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DESIGN AND IMPLEMENTATION OF SMS BASED ON VEHICLE OVERSPEEDING ALERT TO TRAFFIC POLICE

A dissertation submitted to the Faculty of ENGINEERING in partial fulfilment of the requirements for the award of the BACHALOR of Science in AUTOMOTIVE TECHNOLOGY at Université Privée Africaine Franco-Arabe (U.P.F.A.)

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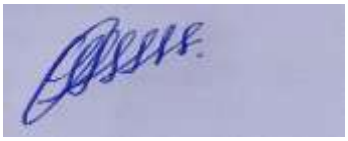
Bamako, 2025

DECLARATION

I, **RUKUNDO JOSEPH Kelly**, declare that the content of this dissertation is my own work except where acknowledged. It has never been presented or submitted anywhere else for any other or similar award at any other university or institution of high learning.

Date: 16 March 2025



RUKUNDO Joseph Kelly

CERTIFICATION

This is to certify that the thesis entitled: “Implementation of SMS based on vehicle over speeding alert to traffic police” Submitted by **RUKUNDO JOSEPH Kelly** to the **Université Privée Africaine Franco-Arabe (U.P.A.F.A.)** for the award of Bachelor of MECHANICAL ENGINEERING (MEE) in AUTOMOBILE MECHANICS under my direct supervision and guidance. The work embodied in this Dissertation is original and has not to my knowledge been published or submitted in part or full for any other Degree of this or other University.

Date: ……..…
Signature: ……..

Names of Supervisor: **Pr Sidi Ahmed Mohamed**

DEDICATION

This research is dedicated to all those affected by the consequences of over-speeding on our roads, To the traffic police who safeguard our streets with diligence and courage and to the dedicated professionals in law enforcement who work tirelessly to ensure our safety. May this work contribute to the ongoing efforts to create safer and more responsible driving practices through innovative technologies.

AKNOWLEDGEMENTS

I would like to express my sincere gratitude to all those who contributed to the successful completion of this research on the implementation of SMS-based vehicle over-speeding alerts to traffic police.

Firstly, I extend my heartfelt thanks to my supervisor whose guidance and insights were invaluable throughout this project. Their expertise and encouragement played a crucial role in shaping the direction of this study.

I am also deeply thankful to Eng. RUZINDANA Eugene, school Manager of KAVUMU TSS a school which is accredited to train the automobile drivers for his assistance in data analysis.

Furthermore, I am grateful to RWANDA National Police and KAVUMU TSS for providing the necessary resources and support that enabled me to conduct this research effectively.

Lastly, my appreciation goes to my family and friends for their unwavering support and understanding during this endeavor.

ABSTRACT

This research proposes an SMS-based vehicle over speeding alert system to address road accidents caused by over speeding. The system uses GPS, GSM (Arduino uno) and speed sensors to monitor vehicle speed and automatically sends alerts to traffic police when over speeding is detected. This solution allows for quick response, enhancing road safety, and provides a cost-effective, scalable method for improving traffic monitoring and enforcement.

LIST OF ABBREVIATIONS ACCRONYMS AND SYMBOLS

DC: Direct Current

GSM Global System for Mobile communication

SMS: Short Message Service

TTL: Transistor-Transistor Logic

GPS: Global positioning system

LCD: Liquid Crystal Display

GNU: Not Unix

LGPL: Lesser General Public License

GPL: General Public License

DIY: Do It Yourself

I/O: Input/output

USB : Universal Serial Bus

IDE: Integrated Development Environment

TV: Television

LED**:** Light Emitting Diode**.**

GND: Short for 'Ground'

PWM: Pulse Width Modulation.

AREF**:** Analog Reference

RX: Receive

TX**:** Transmit

GPRS: Global Packet Radio Service

IMEI: International Mobile Equipment Identity

SIM: Subscriber Identity Module

PCMCIA: Personal Computer Memory Card International Association**.**

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CHAPTER ONE: GENERAL INTRODUCTION

1.1. Background of the study

The issue of vehicle over-speeding has become a significant concern in urban areas, contributing to a high rate of road accidents and fatalities. Current methods for detecting and controlling over-speeding often rely on traditional methods such as radar systems and manual patrols, which have limitations in terms of efficiency and real-time responsiveness. In response to these challenges, there is a growing interest in leveraging mobile communication technologies, specifically SMS alerts, to enable proactive measures by traffic police. SMS alerts can potentially provide instantaneous notifications to authorities, allowing them to intervene promptly and enforce traffic regulations effectively.

1.2. Problem Statement

Despite existing measures, the timely detection and response to over-speeding incidents by traffic police remain inadequate. This inefficiency contributes to increased road safety risks and challenges in maintaining traffic discipline. Therefore, there is a pressing need to explore innovative solutions that can enhance the capability of traffic police to receive real-time alerts about over-speeding vehicles and respond promptly.

1.3. Project Objectives

1.3.1. General Objective

To evaluate the feasibility and effectiveness of implementing an SMS-based system for vehicle over-speeding alerts to traffic police.

1.3.2. Specific Objectives

- Review existing literature on methods and technologies for detecting vehicle over-speeding.
- Develop a prototype system for SMS-based over-speeding alerts.
- Assess the performance and reliability of the prototype system in real-world scenarios.
- Identify challenges and propose recommendations for improving the implementation of SMS alerts for over-speeding detection.

1.4. Research questions

- What are the current challenges faced by traffic police in detecting and responding to vehicle over-speeding incidents?
- How effective are SMS alerts in providing timely notifications to traffic police about over-speeding vehicles?
- What technological and operational factors need to be considered for the successful implementation of SMS-based over-speeding alert systems?

1.5. Choice of the study

The study is significant as it aims to improve road safety by enabling quicker responses to over-speeding incidents, potentially reducing accidents and improving traffic management efficiency. By exploring the feasibility of SMS-based alerts, the study also contributes to advancing the integration of mobile technologies in traffic management practices.

1.6. Interest of the project

1.6.1. Personal interest

Conducting this study requires skills in software development, data analysis, and knowledge of traffic management systems. It also involves understanding the practical implications of integrating SMS technology into existing traffic control frameworks.

1.6.2. Social interest

Implementing SMS-based over-speeding alerts has broader societal benefits, including reducing road accidents, minimizing traffic congestion, and enhancing public safety. By addressing these issues, the study aligns with public policy goals aimed at improving overall quality of life and urban mobility.

1.6.3. Academic interest

“Design and Implementation of SMS Based on Vehicle Over Speeding Alert to Traffic Police" could have several academic interests and contributions.

