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BICYCLE COLLISION AVOIDANCE SYSTEM

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Abstract: Road traffic accidents have been recognized as one of those adverse elements which contribute to the suffocation of economic growth in the developing countries, due to the high cost related to them, hence causing social and economic concern, which are key pillars of vision 2030 of the government of Kenya. Previous endeavors to minimize bicycle accidents has been retarded by accidents caused by motorists on the road. This is reflected in an average yearly increase of 6.57 percent in the number of bicycle accidents in the year 2018. However, studies that have been conducted previously indicate that practicing prudent control of bicycle accidents has led to a decrease in the number of bicycle accidents. However, these studies never constructed and evaluated a bicycle collision avoidance system. Therefore this study sought to investigate the effect of the bicycle collision avoidance system on minimizing bicycle accidents. The specific objectives of this study were to increase reaction time of a bicycle when a vehicle is approaching so as to reduce bicycle accidents; to reduce number of accidents related to bicycles at night and to sustain proximity distance among road users so as to minimize bicycle accidents. The data was collected from Ogembo Omoringamu road, in Gucha town, Kisii County, Kenya. This study analyzed data using tabular and graphical analysis. Where the work of other authors was used, due acknowledgement was done. The researcher obtained a research permit from St Angela Sengera Girls' High school and Kenya Science and Engineering Fair in order to enable the collection of data. The bicycle collision avoidance system helps in increasing the reaction time of bicycles on approaching vehicles. The bicycle collision avoidance system also helps in monitoring the proximity distance of vehicles from the bicycle hence minimizing road accidents. This study recommends that the bicycle collision avoidance system be implemented across all bicycles, motor vehicles and motorcycles in order to minimize road accidents. This study recommends that the government implement this gadget on a large scale basis since road traffic accidents have been recognized as one of those adverse elements which contribute to the suffocation of economic growth in the developing countries, due to the high cost related to them, hence causing social and economic concern, which are key pillars of vision 2030 of the government of Kenya.

Index Terms – Arduino Uno microcontroller, Proximity Sensor, Kenya Vision 2030

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Bicycle accidents across the world have previously not been given much attention by the road and transport authority. Bicycle transport has been used as a mode of transport from the 18th century (Asingo, 2004). The number of cyclists that have been injured has been on the rise. For instance, in the year 2016, table 1.1 below shows the number of cyclist who were injured and those who died in the process (Allen & Singh, 2019). The

table below indicates a total number of 18, 472 people affected by accidents caused by motorcycles, hence necessitating a serious cause for alarm. Hence the current study will investigate the efficiency of the bicycle collision avoidance system constructed in this study to reduce bicycle accidents.

	Child 0-5	**Adults**	**All**
Killed	8	94	102
Seriously injured	309	3088	3397
Slightly injured	1664	13314	14978
Total	1981	16496	18472

Table 1.1: Cyclists injured and those who died in the process in the year 2018

The Kenyan government appreciates that road traffic injuries are a major public health problem amenable to prevention. Road Traffic accident is an unplanned occurrence of auto crash that may result in injuries, loss of lives and properties (Kual, Sinha, Pathak, Singh, Kopoor, Sharma, & Singh, 2005). In Kenya, the Public road transport accounts for about 45% of the bulk goods and passenger transport services (Odero & Kibosia, 2015). This may be seen to as a result of the convenience this transport mode of service renders to its users. Road traffic crashes occur in all continents and they are one of the major contributors of human deaths in Kenya (Duperrex, Roberts & Bunn, 2017). Education programs have been used to increase an individual`s ability to cope with traffic environment and so reduce injuries and it is usually at children with parents or teachers (Duperrex *et al*, 2017).

