due to the driver lack of awareness in the sense that the driver are not alert of the hazard that is happening around them, placing a notification system within the vehicle itself can be crucial to determine the safety of the driver. In the future where implementation of IoT (Internet of Things) is wider than ever, connecting this Road Safety System for Mountains Roads to traffic system all across the city can be a deal breaker and thus revolutionize on how we view road safety. Moreover, the system that this project is dealing with can also be implemented all over the world on all types of road condition. The reason being is through the technology of IoT in which we are going forward nowadays a part of Industrial Revolution 4.0, where everything technology is connected to cloud, the risk of having road accidents can be reduce.

As most data are uploaded to cloud storage nowadays, an improvement can be made by uploading data of places where road accidents occur the most. Through Road Safety System Using Internet of Things (IoT) For Mountain Roads project, it is possible that the data is collected for further study and research as of why road accidents occurs frequently although safety features are implemented on road at certain areas. Through this data, it would make the research much easier as compare to the conventional technique of determine cause of road accidents through forensic research. Data is crucial in most application nowadays and on Through Road Safety System for Mountains Roads projects, it is also important. The types of data that can be recorded are weather condition, amount of cars that passes through road each day and as well as monitoring of driver response to the system that has been install on the road.

However, as this project were conducted in the midst of pandemic of COVID-19 that is currently sweeping our nation, there a lot of limitation. The limitations that are faced during this project has propelled to adapt on new ways to conduct this project. By simulating this project as compare to placing it in real-world application for testing, the results obtained are not the same. If it is placed on an actually area where blind spot occurs as compare to simulation, more data can be obtained as well as more knowledge can be obtained. However, adapting on a different ways to conduct and taking on an unconventional approach has led to learning on how to create a system even without needing hardware. This has save a lot of cost and time and still can produce a good results.

Results

The project's outcomes revolve around the functionality of the system, where the entire system in Proteus has been integrated with the notification on the Blynk app. Therefore, the results can be divided into two parts, which is the whole system itself on Proteus simulation and the notification it sends to the Blynk app.