Here are some key points of focus that could be included:

- ✓ Enhancing the University’s Research Reputation
- ✓ Practical Impact on Society
- ✓ Innovation and Industry Collaboration
- ✓ Development of New Curriculum or Courses
- ✓ Showcasing Student Talent and Capability
- ✓ Opportunities for Further Research or Prototyping
- ✓ Contributing to Government and Policy Development
- ✓ Media and Public Attention

1.7. Scope of the project

1.7.1. Time scope

The project "Design and Implementation of SMS-Based Vehicle over speeding Alert to Traffic Police" is divided into several phases, each with specific tasks and timeframes:**Table of time scope:**

Phase	**Specific Task**	**Timeframes**	**Work to be done**
1	Project Planning and Research	2-3 weeks	1. Conduct a literature review, 2. Define the project scope, finalize objectives, and identify necessary technologies. 3. Deliverables include a research paper, project proposal, and technical specification.
2	System Design and Architecture	**2-3** weeks	1. Design the system architecture, including hardware and software components, and develop a database schema. 2. Deliverables include the system design document and architecture diagram.
3	Development of Hardware and Software Components	4-6 weeks	1. Set up hardware components, develop software for speed detection, and

			implement the SMS notification system. 2. Deliverables include a functional prototype and working code.
4	System Integration and Testing	**2-3** weeks	1. Integrate and test the system, ensuring hardware and software work together. 2. Deliverables include a testing report and optimized code.
5	Evaluation and Optimization	**1-2** weeks	1. Gather feedback, evaluate performance, and optimize the system for reliability. 2. Deliverables include an evaluation report and optimized system.
6	Final Documentation and Presentation	**1-3** weeks	1. Document the entire project and prepare the final presentation. 2. Deliverables include a final report and presentation slides.
Total Estimated Time		12-18 weeks (3-4 months)	Depending on project complexity and available resources.

1.7. 2. Conceptual scope

The dissertation focuses on implementing SMS technology to help traffic police prevent accidents involving passenger cars. The study will utilize information from the Rwanda National Police's traffic department. The project will primarily take place at HANIKA AIP, with a visit to the Nyanza police station (DPU). We believe this initiative will significantly reduce road accidents caused by speeding, addressing the prevalent issue of traffic incidents in Rwanda and supporting the national police's efforts in traffic management.

I.8. Organization of Project

The dissertation will be structured into chapters that include:

- Introduction (including background, problem statement, and research questions)
- Literature Review (reviewing existing literature on over-speeding detection methods and SMS technology in traffic management)
- Methodology (detailing the approach to developing the SMS-based alert system and conducting the evaluation)
- Results and Discussion (including implications, limitations, and future research directions)
- Conclusion and recommendations (summarizing findings and recommendations)

CHAPTER TWO: LITERATURE REVIEW

2.1. Definition of the key words:

Design: In the context of a project, system, or product, design refers to the process of planning and creating a blueprint or structure for how the system will work. This involves defining the system's architecture, components, interfaces, and overall user experience. The design phase sets the foundation for building a product or system, outlining the key features and specifications.

Implementation: Is the phase where the actual development or construction of the product, system, or solution occurs. In software or technology development, it involves writing the code, creating the infrastructure, and executing the plans laid out during the design phase. It is the process of making the design come to life, translating conceptual ideas into tangible and functional output.

A Vehicle Over Speeding Alert: Is a notification or warning system that alerts the driver or fleet manager when a vehicle exceeds a predefined speed limit. This alert can be triggered by various methods, such as GPS tracking, onboard sensors and is often part of a broader vehicle monitoring or fleet management system. The alert aims to improve safety, reduce the risk of accidents, and promote adherence to speed regulations.

A Traffic Police: Is a law enforcement officer who is responsible for maintaining order and safety on roadways. Their duties typically include enforcing traffic laws, directing traffic, preventing accidents, issuing citations for violations (such as speeding, running red lights, or driving under the influence), and responding to traffic-related incidents. Traffic police also play a key role in accident investigations and ensuring that road users, including pedestrians, cyclists, and motorists, follow the rules to ensure the safe flow of traffic.

2.2. Effectiveness in Reducing Speeding Incidents:

Existing research demonstrates positive outcomes in terms of reducing speeding incidents, enhancing traffic management, and facilitating proactive enforcement.

Outcome: Prompt SMS alerts to traffic police enable quicker response times to potential safety hazards, thereby reducing the likelihood of accidents caused by over speeding.

2.2.1. Improvement in Traffic Management:

Real-time data provided by SMS alerts contributes to better traffic management strategies.

Outcome: Traffic police can use the information to deploy resources effectively, optimize traffic flow, and target enforcement efforts where they are most needed.

2.2. 2.Challenges and Limitations

The challenges and limitations when working on the dissertation **"Design and Implementation of SMS Based Vehicle Over Speeding Alert to Traffic Police"** include:

Technical Challenges:

- Integrating hardware (sensors, GPS) and software (SMS system) smoothly.
- Ensuring real-time, accurate speed detection and instant alerting.
- Maintaining SMS system reliability, especially in areas with poor network coverage.

1. **Operational Challenges**:

- Ensuring timely and accurate responses from traffic police.
- Scaling the system across larger areas or regions.
- Overcoming human factors like training police to handle alerts properly.

2. **Legal and Privacy Issues**:

   - Addressing privacy concerns related to vehicle location and speed data.
   - Complying with local traffic laws and regulations.

3. **Design and Implementation Limitations**:

   - Managing costs of hardware, software, and ongoing maintenance.
   - Creating a user-friendly interface for police officers.
   - Dealing with data management issues, such as storage and processing.

2.2.3. Accuracy and Reliability:

- The accuracy of speed measurements, whether from GPS or sensors, is crucial for the effectiveness of SMS-based alert systems.
- **Outcome**: Challenges include occasional inaccuracies due to technical limitations or environmental factors, which may lead to false alerts or missed violations.

2.2.4. Integration with Existing Infrastructure:

- Integrating SMS-based alert systems with existing traffic management and law enforcement infrastructure can pose challenges.
- **Outcome**: Issues related to compatibility, scalability, and cost-effectiveness need to be addressed for widespread adoption.

2.3 Independent Variables

These are the factors or elements that influence the implementation and performance of the SMS-based over-speeding alert system:

2.3.1. Speed Detection Technology

This refers to the tools used for detecting over-speeding vehicles, such as radar sensors, cameras, or GPS-based speed monitoring systems.

Impact: The accuracy, precision, and reliability of speed detection directly affect the system's performance in identifying speed violations.

2.3.2.SMS Notification System

The efficiency of the SMS platform used to send alerts to traffic police (e.g., network reliability, system responsiveness, and coverage).

Impact: A more reliable SMS system ensures that alerts reach traffic officers promptly, increasing the system's effectiveness in law enforcement.

2.3.3. Traffic Monitoring Infrastructure

This refers to the existing traffic cameras, sensors, or speed traps integrated with the SMS-based system.

Impact: A robust infrastructure can improve the detection and reporting of speeding incidents, ensuring better enforcement of traffic laws.

2.3.4. Data Processing Unit (Speed Monitoring and Analysis Software)

The software or algorithms that process speed data, compare it with speed limits, and trigger alerts when over-speeding is detected.

