Study Of Causes Of Traffic Collisions And Development Of Traffic Anti-Collision System In Rwanda

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Abstract: Road traffic accidents are the major causes of death by injury and are in the ten causes of deaths globally now make up a significant portion of the worldwide burden of ill-health. An estimated 1.2 million people are killed in road accidents each year, and about 50 million are injured, occupying 30 percent to 70 percent of orthopedic beds in developing countries hospitals. And if the current trends continue, road traffic injuries are predicted to be the third-leading contributor to the global burden of disease and injury by 2050. More than 85% of all deaths and 90% of disability adjusted life years lost from road traffic injuries occur in developing countries. Road traffic injuries in developing countries particularly affect the productive age group (15-44 years) and children. Among children aged 0-4 and 5-14 years, the number of fatalities per 100 000 population in low income countries was about six times greater than in high income countries in 1998. Rwanda National Police data showed that 128 persons were killed by motorcycles accidents, 81 killed by public transport vehicles, 81 killed by voiture and pickups and 61 were killed by truck and Lorries and the total deaths were 351 persons in 2015 and the police reported that 80% of these accidents were caused by human errors such as substance abuse reckless driving, wrong maneuvers, violation of right of way, speeding, use of cell phones while driving and wrong overtaking, among others. However, Studies and engineered technologies to address roads accidents are at early stage or lacking in developing countries. This work contributes to highlighting this prevailing burden and the need of comprehensive solutions that could weigh down traffic accidents which are creating enormous economic hardship due to the loss of family breadwinners and property damages.

Keywords: Reckless Behaviors, Road Traffic Accidents, Traffic Injuries, Traffic Anti-Collision System

1. Introduction

All of the significant achievements in history, the car is most in all likelihood the only which considerably modified human life. The periodical improvement in technology gives human race a new height. Within the later years after independence, the number of motors finally expanded however within the closing a long time it spreads considerably in each level of the society for this reason safety and protection becomes the primary challenge. Street accidents account an extreme danger to the lives in both areas of concern of an engineer must be protection, because it worries the use of his/her innovations and the accompanying risks due to human boundaries. in terms of the use of a motor automobile, injuries that have come about through the years inform us that something wishes to be executed approximately them from an engineering point of view and that is the automobile collision mitigation machine that consists of sensors manipulate and actuators to avert and take action for any detected collision [2]. The Anti-Collision system is to be made from relatively cheaper components for green procurement and incorporation. This research aims at the layout of a prototype displaying how this system will look like. The principle goal is to find a manner to enforce a minimum spacing between cars to cars, cars to pedestrians, cars to walls , cars to motorbikes, cars to bicycles, cars to animals among others , along to reap protection of all road users. The anti-collision tool, whilst stressed out into the circuitry of a vehicle might assist in research in designing a green and sustainable automobile and driver assisting system [1]. Its miles expected that if the sort of tool is designed and integrated into our vehicles as a road safety device, it will lessen the incidence of injuries on our roads and various premises, with next discount in lack of life and belongings. However, a major area of concern of an engineer must be protection, because it worries the use of his/her innovations and the accompanying risks due to human boundaries. in terms of the use of a motor automobile, injuries that have come about through the years inform us that something wishes to be executed approximately them from an engineering point of view and that is the automobile collision mitigation machine that consists of sensors manipulate and actuators to avert and take action for any detected collision [2]. The Anti-Collision system is to be made from relatively cheaper components for green procurement and incorporation. This research aims at the layout of a prototype displaying how this system will look like. The principle goal is to find a manner to enforce a minimum spacing between cars to cars, cars to pedestrians, cars to walls , cars to motorbikes, cars to bicycles, cars to animals among others , along to reap protection of all road users. The anti-collision tool, whilst stressed out into the circuitry of a vehicle might assist in
the reduction of street mishaps. Though no longer can every form of collision be helped by means of this, and it should be said right here that no allusion is being made that technology is the great line of action to take. It must be in addition stated that some already current laws made use of technologies like avenue lighting fixtures and traffic lights. This will be a supplementation and not an alternative [3]. The idea of incorporating radar systems into vehicles to improve road traffic safety dates back to the 1970s. Such systems are now reaching the market as recent advances in technology have allowed the signal processing requirements and the high angular resolution requirements from physically small antennas to be realized. Automotive radar systems have the potential for a number of different applications including adaptive cruise control (ACC) and anti-collision devices. The problem with this brand of cars is that they are expensive. This becomes an even bigger challenge when you consider a developing country like Rwanda. Anti-collision devices are the electronic systems that use sensor technology to record every obstacle present in the direction of driving and generates electronic signal that is processed by the controller to avert a driver of an imminent collision and to help him take a preventative action [3]. Technology has been revolutionized not only to ease a daily work of mankind but also to ensure his safety, securing his life and properties. Vehicles have been using hydro-mechanical brake at the most profound and some improvements have been developed and still need to develop to improve safety.

