Smart Road Signs Project: Project Proposal

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Executive Summary

This project report presents the problem of reduced vehicle driver awareness in Rwanda and proposes a Smart Road Signs System as a solution. The Arduino ATMEGA 2560 based system increased driver awareness by providing information generated from the calculation outputs of sensors. Information was presented as visual and audio messages to the driver. In addition, vehicle tracking was added as well as communication with emergency service or next of kin in case of a vehicle collision.

1 Introduction

The volume of motor vehicles on the Rwandan Roads is increasing with the increased ability to buy motor vehicles by the Rwandan People. Motor vehicles generally increase the owner's mobility and flexibility to traveling options. More and more people can stay further away from their work places, schools and other service point by utilising the reduced time of travel and complexity.

However, the operation of motor vehicles present challenges to the safety, health and the environment. Human safety and health is compromised by the failures of motor vehicles and/or humans. A study by CLARISSE MARIE CLAUDINE SIMBI shows that road traffic accidents are some of the major causes of death in Rwanda and that negligence of drivers as the main cause of accidents in Kigali City [1].

In addition, to the risks posed by human error, there are short comings in the dissemination of information on the road. Communication mediums like road signs, and maps are available but drivers often do not see the road signs nor do they have information about changes like construction zones, traffic jams or road closures in time. This results in a vehicle operator who is unaware of the road and area in which they are travelling. That lack of real time information to assist the driver in decision making may lead to accidents when critical data is not presented to the driver [1].

1.1 Research problem

Motor Vehicle Operators need a low-cost solution that helps mitigate road traffic accidents caused by human error. This will be achieved through implementing warning systems, providing more information, and warning against collisions. The solution will increase driver situational awareness and improve their driving experience.

1.2 Project objectives

This project aims to create a Smart Road Signs system that employs the use of sensors, communications and a microcontroller to evaluate the area around the vehicle. System will present relevant information about the environment to the driver so that the driver has increased situational awareness. The system lowers the risk of a road traffic accident and provide useful information to increase driver convenience which addresses the problem highlighted in the problem statement.

- Design and Build a smart, efficient, reliable Smart Road Signs system based on the project requirements.
- Select the suitable and affordable components that meet the project requirements to build the system.
- Build and asses subsystems performance and compare the results with the requirements for the project.
- Build the solution from subsystems and test the solution against requirements.
- Conclude and report on the findings

1.3 Project requirements

The problem statement further divided into specifics needs in the form of a requirement as below [2].

- Warn driver of possible collision
- Present visual and audio signals to alert the driver of possible hazards and important information.
- Alert emergency services and next of kin, in case of collision.
- Load a map from a database and use the vehicle geographical location to present the information in the area where the vehicle is from the database map data.
- Ensure the system can run using power from the car battery.

- Simplify the technology developed so that other engineers and people can utilise the solution.

- The system must work reliably, fast and accurately, all the time irrespective of environmental conditions (road, weather, area, etc.).

- Ensure the system is operational and functions as specified at all times when vehicle is in use.

- Ensure system is compatible with current systems on vehicle and that the system can be easily to installed

2 Literature review

"FACTORS CONTRIBUTING TO ROAD TRAFFIC ACCIDENTS IN KIGALI CITY" by Simbi elaborates the challenges faced by the vehicle drivers [1]. It shows there is need for a solution to reduce the road traffic accidents. However, they do not discuss the solutions at low level. The paper focuses on government and police enforcement over user specific solutions.

"Low-Cost Driving Assistance System" by Mangezi does well to discuss solutions and affirm the existence of the problem for drivers [2]. Mangezi suggest the use of image recognition to identify road signs and inform the driver of the sign and information. They even go further to develop front end collision warning systems. However, the solution assumes the road signs are present, visible and and not blocked by structures or trees. This assumption is limiting since tall grass, trees, any blockage limits the recognition accuracy. The inaccuracies make for an inefficient system that can not be fully utilised on most roads in Rwanda. Also, the image recognition is slow such that it is ineffective on winding mountain roads like those in Rwanda. The system works well of roads with longer stretches .

3 Project Methodology

3.1 Proposed Solution

A solution that takes input from the map database, system (vehicle) and environment, process the information and determines the action to take as well as a warnings to give to the driver so that the driver is aware of what is going on within the system (vehicle) and the environment as shown in Figure 1. The system must meet the requirements given in the requirements section [2].