Impact: The accuracy and speed of data processing directly affect the timeliness and reliability of alerts.

2.3.5. Communication Network Coverage

The quality and range of mobile network services (e.g., 4G/5G) that support the transmission of SMS alerts to traffic police.

Impact: A wider, more stable network ensures that alerts are delivered without delays, even in remote areas.

2.3.6. Driver Behavior Monitoring System (Optional)

This refers to any supplementary system used to track and monitor driver behaviors (e.g., using vehicle GPS to track location or driving patterns).

Impact: The incorporation of more detailed data allows the system to provide more specific alerts and feedback to traffic officers, improving decision-making.

2.4. Dependent Variables:

These are the outcomes or results that the SMS-based over-speeding alert system aims to achieve:

2.4.1. Effectiveness of Traffic Law Enforcement

Definition: The ability of traffic police to enforce speed limits and take timely action against over-speeding violations.

Impact: The more accurate and timely the alerts, the more effectively traffic laws can be enforced.

2.4.2. Reduction in Over-Speeding Incidents

Definition: The decrease in the frequency of vehicles exceeding speed limits after the system is implemented.

Impact: The system is expected to reduce speeding violations through real-time alerts, acting as a deterrent to drivers.

2.4.3. Response Time of Traffic Police

Definition: The time taken for traffic police to respond to an over-speeding alert.

Impact: Faster and more reliable alerts can reduce response times, allowing officers to take immediate action and prevent accidents.

2.4.4. Road Safety Improvement

Definition: The overall impact on reducing accidents and fatalities caused by speeding.

Impact: By addressing over-speeding promptly, the system aims to improve road safety, reducing the likelihood of accidents and injuries.

2.4.5. System Usability and Efficiency

Definition: The ease of use and efficiency of the system in terms of alerting officers and reducing manual intervention.

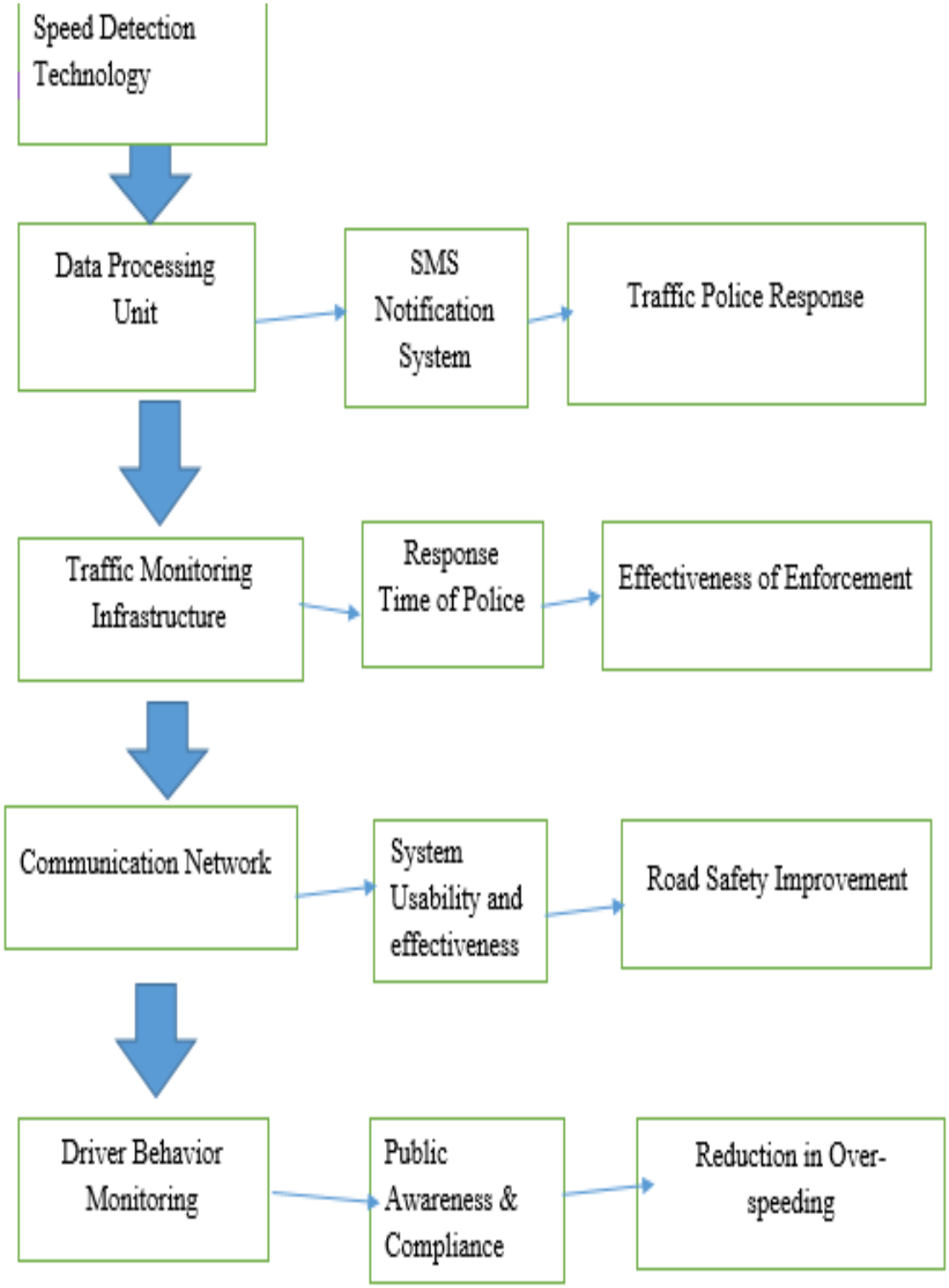
Impact: A user-friendly and efficient system minimizes human error and ensures smooth operations, making the entire process more effective.

2.4.6. Public Awareness and Compliance

Definition: The level of awareness among drivers regarding the speed alert system and their voluntary compliance with speed limits.

Impact: Increased public awareness can lead to better compliance with speed limits, as drivers will know that there are automated monitoring systems in place.

2.5.Conceptual framework



COMPARISON BETWEEN FIXED SPEED CAMERA AND SMS BASED ON VEHICLE OVERSPEEDING ALERT TO TRAFFIC POLICE

FIXED SPEED CAMERA	SMS BASED ON VEHICLE OVERSPEEDING ALERT TO TRAFFIC POLICE
➢ Fixed-location system. Only detects speeding where cameras are installed.	➢ Can function **anywhere** the vehicle goes (assuming mobile or GPS integration), making it **mobile and dynamic**.
➢ Involves processing visual data and images to determine speed and identify vehicles.	➢ Focuses on processing alert data and managing the SMS notifications to ensure timely delivery.
➢ Useful for post-incident law enforcement and statistics.	➢ Useful for **live monitoring**, enforcement, and possibly even **accident prevention**.
➢ It passively captures overspeeding vehicles using radar and camera systems, typically without real-time communication to police unless manually reviewed or integrated with central systems.	➢ Actively sends a real-time **SMS alert** to traffic police when a vehicle exceeds the speed limit, enabling quicker action and potentially live intervention.
➢ Typically static and reactive. It records data but doesn't automatically trigger any enforcement or communication.	➢ More **proactive**—it can be integrated with a GPS or onboard speed detection system that detects and reports the violation **as it happens**.
➢ High infrastructure and maintenance cost—cameras, poles, wiring, data storage, etc.	➢ Lower cost—primarily involves sensors in the vehicle, mobile communication modules (like GSM), and SMS gateway services.