2. Research Elaboration

2.1. Traffic Accidents Status Globally and in Rwanda

The number of road traffic deaths continues to rise steadily, reaching 1.35 million in 2016. However, the rate of death relative to the size of the world’s population has remained constant. When considered in the context of the increasing global population and rapid motorization that has taken place over the same period, this suggests that existing road safety efforts may have mitigated the situation from getting worse. However, it also indicates that progress to realize Sustainable Development Goal (SDG) target 3.6 – which calls for a 50% reduction in the number of road traffic deaths by 2020 – remains far from sufficient [22].

![Figure 1: Number and rate of road traffic death per 100,000 population: 2000–2016.](image1)


In 2015, 245 accidents involving public transport vehicles were occurred and killed 91 people while 408 others sustained injuries, a police report states [10]. Police said reckless driving, wrong maneuvers, a violation of the right of way, speeding, use of cell phones while driving and wrong overtaking, among others, caused that most of these accidents. The net underwriting losses for private insurers stood at Rwf4.3 billion ($5 million) as at December 2017 and the current minimal wage used as a basis for compensating accident victims is the biggest contributor to the losses; we are not tapping out millions of property losses when collisions take place [10]. Rwanda National Police data showed that motorcycles accidents killed 128 persons, 81 killed by public transport vehicles, 81 killed by voitures and pickups and truck and Lorries killed 61 and the total death will be 351 persons in 2015 [10].

2.2. Methodology

Under this section, we have discussed on design procedure, population, data collection and description of the project.

2.2.1. Design procedure

To realize the project; we have collected accidents data from the national police, world health organization and the national institution of statistics of Rwanda, Rwanda transport development agency to know exact figures of people dying day to day by traffic accidents in Rwanda and on the globe at large. We have also conducted a survey with the road users and companies in the automobile industry (automobilists, motorcyclists, transport agencies, cyclists and pedestrians) to record their daily challenges in roads and their different expectations and reactions to the anti-collision system. After this step, we shall start prototyping, test the prototype, analyze the results and correct errors, then run a trial as a small company towards expansion and a full setup.

2.2.2. Population

Rwanda is a country in Central and East Africa, located a few degrees south of the Equator has the current population of 12,374,397 with 183,703 registered vehicles in 2016. The University Teaching Hospital of Kigali (CHUK) reports that it receives an average of 2250 accident cases every year with motorcycle injuries accounting 70%. [16]

![Figure 2: Evolution of registered vehicles in Rwanda Source: the atlas, 2018.](image2)
Table 1: Number of different types of public transport vehicles and their passenger carrying capacity in year 2009.

<table>
<thead>
<tr>
<th>Type of vehicle operator</th>
<th>Number of Vehicle</th>
<th>% of Vehicle</th>
<th>Passenger capacity/ Vehicle</th>
<th>Total passenger Carrying capacity</th>
<th>% of passenger Carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>110</td>
<td>0.8%</td>
<td>51 to 80</td>
<td>5,162</td>
<td>7.1%</td>
</tr>
<tr>
<td>Medium Bus</td>
<td>588</td>
<td>4.5%</td>
<td>25 to 33</td>
<td>16,271</td>
<td>22.5%</td>
</tr>
<tr>
<td>Minibus</td>
<td>2,163</td>
<td>16.6%</td>
<td>18</td>
<td>38,934</td>
<td>53.9%</td>
</tr>
<tr>
<td>Taxi Cab</td>
<td>579</td>
<td>4.4%</td>
<td>4</td>
<td>2,326</td>
<td>3.2%</td>
</tr>
<tr>
<td>Motorbike</td>
<td>9,909</td>
<td>73.6%</td>
<td>1</td>
<td>9,909</td>
<td>13.3%</td>
</tr>
<tr>
<td>Total for all vehicles</td>
<td>13,049</td>
<td>100.0%</td>
<td></td>
<td>72,292</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 2: Roads accidents: number of victims and died persons by kinds of vehicles

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td>700</td>
<td>884</td>
<td>902</td>
<td>585</td>
<td>132</td>
<td>129</td>
<td>123</td>
</tr>
<tr>
<td>Public transport Vehicles</td>
<td>292</td>
<td>642</td>
<td>457</td>
<td>499</td>
<td>540</td>
<td>635</td>
<td>459</td>
</tr>
<tr>
<td>Voitures and Pickups</td>
<td>308</td>
<td>636</td>
<td>393</td>
<td>288</td>
<td>640</td>
<td>496</td>
<td>346</td>
</tr>
<tr>
<td>Truck and Lorries</td>
<td>602</td>
<td>108</td>
<td>126</td>
<td>79</td>
<td>104</td>
<td>61</td>
<td>167</td>
</tr>
<tr>
<td>Tractors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 3: Distribution of passenger carrying capacity of different types of public transport vehicles in Rwanda in 2009