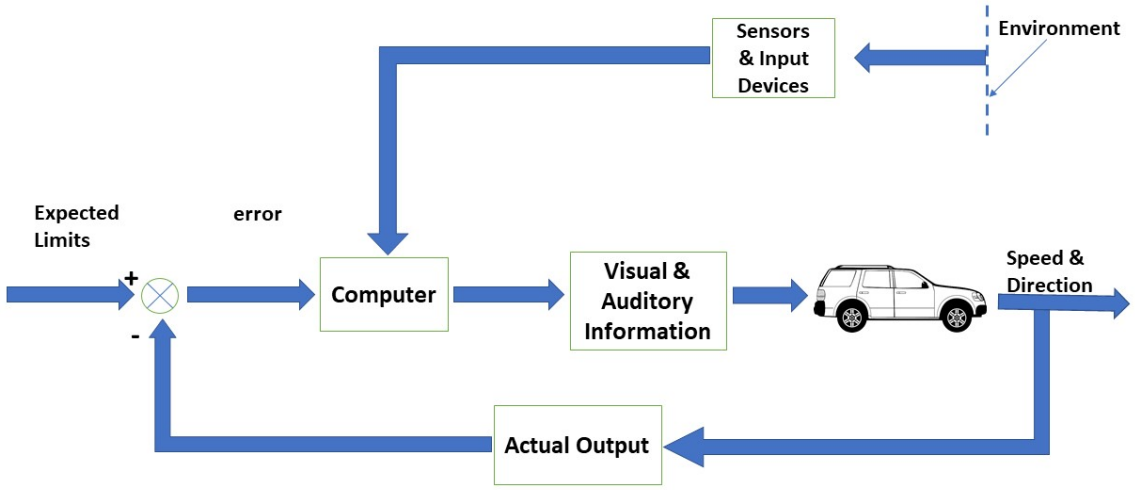

Figure 1. Overall System

The overhead embedded system design to be implemented is as shown in Figure 2. An Arduino Mega will be used for the initial solution and an upgrade will be done with further progress to a more powerful micro-controller, Raspberry Pi 3 B+.

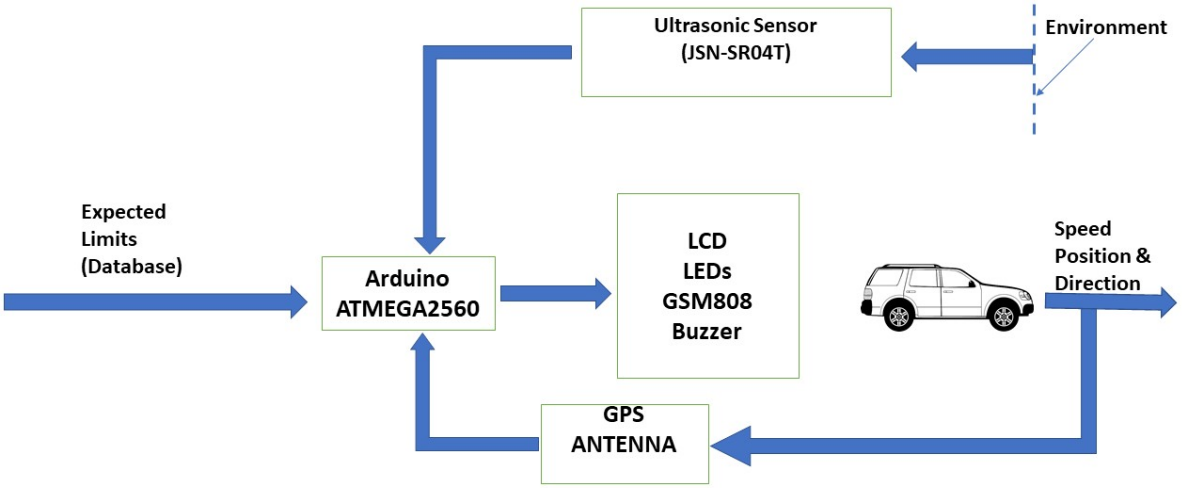

Figure 2. Embedded System

3.2 Preliminary Equipment Selected

- Arduino MEGA

- 9V Battery Source
- Ultrasonic Sensor (JSN-SR04T)
- GPS Antenna
- GPRS Shield (GSM808)
- LCD (i2c 2x16)
- LEDs
- Resistors
- Buzzer
- Prepaid GSM SIM Card

3.3 Expected Outputs

- Working Prototype: Meets the operational requirements.
- Project Write-up: Articulates the project for understanding and leaves room for further research and verification.

3.4 System design and modeling

The project was done in a series of milestones as shown in Table 1 on page 6. this is done to better evaluate progress and evaluate scope suitability.