CHAPTER THREE: MATERIALS AND METHODS

3.1. Introduction

Methodology is the systematic theoretical scientific analysis of methods applied to gather all necessary information to accomplish this project report. We used the following technics in this project preparation. Documentation, interview, observation, internet

3.2. Documentation

For this method of data collection, I used the engineering books especially electronic engineering books, automotive engineering books and searching information from Rwanda National Police especially traffic police department.

3.3. Interview

This project needs more specialization, I use the direct conversation face to face with automotive technicians, traffic police and passengers about vehicle over speeding. After expressing our project to them, they told us this system is the best one because it will solve the vehicle over speeding problems especially road accidents and vehicle cost.

3.4: Internet

In this method of data collection of data collection, I visited different websites in order to get more information about our project.

3.5: Observation

This is the way how we made a research by watching behaviors of vehicles in the roads. In this way, we observed the passenger cars which make tours through the roads of Nyanza, Kigali, Nyanza, and Rusizi, we saw how they move with high speed that cause some accidents thus the death of many people such as drivers, passengers etc. After doing our observation, we prefer to make this project which will help to reduce the accidents occur due to vehicle over speeding

3.6: Research design

The design will be composed by the following components: speed sensor, speedometer, Arduino Uno, global system for mobile communication (GSM), SIM card and GPS.

3.7 Data analysis

The variables to be analyzed, processed and presented are those found to be most relevant to the objectives of the study. Required data will be analyzed, based on data which will be collected from internet, interview and engineering books…

3.8 Limitations of the study

In the realization of the study the researchers find time as a challenges due to study will be done at the same time during industrial attachment period, in addition there will be difficulty for gathering materials as it requires market experience and much money

From the above proposed challenges, the researchers will work hard in order to cover everything in a suitable time also the researchers will find sponsor for solving the issue of money and gathering materials will be done as soon as possible to avoid any delay that would be caused of market problem.

3.9. Instruments and materials

Instruments and materials used for investigating are the following;

- Computer(pc)
- Pens
- Note books
- Sound recorder
- Car
- Printer
- Population

CHAPTER FOUR: CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This project of implementing traffic police SMS based accidents prevention for passenger cars is concerned with description, soldering, programming, and assembling.

As Rwanda we are a country of thousand hills our roads have many corners, not only high slopes but also very small and we haven't the high way for high speed vehicles. Due to those situations the Rwanda national police have been set the regulations for the vehicle speed limit in order to prevent and reduce the road accidents.

This project will send the information to Rwanda national traffic police of the passenger car that traveling beyond the speed limit in order to prevent and reduce the road accidents.

4.2. Results and discussions

The traffic police SMS based accidents prevention for cars and commercial vehicles is presented by different components such as speedometer, Arduino Uno, GPS and GSM module, all those are presented under with depth information about it.

4.3. Speedometer

A speedometer is a gauge that measures and displays the instantaneous speed of a vehicle. There are two types of speedometers: electronic and mechanical. Because the **electronic speedometer** is actually a relatively new invention

4.3.1. Mechanical speedometers

Here's what we want out of our speedometer. We have the car's wheels rotating at a certain speed and we want to know, with a simple pointer and dial, what that speed is. So we need to connect the spinning wheels to the pointer in some clever fashion.

Even that is pretty tricky: the wheels are racing around but the pointer, some distance away, merely flicks back and forth. How do we convert continuous, spinning motion into intermittent, pointer motion? The answer is to use electromagnetism! The shaft that turns the car's wheels is connected to the speedometer by a long, flexible cable made of twisted wires. The cable is a bit like a mini driveshaft: if one end of the cable rotates, so does the other even though the cable is long and bendy.

At the top end, the cable feeds into the back of the speedometer. When it rotates, it turns a magnet inside the speedometer case at the same speed.

The magnet rotates inside a hollow metal cup, known as the speed cup, which is also free to rotate, though restrained by a fine coil of wire known as a hairspring. However, the magnet and the speed cup are not connected together: they're separated by air. The speed cup is attached to the pointer that moves up and down the speedometer dial.

How does it all work? AS the speedometer cable rotates, it turns the magnet at the same speed. The spinning magnet creates a fluctuating magnetic field inside the speed cup and, by the laws of electromagnetism that means electric currents flow inside the cup as well. In effect, the speed cup turns into a kind of electricity generator. But, unlike in a proper generator (the kind that makes electricity for your home in a power plant), the currents in the speed cup have nowhere to go: there's nothing to carry their power away. So the currents just swim about uselessly in swirling eddies we call them eddy currents for that very reason.

Since they're electric currents, and they're moving in an electrical conductor inside a magnetic field, another law of electromagnetism says they will create motion. The currents actually make the speed-cup rotate in such a way that it tries to catch up with the spinning magnet. But the hairspring stops the cup from rotating very far so it just turns a little bit instead, pulling the pointer up the dial as it does so. The faster the car goes, the faster the cable turns, the quicker the magnet spins, the bigger the eddy currents it generates, the greater the force on the speed cup, and the more it's able to pull the pointer up the dial. If you can't picture all that clearly, take a look at the figure

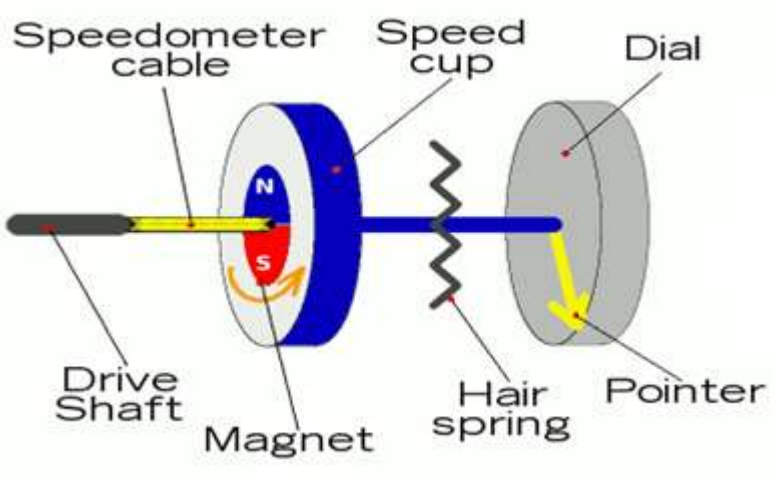


Figure 1: Mechanical speedometer

4.3.2. Electronic speedometers

Electronic speedometers work in a completely different way. Small magnets (1) attached to the car's rotating drive shaft sweep past tiny magnetic sensors (2) (either reed switches or Hall-effect sensors) positioned nearby. Each time the magnets pass the sensors, they generate a brief pulse of electric current. An electronic circuit (3) counts how quickly the pulses arrive and converts this into a speed, displayed electronically on an LCD display (4).