Simulation

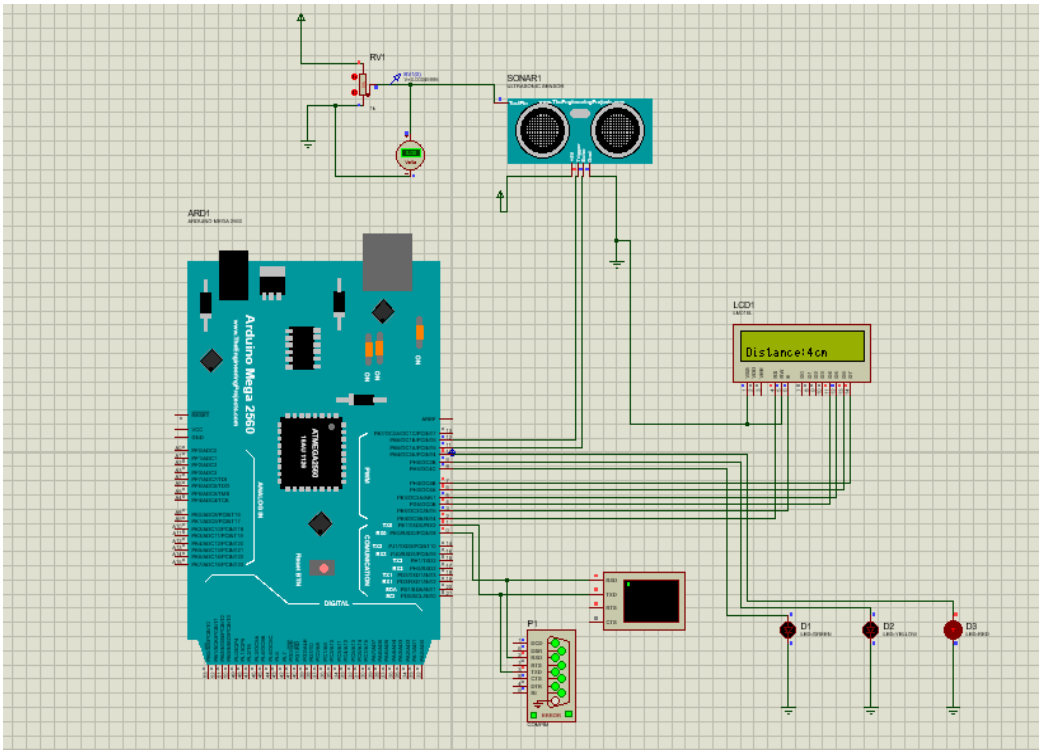

Figure 5. Overview Schematic Diagram of Circuit

As for the simulation, the system were able to run on its own once it has been simulated. As shown on the Figure 5, the system consists of a 3 colors traffic system, red, yellow and green. Whenever the incoming vehicle A comes towards the cornering or blind spot of the mountain areas, it will first passed through the green light area. The green light area represents that it is safe for incoming vehicle to pass through the cornering or blind spot as shown on Figure 6. The distance that has been set at the area are 100 meters and above.

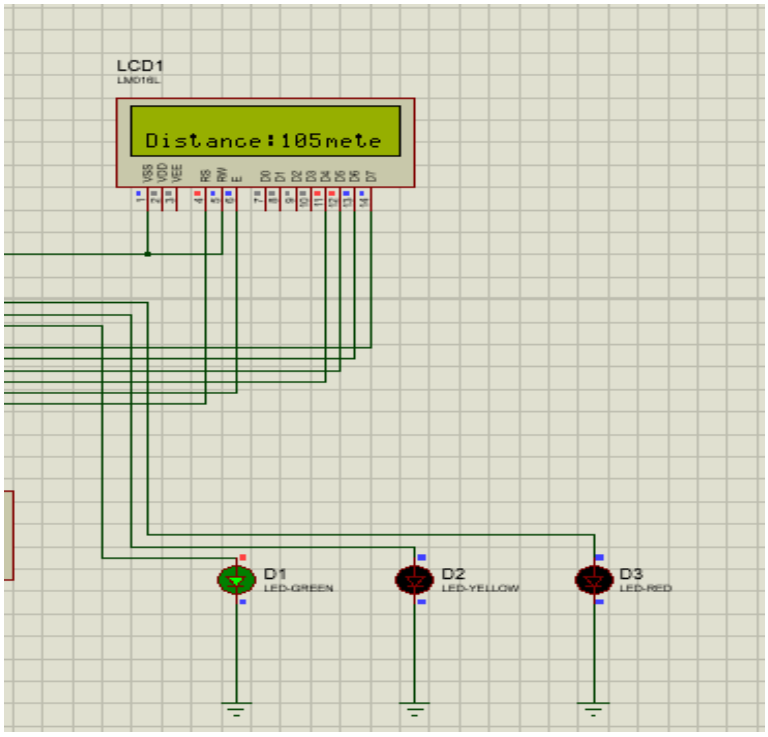

Figure 6. Distance More Than 100 Meters

However, whenever there is an incoming vehicle A, that is coming in the opposite direction, the vehicles will pass through the yellow area in which its distance has been set at 50 to 100 meters towards the cornering or blind spot.

An incoming vehicle B, from the opposite direction will be notified that there is a vehicle A coming in. As the light turns to yellow color as shown on Figure 7, the driver in incoming vehicle B can be ready for the vehicle.