Fig 1.1: Bicycle accident

1.2 Statement of the problem

Road traffic accidents have been recognized as one of those adverse elements which contribute to the suffocation of economic growth in the developing countries, due to the high cost related to them, hence causing social and economic concern (Towner & Mytton, 2009). One of the major challenges faced today is the improvement of the quality of service in both urban and rural transportation systems in order to make them efficient and safe. Safe roads are key to protecting our investment in the road network, reducing the cost in the network; reducing the cost of doing business in the Kenyan economy; improving the welfare of households and retaining productive personnel in institutions and enterprises. In this regard, accurate and objective road safety data is key (Odero & Kibosia, 2015) observe that Kenya, with an average of 7 deaths from the 35 crashes that occur each day, has one of the highest road fatality rates in relation to vehicle ownership in the world. The majority of injuries suffered following road traffic crushes are of orthopedic concern (Asingo, 2004).

1.3 Objectives of the study

1.3.1 General Objective of the study

To construct a bicycle collision avoidance system that will help minimize bicycle accidents.

1.3.2 Specific Objectives of the study

i. To increase reaction time of a bicycle when a vehicle is approaching so as to reduce bicycle accidents.

ii. To reduce number of accidents related to bicycles at night.

iii. To sustain proximity distance among road users so as to minimize bicycle accidents.

1.4 Research Hypothesis

The bicycle collision avoidance system is the best method of controlling bicycle accidents.

1.5 Research question

What is the best method of controlling bicycle accidents?

1.6 Variables of the study

The independent variable of the study is Reaction time while the dependent variable is the bicycle type. Another independent variable of the study is number of accidents at night while the dependent variable is the bicycle type. The third independent variable of the study is number of bicycles observing a proximity distance of 5 meters while the dependent variable is the bicycle type.

1.7 Assumptions of the study

The proximity distance of the motor vehicles, bicycles and motor cycles from each other is 5 meters.

1.8 Scope of the Study

This study investigated the effect of the bicycle collision avoidance system on minimizing bicycle accidents. The study was carried out from the month of November to December, 2022 a period of one month. The study concentrated on the Ogembo Sengera road in Gucha sub county, Kisii County, Kenya.

1.9 Organization of the study

The study is divided into five chapters. Chapter one brings out the introduction to this study. This chapter will include the background of the study, the statement of the problem, the research objectives, the hypothesis, the significance, the scope and the limitations of the study. Chapter two will entail the Literature review of the study Chapter three of the study will have the research methodology of this study. Chapter 4 will include the Data analysis and discussion while chapter 5 will entail the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Empirical Literature Review

Gokulakrishnan and Ganeshkumar (2015) proposed an accident avoidance routing scheme named Road Accident Prevention (RAP). This scheme introduced the Early Warning (EW) message in order to make essential decisions—selecting alternate routes, slowing down the vehicle, and changing lanes. Furthermore, the Road Side Unit (RSU) detects any unusual activity in the highway scenario and broadcasts an Early Warning (EW) message to all the vehicles in the range of the RSU. In this way, the EW message must be sent at the exact time to prevent the road accident.

The authors introduced different types of risk zone, namely, high, average, and low risk zones. The high-risk zone comprises those vehicles that are nearest to vehicles that are involved in road accidents. The routing scheme successfully achieved less delay. However, the limitation of the proposed scheme was the high network processing overhead due to the extra warning message transmitted, the EW message and identification of the risk zone. Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense an approaching vehicle at a distance of 1 meter through a sensor.

Lozano, Barba, Igartua and Campo (2013) proposed the warning message scheme to avoid traffic accidents between vehicles by sending a warning message to alert drivers about the condition of the current accident. The proposed scheme used the distance-based flooding scheme. The author calculated the time of the vehicle's reaction after the occurrence of the accident in order to prevent further traffic accidents. The proposed routing scheme achieved the best high and low priority message dissemination in drastic weather conditions such as rain, and sun. However, the limitation of this routing scheme is that it does not work in a highly dense vehicular environment. Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense an approaching vehicle at a distance of 1 meter through a sensor.

Dawood and Wang (2013) proposed an accident avoidance scheme named the Efficient Emergency Message Broadcasting (EEMB) routing scheme. The objective of the proposed scheme was to reduce traffic bottlenecks and prevent multiple road accidents by broadcasting emergency messages with low overheads at high velocity. After an accident has occurred between two vehicles, the affected vehicle will select the best forwarder and broadcast the emergency message until the emergency message covers the whole risk zone.