Since the circuit is measuring the number of wheel rotations, it can also keep a count of how far you've traveled, doubling-up as an odometer (distance-measuring meter). Electronic speedometers can also display speeds with analog pointers and dials, just like traditional eddy-current speedos: in that case, the electronic circuit drives a highly controllable electric motor (called a stepper motor) that rotates the pointer through an appropriate angle.

Electronic speedometers are more reliable and compact than mechanical ones and the motion sensors can be any distance from the display that shows you your speed, making them suitable for any kind of vehicle from a bicycle to a 40-ton truck as shown in figure 2.

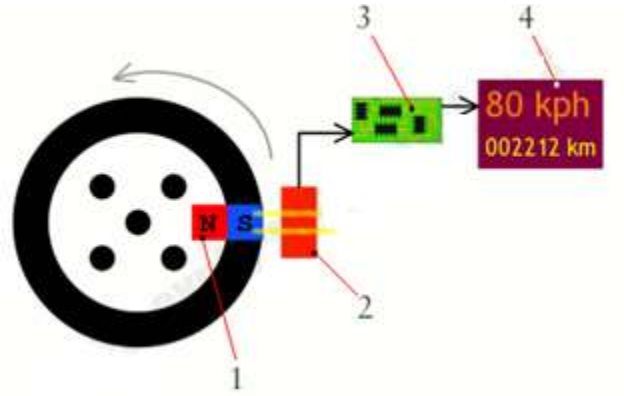


Figure 2: Electronic speedometer

4.4. Arduino Uno

Arduino uno is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators.

Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

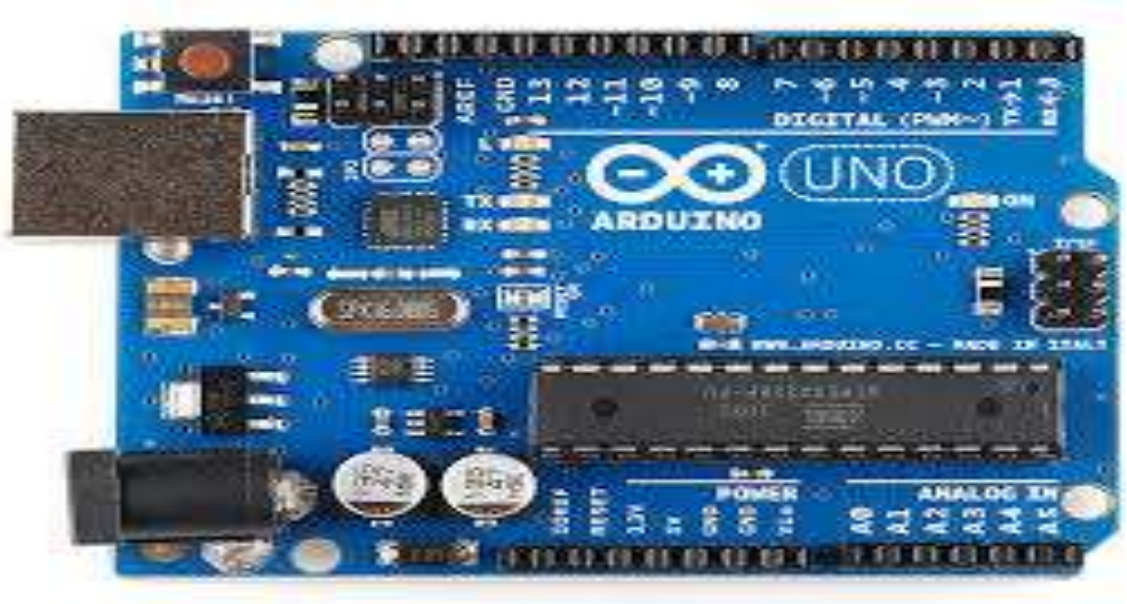


Figure 3: The Arduino

4.4.1: Applications

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV, this flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a **huge** variety of Arduino-based projects. The Arduino can be used as the brains behind almost any electronics project.

4.4.2. The Arduino's components

There are many varieties of Arduino boards that can be used for different purposes. some boards look a bit different from the one below, but most Arduinos have the majority of these components in common.

4.4.2.1. Power (USB / Barrel Jack)

Figure 4: Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the figure2.3 the USB connection is labeled **(1)** and the barrel jack is labeled **(2).** The USB connection is also how you will load code onto your Arduino board. More on how to program with Arduino can be found in our Installing and Programming Arduino tutorial.

NOTE: Do not use a power supply greater than 20 Volts as you will overpower (and thereby destroy) Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts. Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF). The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjunction with breadboard and some wire). They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

GND : Short for ‘Ground’. There are several GND pins on the Arduino, any of which can be used to ground your circuit.

5V (4) & 3.3V (5): As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

Analog (6): The area of pins under the ‘Analog in’ label (A0 through A5 on the UNO) is Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.

Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).

AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Just like the original Nintendo, the Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn’t repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn’t usually fix any problems.

4.4.2.3. Power LED Indicator

Just beneath and to the right of the word “UNO” on your circuit board, there’s a tiny LED next to the word ‘ON’ **(11)**. This LED should light up whenever you plug your Arduino into a power source. If this light doesn’t turn on, there’s a good chance something is wrong. Time to re-check your circuit!

Figure 5: Power LED Indicator

RX LEDs TX

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we’re loading a new program onto the board).

4.4.2.4. Voltage Regulator

The voltage regulator is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says,It controls the amount of voltage that is let into the Arduino board. Think of it is a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts as shown in figure 3.

Figure 6: Voltage Regulator

4.4.2.5. GSM Module

GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer. GSM/GPRS MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM and GPRS network.

It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification.

Figure 7: GSM Module

A GSM/GPRS MODEM can perform the following operations:

- Receive, send or delete SMS messages in a SIM.
- Read, add, search phonebook entries of the SIM.
- Make, Receive, or reject a voice call. [6]

The communication between Arduino and GSM module is serial. So we are supposed to use serial pins of Arduino (Rx and Tx). You may connect the TX pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino.

Now connect the ground pin of Arduino to ground pin of GSM module! So that's all! You made 3 connections and the wiring is over! Now you can load different programs to communicate with GSM module and make it work.