Milestone	Description	Expected Date of Completion	Status
Raspberry Pi 3 B+ Setup and Arduino Mega Setup.	Connect the sensors and test them individually with the microcontrollers. Compare the outputs for best readings	01/05/2021	Completed: Arduino Selected
Collision Avoidance	Build system to detect and warn against collisions and send text to next of kin and emergency service in case of collision	04/05/2021	Completed:
GPS location	Find position of system using latitude, longitude and altitude	07/05/2021	Completed:
Combine Systems	Unify the operation of the collision avoidance together with the GPS. Locate and display position from the map where possible.	14/05/2021	Completed:
Report and Presentation	Do a project write up finalization and final Demo presentation preparations	19/05/2021	Completed:
Project closure	Submit all and return all equipment used for storage.	19/05/2021	Complete

Table 1
: Milestones

3.5 System Circuits

Figure 3 shows a the system circuit as was connected physically.

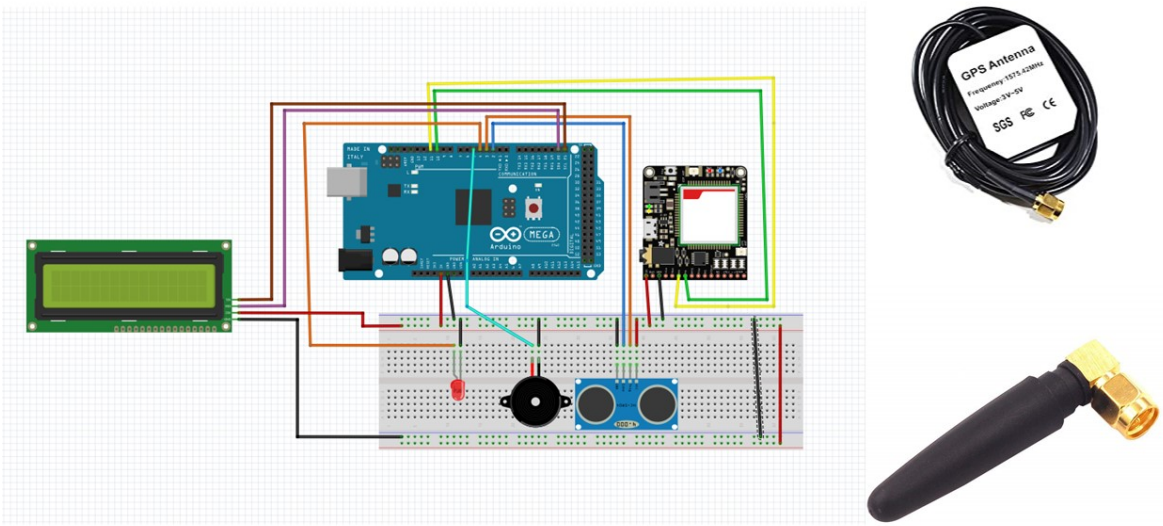

Figure 3. System Circuit

Figure 4 shows a the SIM808 GPRS Shield.