The forwarding scheme achieved the minimal overhead caused by the beacon message by using the method of the early prediction system. However this bicycle collision avoidance system failed to overcome the problem of network fragmentation by using the mechanisms of store-carry and forward. Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense an approaching vehicle at a distance of 1 meter through a sensor.

2.2 Summary of Empirical Literature Review

Table 2.1 Summary of Empirical Literature Review

Author and Context of Study	Objectives	Findings	Knowledge gaps	Research gap filled by the current study
Gokulakrishnan and Ganeshkumar (2015)	Proposed an accident avoidance routing scheme named Road Accident Prevention (RAP). This scheme introduced the Early Warning (EW) message in order to make essential decisions—selecting alternate routes, slowing down the vehicle, and changing lanes.	The authors introduced different types of risk zone, namely, high, average, and low risk zones. The high-risk zone comprises those vehicles that are nearest to vehicles that are involved in road accidents. The routing scheme successfully	However, the limitation of the proposed scheme was the high network processing overhead due to the extra warning message transmitted, the EW message and identification of the risk zone.	Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense a n approaching vehicle at a distance of 1 meter through a sensor

		achieved less delay.		
Lozano, Barba, Igartua and Campo (2013).	Proposed the warning message scheme to avoid traffic accidents between vehicles by sending a warning message to alert drivers about the condition of the current accident.	The forwarding scheme achieved the minimal overhead caused by the beacon message by using the method of the early prediction system.	However, the limitation of this routing scheme is that it does not work in a highly dense vehicular environment.	Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense a n approaching vehicle at a distance of 1 meter through a sensor
Dawood and Wang (2013)	Proposed an accident avoidance scheme named the Efficient Emergency Message Broadcasting routing scheme. The objective of the proposed scheme was to reduce traffic bottlenecks and prevent multiple road accidents by broadcasting emergency messages with low overheads at high velocity.	The forwarding scheme achieved the minimal overhead caused by the beacon message by using the method of the early prediction system.	The beauty of this bicycle collision avoidance systems is that it failed to overcome the problem of network fragmentation	Therefore, the current study will investigate the construction of a bicycle collision avoidance system that is able to sense a n approaching vehicle at a distance of 1 meter through a proximity sensor

CHAPTER THREE

METHODOLOGY

3.1 Requirements

i. Structure
ii. Ultra-Sonic sensor
iii. Connecting wires
iv. Arduino Uno board
v. Buzzer & LED
vi. Display unit

3.2 Procedure

- The structure is what houses the components and is kept on the bike carrier.
- The ultra-sonic sensor keeps monitoring the proximity from the car and gives alerts depending on the distance.
- Connecting wires allow connection between the components. To transmit both voltage and signals.
- The Arduino Uno board acts as the project brain. It reads sensor inputs to give a desired output.
- The LED and buzzers give an audio-visual output. LED's in terms of light while buzzers in terms of sound.
- The display unit/ Liquid Crystal Display (LCD) gives a visual alert to the bike rider in a manner in which he can read it.

3.3 Block diagram

Fig 3.1 Block diagram

3.4 Observation

When there is no car, the LED lights green and the LCD informs the driver that he is safe. If a car starts getting close, the buzzer beeps and alerts the driver. The LCD also says a car is approaching. When it gets dangerously close, the red LED light comes on and the buzzer sound persists warning the rider. The LCD also tells him that the car is dangerously close.

Fig 3.1 Rear view, front view and three-dimensional view of the bicycle collision avoidance system

3.5 Limitations and constraints

- The limitation of the bicycle collision avoidance system is that it cannot be able to see through other parked vehicles or obstructing vehicles.
- Harsh environments that include obstacles can trigger false alarms.

3.6 Merits

The bicycle collision avoidance system will be important in enhancing the economic pillar of vision 2030 of the government of Kenya. This is possible in that it will aid in minimizing bicycle accidents which lead to loss of lives and income hence impoverishing the country. The Highway and Road Authority commission stands to benefit a lot from this study in regards to the managing of the roads. They could be able to consider an incorporation of findings obtained from this study to minimize road accidents by installing this gadget on bicycles, vehicles and even motorcycles. This study will also provide a very great input to the researchers. The results and recommendations from this study will be an eye opener to various researchers to venture into road transport as road hazards have been minimized.