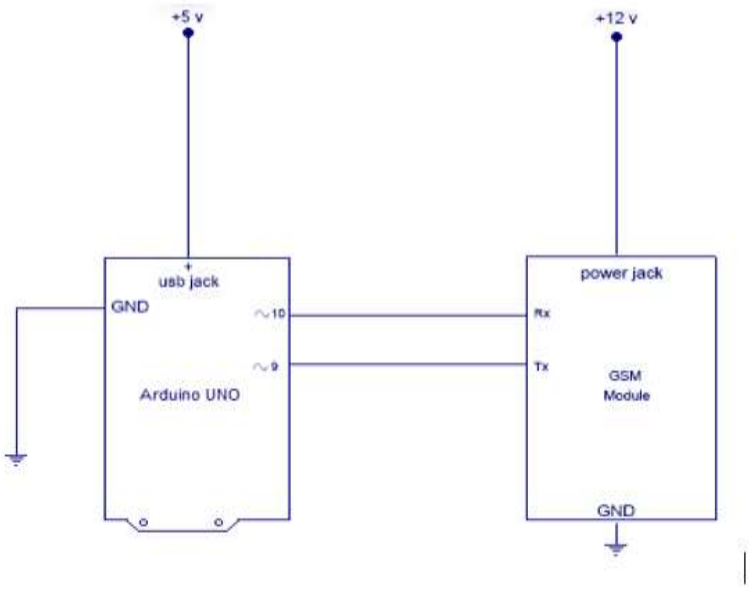


Figure 8: Circuit diagram to connect GSM to Arduino

4.4.2.6. GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

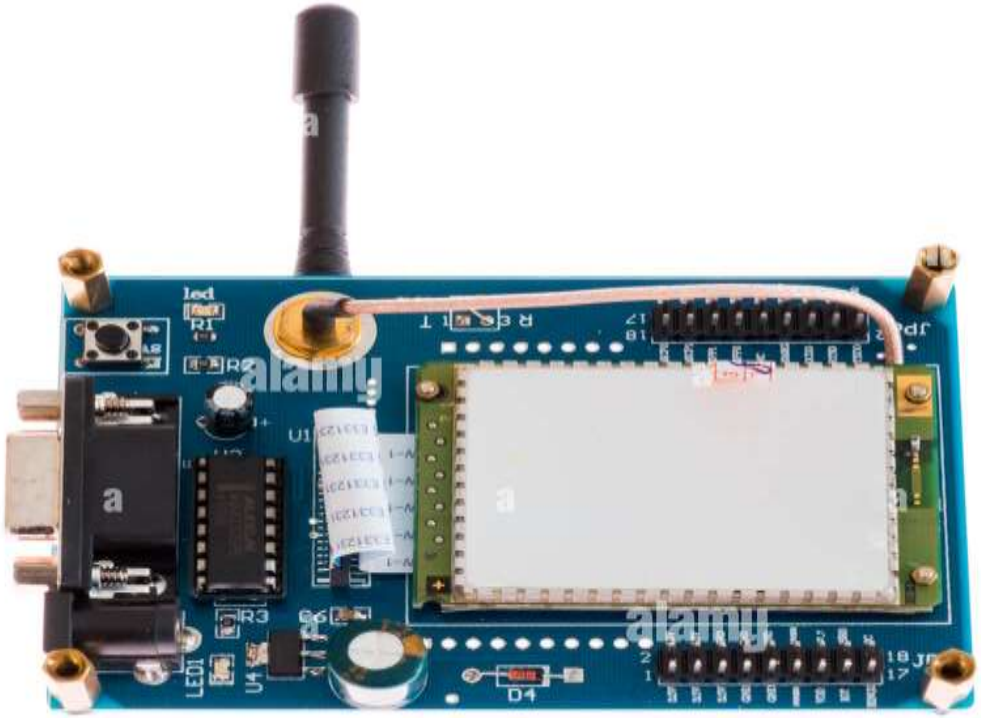


Figure 9: GSM Modem

4.4.2.7. Subscriber Identity Module (SIM)

One of the key features of GSM is the Subscriber Identity Module (SIM), commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as SIM locking, and is illegal in some countries.

Figure 10: Subscriber Identity Module (SIM)

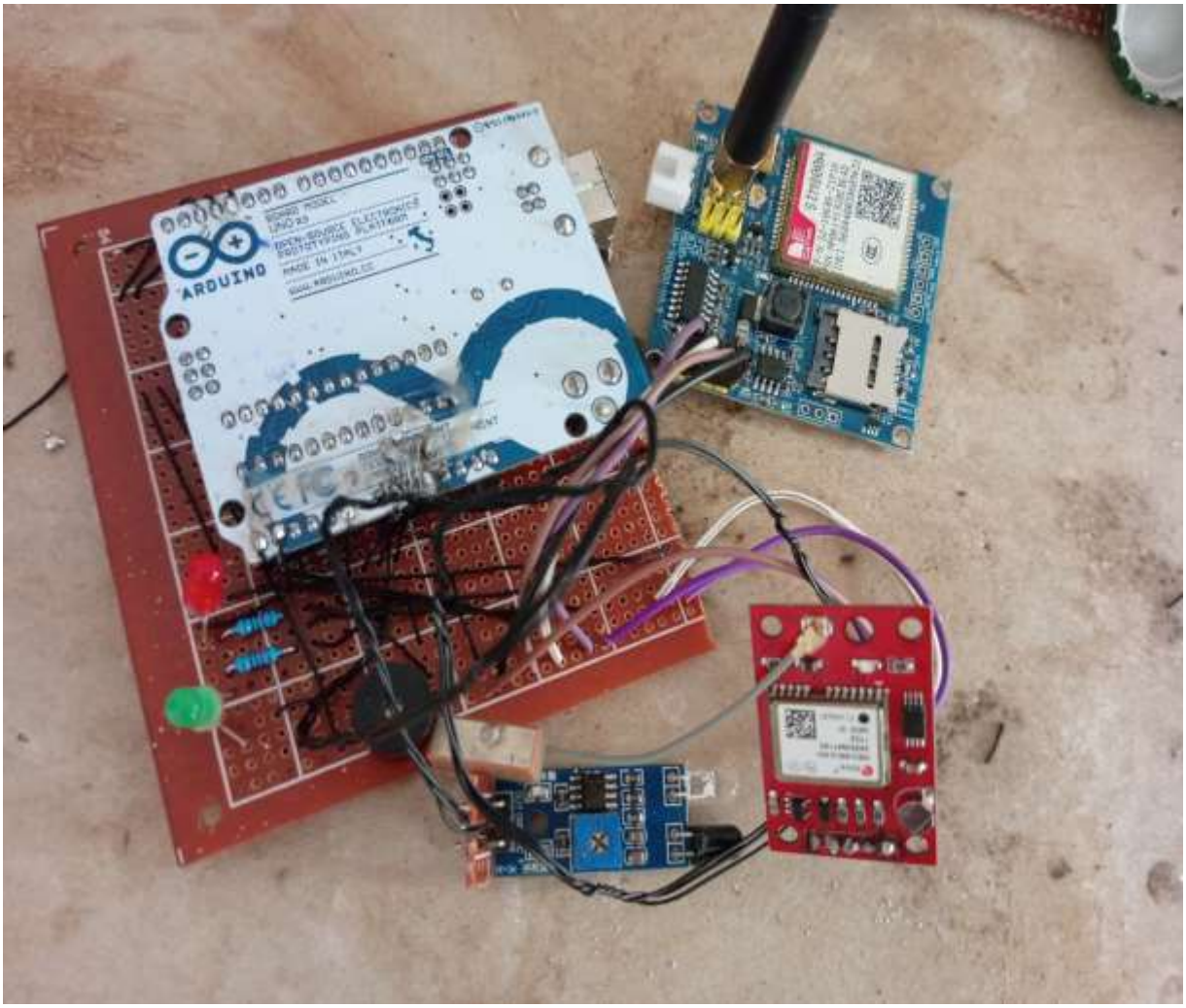
4.5. The power requirements of GSM module