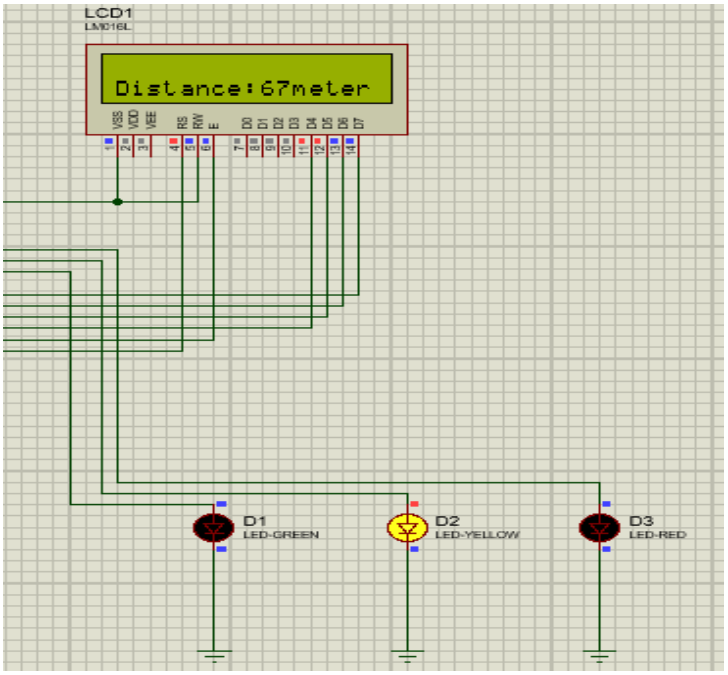

Figure 7. Distance 50 to 100 Meters

As for the last area which is the red area, it symbolized that the incoming vehicle A is less than 50 meters to the cornering or blind spot on the mountain area. When the vehicle B saw the light turns red as shown on Figure 8, the driver can be ready to slow down and stay cautious as the incoming vehicle A does not know that vehicle B is incoming. The system is design that in such it protects the drivers on the sloppy mountain areas as well as to prevent accidents from happening.