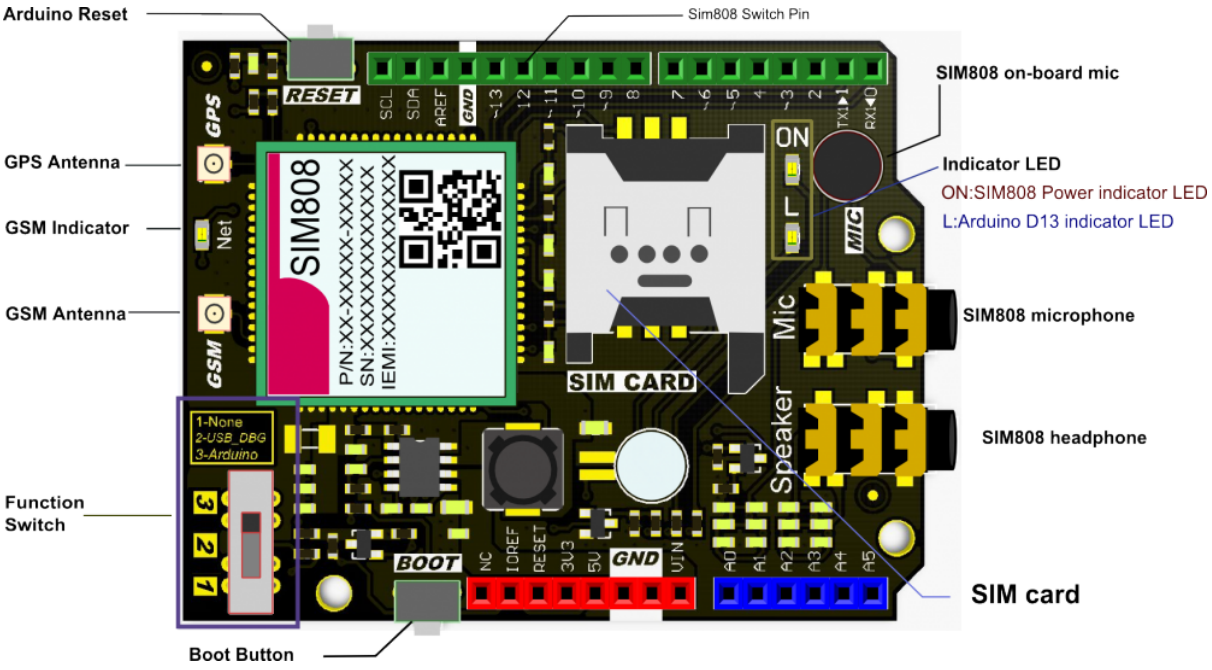

Figure 4. SIM808 GPRS Shield

Here the GPS Antenna was connected to the active GPS antenna port on the SIM808 GPRS Shield. The network antenna was connected to the GSM antenna port. The prepaid GSM SIM was inserted in the SIM Card slot. The GPRS shield in Figure 4 was connected to the Arduino ATMEGA2560 as shown in Figure 3.

The JSN-SR04T was connect as shown for the ultrasonic sensor shown in Figure 3. The buzzer and red LED were also connected as guided by the system circuit. The LCD was also connected as shown in Figure 3. The Arduino ATMEGA2560 was connected to a computer and the code in the GITHUB Repository was pushed. The system was tested and calibrated accordingly. It is key to note that the SIM808 requiresone to press and hold the reset button so that it initializes GSM connectivity. The LED blinks once every 3 seconds when connection is achieved others it blinks very fast.

The code was created borrowing ideas from inbuilt libraries namely TinyGPS Library, DFRobot_simsim808 Library and NewPing Library [3] [4] [5]. Here GPS location, sending messages, making calls and using the ultrasonic sensor were modified from the various library examples as needed to produce main code that has desired functionality. Some calculations for distance and other functionalities were programmed using functions.

Code Link: https://github.com/mangezi64/ESD_Final_Project/blob/cce1bffc8a068779017d1b5a865806a1852e4790/Main_Code

4 Results

System functionality is listed below and it refers to the particular requirement fulfilled:

- The collision warning system gave audio buzzer warnings and a red led to warn driver off possible collision. The lcd also displayed the danger warning when there is possibility of collision.
- In the event of a collision the system calls the next of kin to draw attention to a sms message showing the location of the collision.
- User can track their motor vehicle by requesting the vehicle location on an sms.
- System can run on a battery power source like a car battery.
- The GITHUB repository shows all the files with well commended code to guide any user on how to utilize the system. Only private information was excluded like phone numbers.
- System is relatively reliable with the JSN-S04T giving false readings at times but otherwise all systems worked as expected.

5 Discussion

The GPS location obtained by the system is not exactly accurate and has large room for error with deviations of up to 50 meters to actual location. The JSN-S04T is not reliable and a better sensor should be used to replace this ultrasonic sensor. There is significant delay when messages are send to the user and next of kin since the GSM module takes some time initializing before it sends message or make a call.

6 Conclusion

The system requirements were met as described in the discussion and results sections. The component limitations significantly affect the operation of the system and thus robust components are required to improve system performance.

6.1 Recommendations for Future Work

- Connect the GPS location to the road signs data base so that the driver can receive information from the system about their surrounding. This was not achieved in this scope.
- Consider how to modify the collision system so that it can be optimized and accurate by changing the sensors used.
- Allow the vehicle to utilise the speed information and the inter vehicle distance information to determine severity of collision.
- Connect the system collision system with other vehicle sensors like the are bag sensors for cases of collision while vehicle is not moving.

7 References

1. Simbi, C. M. C. *FACTORS CONTRIBUTING TO ROAD TRAFFIC ACCIDENTS IN KIGALI CITY* http://197.243.10.178/bitstream/handle/123456789/6034/FACTORS%20CONTRIBUTING%20TO%20ROAD%20TRAFFIC%20ACCIDENTS%20IN.pdf?sequence=1&isAllowed=y (2021).
2. Mangezi, S. T. M. *Low-Cost Driving Assistance System* https://air.ashesi.edu.gh/handle/20.500.11988/607?show=full (2021).
3. Taster, B. *NewPing Library* https://forum.arduino.cc/t/newping-library-hc-sr04-srf05-srf06-dyp-me007-parallax-ping-v1-7/103737 (2021).
4. Jason. *DFRobot*$_{SIM808Library}$ https://github.com/DFRobot/DFRobot_SIM808 (2021).
5. Hart, M. *TinyGPS Library* https://github.com/mikalhart/TinyGPS (2021).

A GITGUB Links

Link to the GITHUB repository holding all code files used for the project as well as the fritzing circuit files. The mainn code for the project is the **"Main_Code"** file.

Repository: https://github.com/mangezi64/ESD_Final_Project
Main Code: https://github.com/mangezi64/ESD_Final_Project/blob/cce1bffc8a068779017d1b5a865806a1852e4790/Main_Code