GSM modules are manufactured by different companies. They all have different input power supply specs. You need to double check your GSM modules power requirements. In this tutorial, our GSM module requires a 12 volts input. So we feed it using a 12V,1A DC power supply.

4.6. Check for TTL Output Pins in the module

You can feed the data from GSM module directly to Arduino only if the module is enabled with TTL output pins. (Transistor-Transistor Logic)

4.7. Circuit of the Project



CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The DESIGN AND IMPLEMENTATION OF THE SMS-BASED VEHICLE OVERSPEEDING ALERT TO TRAFFIC POLICE system marks a significant advancement in monitoring traffic violations, particularly speeding, on roadways. This study has shown that SMS technology can facilitate real-time alerts to traffic police officers when a vehicle exceeds the speed limit, promoting a more proactive approach to enforcing traffic regulations. The system aims to minimize human intervention in traffic monitoring, enhance enforcement efficiency, and potentially decrease the number of accidents attributed to speeding.

This system effectively integrates GPS-based speed tracking, automated message generation, and immediate communication with law enforcement, which are crucial for improving the

responsiveness of traffic policing. By utilizing existing mobile phone networks and basic SMS technology, the proposed solution provides a cost-effective alternative for regions with limited access to sophisticated traffic monitoring infrastructure.

The prototype developed in this study has yielded promising results, demonstrating that its real-time notification feature could significantly improve the ability of traffic police to respond swiftly to speeding incidents. Nonetheless, further testing and real-world implementation are necessary to evaluate the system's scalability, reliability, and effectiveness across various traffic conditions and environments.

5.2. Recommendations

5.2.1. Recommendations for Traffic Police

Adopt and Integrate the System into Daily Operations: It is recommended that traffic police departments adopt the SMS-based vehicle over speeding alert system to enhance real-time enforcement of speed limits. The system will enable quicker responses and more efficient traffic law enforcement, potentially reducing road accidents caused by speeding.

Training and Capacity Building: Traffic officers should undergo training to effectively use the system. This includes familiarization with the SMS alert system, understanding its functionalities, and integrating it into their routine operations to ensure prompt and accurate enforcement.

Enhance Collaboration with Other Agencies: Collaborate with other government agencies, such as road safety authorities and the Ministry of Infrastructure, to strengthen the enforcement of road safety laws, and consider expanding the system to other types of traffic violations in the future.

Periodic System Evaluation: The traffic police should regularly evaluate the performance and reliability of the SMS-based alert system to ensure that it remains effective in detecting and responding to over speeding incidents.

5.2.2. Recommendations for the Government of Rwanda

Support System Implementation Nationwide: The government should invest in the nationwide implementation of the SMS-based over speeding alert system. This would support the broader objective of improving road safety and reducing traffic-related accidents, aligning with Rwanda's commitment to enhancing infrastructure and public safety.

Infrastructure Development: The government should ensure the development of the necessary infrastructure for the system to function effectively. This includes strengthening mobile network coverage in rural and remote areas, as well as ensuring that law enforcement officers have the necessary tools to respond to alerts promptly.

Legislative and Policy Support: The government should enact or update policies and regulations that support the use of technology for traffic monitoring and enforcement. This includes integrating the SMS alert system into the broader traffic management framework and ensuring that the legal framework supports such innovations.

Public Awareness Campaigns: The government should launch public awareness campaigns to educate the public about the system's existence and benefits, encouraging drivers to adhere to speed limits, knowing that real-time monitoring is in place.

5.2.3. Recommendations for Motor Vehicle Drivers

Compliance with Traffic Laws: Drivers are encouraged to strictly adhere to speed limits and traffic regulations to avoid fines or penalties. Awareness of the SMS-based alert system should serve as an additional motivation for responsible driving behavior, which will contribute to safer roads for all.

Education on Road Safety: Drivers should be educated on the importance of road safety and the role they play in reducing accidents caused by over speeding. Road safety campaigns can be initiated to emphasize the importance of following speed limits for personal and public safety.

Use of Technology: Drivers should be encouraged to use available in-car technology, such as GPS speed tracking devices or mobile apps, to monitor their own speed and prevent accidental over speeding.

5.2.4. Recommendations for Automobile Owners

Equip Vehicles with Speed Monitoring Technology: Automobile owners should consider equipping their vehicles with GPS-based speed monitoring devices or smart speed alerts that can provide feedback to drivers in real time, ensuring they are always aware of their speed and avoid over speeding.

Promote Safe Driving Practices: Owners should promote safe driving practices within their families and among their employees, especially if they own fleet vehicles. This can include providing training or implementing policies that encourage adherence to speed limits.

Maintain Vehicle Safety Standards: Automobile owners should regularly maintain their vehicles to ensure they are in optimal condition for safe driving. Proper vehicle maintenance, including functional brakes and tires, plays a critical role in safe driving and reducing accidents