CHAPTER FOUR

DATA AND DATA DISCUSSION

4.1 Data collection

This involved a descriptive cross-sectional study of 10 bicycles with the gadget and 10 bicycles without the gadget for a period of 1 month. The experiment was done at night since most bicycles do not have hazards or headlights, so they are not easily spotted by other motorists at night. The data collected is presented in form of tables and graphs.

4.2 Data analysis

Table 4.1 Reaction time of bicycles to an approaching vehicle

Type of Bicycle	Average reaction time when approaching vehicle is 2m from the bicycle (seconds)
Bicycles with gadget	1
Bicycles without gadget	3

Table 4.2 Number of Bicycle accidents at night

Type of Bicycle	Number of accidents at night
Bicycles with gadget	1
Bicycles without gadget	5

Table 4.3 Proximity Distance (1 meter) observation

Type of Bicycle	Number of bicycles observing Proximity Distance
Bicycles with gadget	10
Bicycles without gadget	3

Fig 4.1 Reaction time of bicycles to an approaching vehicle

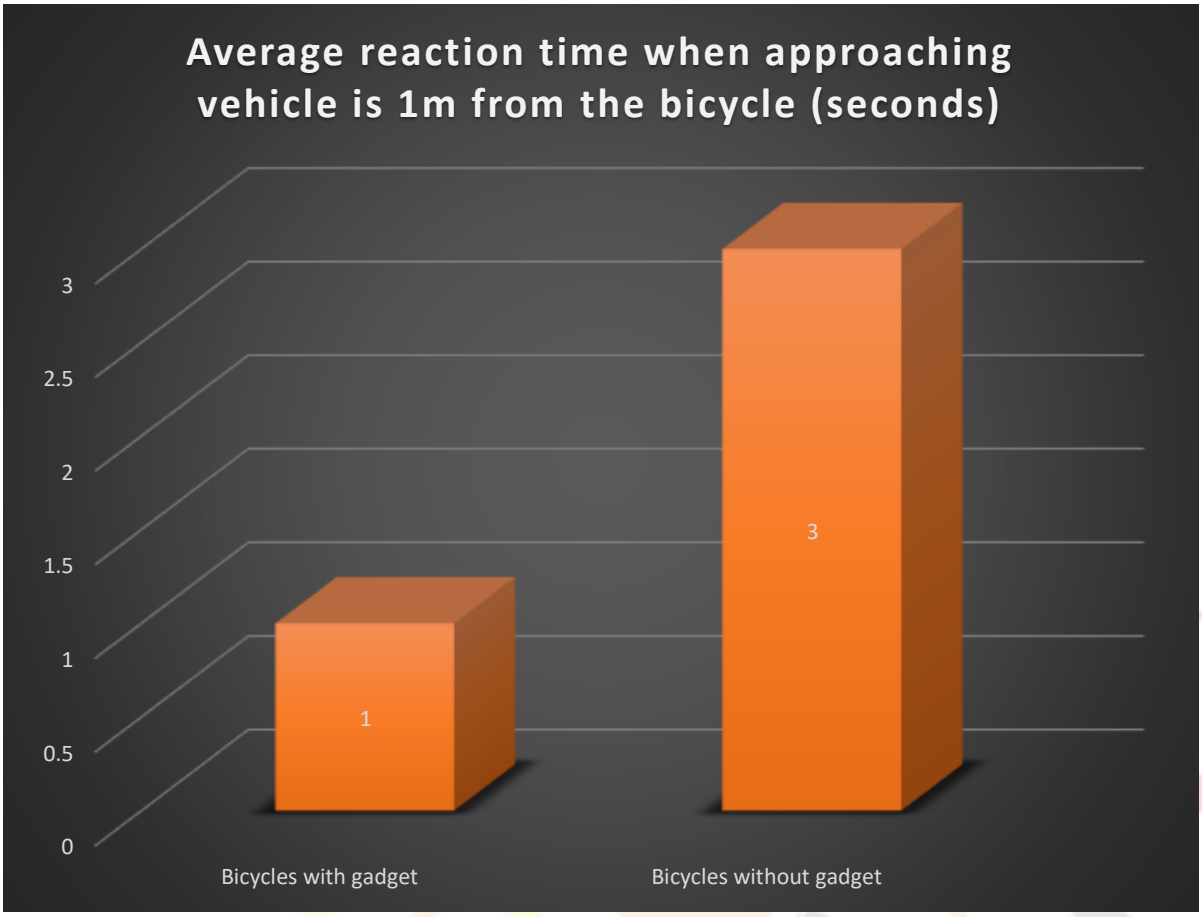


Fig 4.2 Number of Bicycle accidents at night

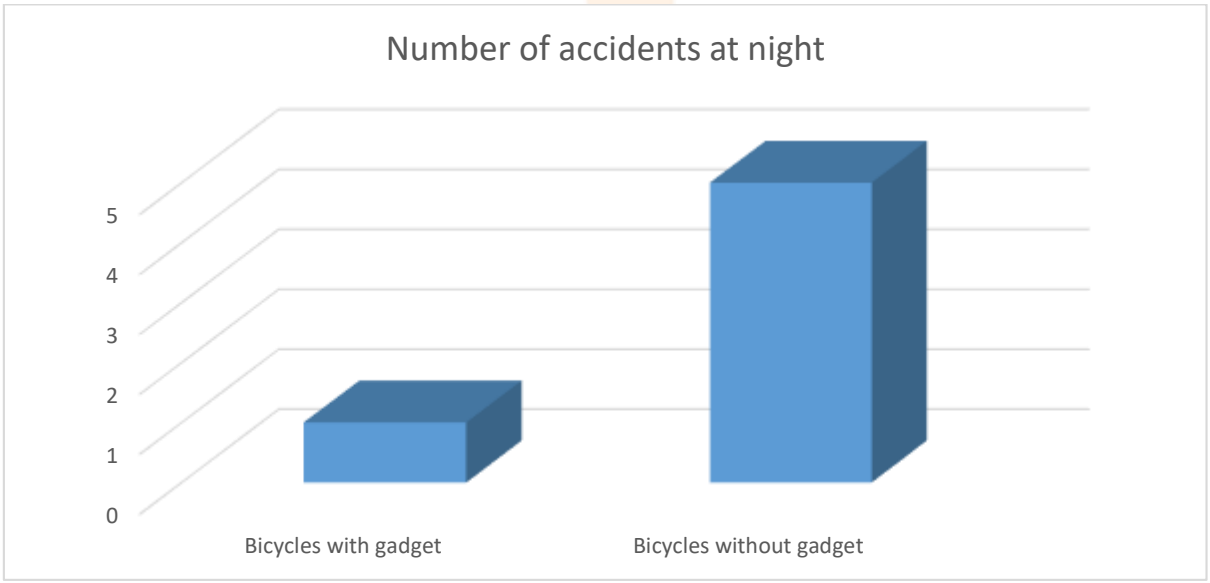
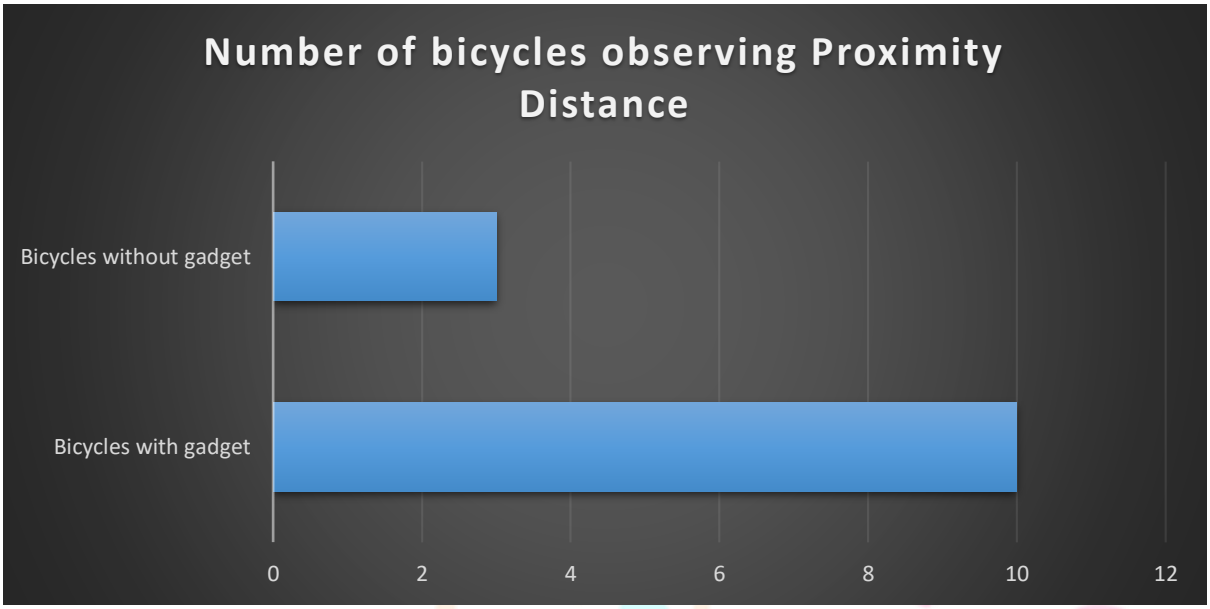