2.2.3. Data collection

1) Statistical data for accidents in Rwanda
The table below shows the roads accidents from different vehicles from the year 2009-2015. While gathering inputs from all who will be intact with the system, data was collected from: the road users including pedestrians, motorcyclists, drivers, companies and institutions in the transport sector their traffic challenges were almost the same reflecting to the causes such as overtaking, over speeding, driver’s inattention and so on and so forth. Most of participants showed that solutions to address traffic accidents are in need in Rwanda and in the world over. [10]

Table 2: Roads accidents: number of victims and died persons by kinds of vehicles

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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 4: Top ten causes of death among people aged between 15 29 years, 2012 globally.


2.2.4. Design of Traffic Anti-Collision System
The working principle of the proposed anti-collision system refers to the below figure. When the driver is driving, the sensor records the presence of people, cars, animals, walls and or materials generates and feed the signal to microprocessor and the latter communicates to the controller, then the controller actuates the stepper motor to decelerate the car.

Figure 5: Traffic Anti-Collision system

Components
- Power supply: provides electrical power.
- Motor driver controller: controls the stepper motor.
- Arduino: processes the input signal from sensor to determine the required output to controller.
- Ultrasonic sensor: converts physical obstacle into electronic signal to feed Arduino.
- Stepper motor: provides the torque required to adjust pedals mechanism thus retarding the speed.

Program codes

```c
Void loop ()
{
    Long dur,inc,cm;
pinMode(tpin,OUTPUT);
digitalWrite(tpin,LOW);
delayMicroseconds(2);
digitalWrite(tpin,HIGH);
delayMicroseconds(10);
digitalWrite(tpin,LOW);
pinMode(epin,INPUT);
dur=pulseIn(epin,HIGH);
cm=MicrosecondsToCentimeters (dur);
Serial.print(cm);
Serial.print(" cm");
Serial.printIn();
if ( cm>5&&cm<=20&&a==0)
{
pizo();
steppfwd1 ();
a=a+1;
}
if ( cm>20&&a==1)
{
stepbwd1 ();
a=a+1;
}
if ( cm>21&&cm<=100&&b==0)
{
pizo ();
steppfwd2 ();
b=b+1;
}
if ( cm>100&&b==1)
{
stepbkwd2 ();
b=b+1;
}
longMicrosecondsToCentimeters(long Microseconds)
{
return Microseconds/29/2;
}
```

3 Cumulative Results and Discussions

The sensor is assumed to be installed on the car’s bumper, when driving it records physical conditions and reports the electronic signal to Arduino which also compares it with preset values to feed input to the motor driver controller and the latter adjusts the pedal mechanisms to decelerate the car in relation to the obstacle.

**Condition 1:** When the obstacle is present between 5 cm and 20 cm, the stepper motor is commanded to quickly turn in forward direction allowing for primary auto brake if the driver does not act.

**Condition 2:** If an obstacle is recorded in the distance between 21 cm to 100 cm, the stepper motor still moves in forward direction will a reduced speed. Medium auto brake action.

**Condition 3:** If the sensor records an obstacle in the distance above 100 cm, the stepper motor reverses the direction with implication that at this range no brake action is required. The distance, at which the auto brake is to be applied depends on the capacity (sensing range) of sensor utilized, the more the range goes higher, the higher safety degree could be achieved.

4 Conclusion

Today’s increasing traffic accidents are bringing much attention to the world to design new technologies that will help restore human safety in roads and reduce driving constraints that lead to death, injuries and properties damage. The Study of causes of traffic collisions and development of traffic anti-collision system in Rwanda is one of the key mitigation measures and highlights the real accidents cases as well as the effort needed to drive down these prevailing issues.

Future Work

Since now it is clear that traffic accident cases are prevailing and are in urgent need to be addressed in Rwanda and in developing countries, Further studies are needed to upscale this contribution and be able to achieve a full controlled mobility and roads safety by 2030, and this underscores the sense of traction and viability as countries adopt E-mobility for zero emission and carbon neutrality by 2050.

5 References


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Author Profile

Dr. Venant Kayibanda got his ING.DR (PHD) MECHANICAL ENGINEERING at DON STATE TECHNICAL UNIVERSITY, RUSSIA, 2010. His Master of Science in Engineering, Specialization in Technology of Machines Building in 1996 and holds Bachelor Science in Engineering, Technology of Machines Building from Don State Technical University, Russia in 1995.

He is currently a Senior Lecturer at University of Rwanda since 2016 and prior to that he was a Postdoctoral Researcher at University of Yaoundé I. 2013-2016, a Senior Lecturer and Head of Mechanical Engineering Department at <Kiga Institute of Science and Technology (KIST). Facilitator of KTH (Sweden) Worldwide Online Master in Sustainable Energy Technologies program.