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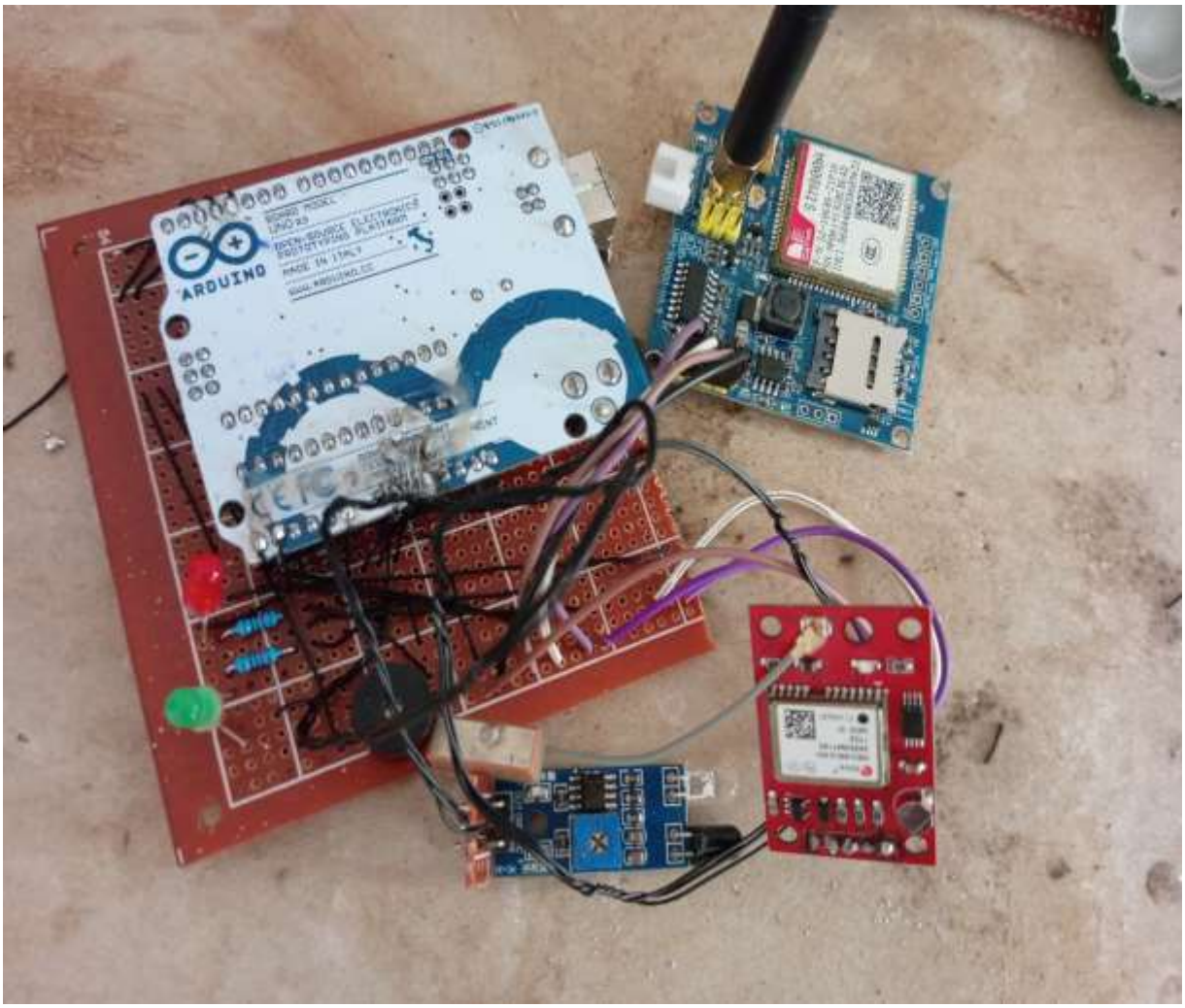
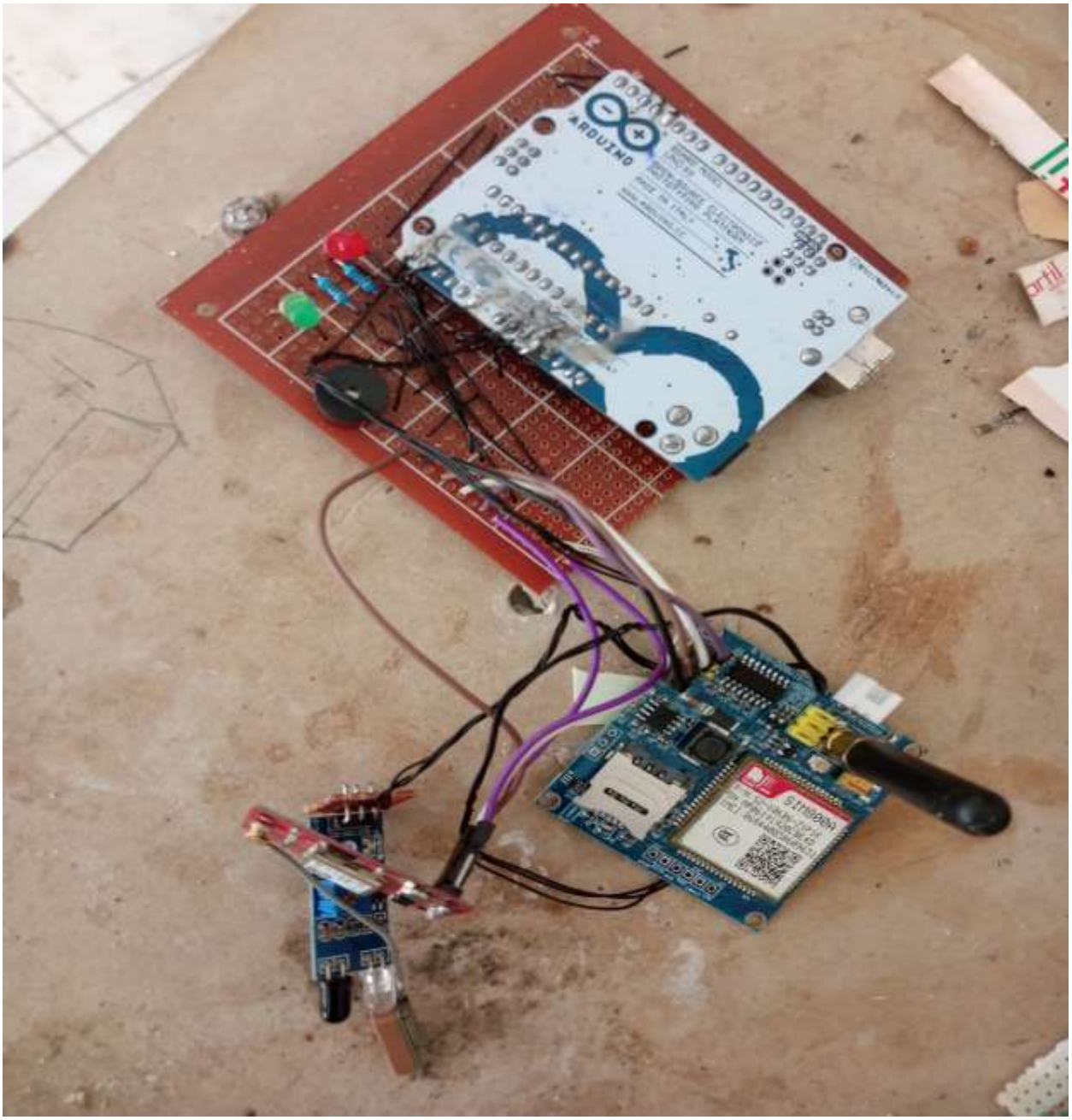
APPENDICES

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