Fig 4.3 Proximity Distance (5 meters) observation



4.3 Data Discussion

From the results obtained in Table 4.1 and Fig 4.1, the average reaction time taken for bicycles without the gadget to detect an approaching vehicle is 3 seconds while the average reaction time taken for bicycles without the gadget to detect an approaching vehicle is 1 second. These results indicate that the bicycle collision avoidance system helps in increasing the reaction time of bicycles on approaching vehicles.

From the results obtained in Table 4.2 and Fig 4.2, the number of accidents occurring at night for bicycles without the gadget is 83.33 percent while the number of accidents occurring at night for bicycles with the gadget is 16.67 percent These results indicate that the bicycle collision avoidance system helps in reducing the number of bicycle accidents which occur at night.

From the results obtained in Table 4.3 and Fig 4.3, the number of bicycles with the gadget observing proximity distance is 77 percent while the number of bicycles without the gadget is 23 percent. These results indicate that the bicycle collision avoidance system helps in monitoring the proximity distance of vehicles from the bicycle hence minimizing road accidents.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the results observed in chapter IV above, the bicycle collision avoidance system helps in increasing the reaction time of bicycles on approaching vehicles. The bicycle collision avoidance system also helps in monitoring the proximity distance of vehicles from the bicycle hence minimizing road accidents. The study finally concludes that the bicycle collision avoidance system helps in monitoring the proximity distance of vehicles from the bicycle hence minimizing road accidents. With this data, the study has proved the hypothesis, answered all the research questions and achieved all the specific objectives.

5.2 Recommendations

This study recommends that the bicycle collision avoidance system be implemented across all bicycles, motor vehicles and motorcycles in order to minimize road accidents. This study recommends that the government implement this gadget on a large scale basis since road traffic accidents have been recognized as one of those adverse elements which contribute to the suffocation of economic growth in the developing countries, due to the high cost related to them, hence causing social and economic concern, which are key pillars of vision 2030 of the government of Kenya.

5.3 Future Adjustments

This study in future plans to install CCTV technology on the bicycle collision avoidance system in order for the owner of the bicycle technology to see a vehicle approaching from behind.

The study will also increase the distance of sensitivity by investing in a sensor that can sense a larger distance.

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APPENDICES

APPENDIX I: LETTER TO THE RESPONDENT

Dear Respondent,

I am currently a teacher at St Angela Sengera Girls' High School, Kenya. My Science club students are currently carrying out a research study on a project whose topic is:

"BICYCLE COLLISION AVOIDANCE SYSTEM".

I therefore request for your information and cooperation in this exercise. All information will be treated with confidentiality.

Yours with regard

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