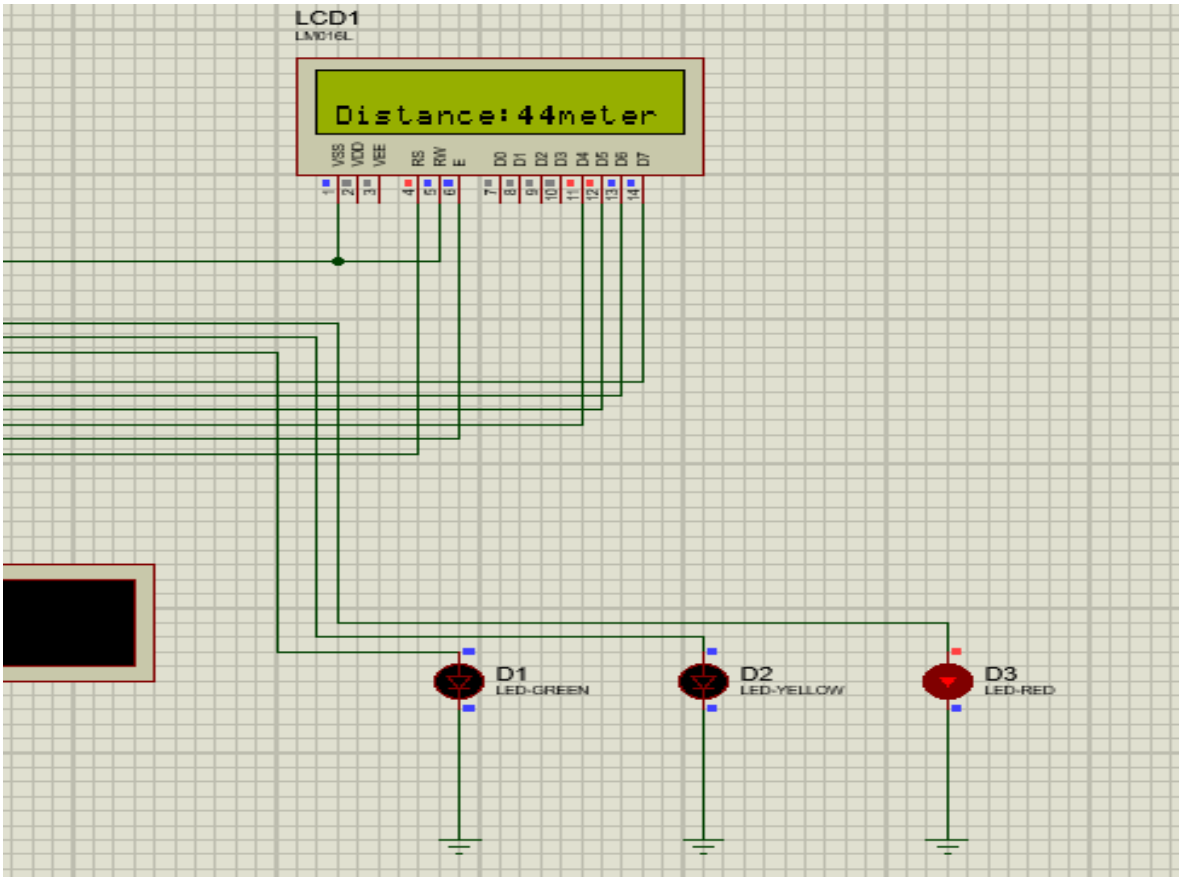

Figure 8. Distance below 50 Meters

Moreover, for this simulation, the LCD represents an interactive billboard in real time application. The billboard serves as a function in which it can show that how is the distance of the incoming vehicle can be monitored by the incoming vehicle. As vehicle A is approaching the cornering or blind spot, it will passed through those three area which is the green area, yellow area and red area. The main function of the billboard is to serve as a reminder for the driver in vehicle B how far of a distance is the vehicle approaching that blind spot or cornering area.

This could prevent collision from happening and save countless lives of driver while they are commuting on uphill or downhill roads. However, as for the billboard, it is difficult to be seen in extreme weathers. Therefore, it is an obstacle for this project if it is applied in real world application.

Blynk App

Due to its limitation that involves the application of the billboard in extreme weathers, the usage of notification in smartphone are being put into used. Nowadays, almost owns a smartphones and the presences of smartphone among road users will always be there. Some vehicle allows the smartphone to be connected to the audio player that has been built in into the entertainment specification of a vehicle.

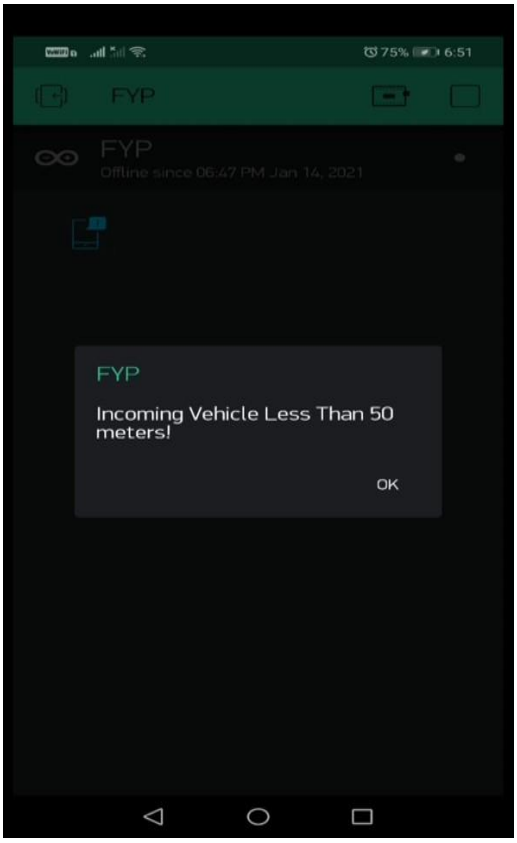

Figure 9. Notification on Blynk App

As the Blynk app is integrated and serves as function to remind the upcoming vehicle B as shown on Figure 9, that there is incoming vehicle coming from the opposite direction. When the vehicle A passes through the green area on the opposite direction, it directly sends signals to the microcontroller Arduino Mega. And through the microcontroller Arduino Mega, it sends the signal to the Blynk app via the Port Interface Physical Model using the Wi-Fi medium. It send the notification “Incoming Vehicle Less Than 50 Meters”.

Conclusion

The main goal of this research is to create a system that incorporates safety for road users so that they feel safe when driving in any weather condition or location. Due to the current pandemic that is sweeping our nation, the limitations to executing are greatly discovered while conducting the research. However, these constraints have little impact on this project because it focuses on system simulation rather than hardware applications.

In addition, through this project, a lot of other uncover possibilities to make this project greater also has also been discover. The application that is implemented in this project can also be executed at areas such as traffic light and area with blind spot. Moreover, the main system of this project in which includes a three light system also can be implemented at area in which has a high accident. This is because there are various factors that affects a certain area when accident

always occurs. Some factors cannot be avoided, therefore implementing this system could prevent accidents.

In a nutshell, the project can benefits a lot of other party and user depending on how they implement it or applying. Through the technology that are being possessed nowadays, the possibilities are limitless.

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