Social and environmental equity in the improvement of rural accessibility with ICT support

Equidad social y Ambiental en el mejoramiento de la accesibilidad rural con apoyo de las Tic´s

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Abstract

Nowadays there are many traffic accidents due to lack of attention and excessive traffic when driving, which, as a consequence, puts the lives of some people at risk. This is caused by several factors, among them, the lack of respect for traffic signals and traffic lights. The present project proposes a small-scale prototype of an automatic detection system to help control drivers of vehicles that do not respect the red light of the traffic signal. This autonomous system consists of 2 sensor devices and 2 alarms, the function of the first sensor is to detect the movement of a vehicle at the moment of running the red light, and immediately the two alarms are activated, the first alarm is located in the place where the infraction is committed, to alert the other drivers and pedestrians, and the second alarm located further ahead, which helps to alert the other drivers and pedestrians that are in that place.

Keyword: Traffic lights, alarms, streets, vehicles, prevention.

Resumen

En la actualidad existen muchos accidentes de tránsito por la falta de atención y el exceso de tráfico a la hora de conducir, por lo cual, como consecuencia, se pone en riesgo la vida de algunas personas, esto es ocasionado por varios factores, entre ellos, la falta del valor respeto a las señaléticas de tránsito y semáforos. El presente proyecto propone un prototipo a pequeña escala de un sistema de detección automático para ayudar al control de los conductores de vehículos que no respeten la luz roja del semáforo. Este sistema autónomo consiste en 2 dispositivos sensores y 2 alarmas, la función del primer sensor es detectar el movimiento de un vehículo al momento de pasarse la luz roja, e inmediatamente se activan las dos alarmas, la primera alarma está ubicada en el lugar donde se comete la infracción, para alertar a los demás conductores y peatones, y la segunda alarma ubicada más adelante, la cual ayuda a alertar a los demás conductores y peatones que se encuentra en ese lugar.

Palabras clave: Semaforización, alarmas, calles, vehículos, prevención.

Introduction

In the central countries, local development is the response of localities and regions to a global challenge. This phenomenon, which took place in the 1980s, developed both in its economic dimension (loss of state autonomy, economic restructuring, adjustment policies, relocation of companies, horizontal-territorial exchange schemes) and in its cultural dimension (weakening of national identity, privileging of the local). (Paolo, 2014).

In the research "Acceptance and appropriation of traffic rules that protect the pedestrian by drivers in the city of armenia (Quindío)", (Rojas, 2018) aims to make an approach that allows understanding the level of acceptance and appropriation of traffic rules that protect the pedestrian by drivers in the city of Armenia (Quindío) within the research line of Management and Public Policy as a scenario of knowledge construction from the territorial development and understanding of the concrete reality in aspects such as citizen coexistence, participation and administrative presence in the exercise of public power from the collective imaginary of the city. In this research, all these basic aspects of understanding are described -in an approximate manner- in order to propose an approach that allows analyzing in context the citizen appropriation of traffic regulations and how these are immersed in the behaviors and habits of drivers and pedestrians.

According to (Ospina, 2021) in his study and proposal of an intelligent traffic light model as a solution to mobility problems in Bogotá, he indicates that the growth of vehicular mobility has increased assiduously, but in contrast, the resources provided for the development of road infrastructure are very limited, and this has manifested itself in scenarios where the volume of traffic in one or more points of a route exceeds the maximum volume circulating through them. Consequently, intelligent traffic control is a

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very important instrument in the future to control traffic congestion and thus favor the quality of life of the inhabitants, the environment and the economy of the city.

(Caiza, 2016) in his study indicates that the design and construction of a prototype of an intelligent traffic light system is intended to perform a simulation that allows to appreciate the benefits generated by the programming of the system in terms of vehicular mobility in one of the streets with the highest traffic demand in the city of Quito; For the development of the TT we applied the use of ATmega microcontrollers that represent the control part and end up being the brain of the system to act according to the existing traffic situation, the ATmega microcontrollers control the traffic lights, in a first stage in a synchronized manner, so that the traffic lights in normal hours work under the system called green waves.

On the other hand (Riofrío, 2018), focuses on the simulation of an adaptive traffic light system, aimed at controlling the duration times of traffic light phases, directly linked to the number of vehicles on the road, always giving preference to the route with the highest number of motorists, through image processing.

Traffic accidents that occur in Ecuador are caused by many factors, for example: disrespect to traffic signals by drivers or pedestrians. "Art. 270 of the General Regulation of the Traffic Law provides: 'At all times drivers are responsible for their safety, the safety of passengers and the safety of other road users. Drivers have a great responsibility on themselves and on the other road users when driving their vehicle, one of these responsibilities is to respect the traffic light. (Perez , 2018).
The city of Quevedo is one of the places where traffic accidents caused by disrespect to traffic lights are frequent, the main cause of this is the indifference of respect, but it is also worth mentioning that the lack of knowledge of traffic laws has a great influence. The same social culture with respect to vehicular traffic laws lacks responsible traffic education, not only in drivers but also in pedestrians. People do not respect zebra crossings and cross wherever they need to, drivers of cars, motorcycles and even bicycles do not usually respect red and yellow lights, many of them when faced with a yellow light that means "slow down" make the grandiose maneuver of accelerating, thus crossing the red light with great speed (Chiriboga, 2015).

The purpose of this project called "Automatic detection system of disrespect to the traffic lights on Walter Andrade Avenue and 1st Street in the canton of Quevedo", is to develop a prototype system that automatically detects vehicles that disrespect the traffic lights in that place, so that through the use of motion sensors and sound alarms, located respectively in strategic locations in the area, allow the detection of vehicles that disrespect the traffic lights, The system will be located in strategic locations in the area, allowing the detection of vehicles that disrespect the traffic lights, and the warning alert to prevent traffic accidents in the place where the traffic light is located and also in the next corner where the vehicle that disrespected the traffic light will cross.

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Materials and methods

In this research, the inductive method allowed asking questions for the correct orientation during the development of the research, for example: How can a moving vehicle be detected while the red light of the traffic light is on; how can audible alarms be activated to alert other drivers and/or pedestrians on the road when a vehicle runs the red light; what devices will allow the deactivation of alarms when the driver who committed the infraction stops his vehicle; what devices will allow the deactivation of alarms when the driver who committed the infraction stops his vehicle?

The direct observation used in this study allowed us to learn more about the problem and thus gather information to analyze and find solutions to detect drivers who do not respect the traffic lights. This study was conducted at the traffic light located on Walter Andrade Avenue and 1st Street in the parish of 7 de Octubre in the canton of Quevedo, due to several factors such as lack of attention, traffic control and recklessness of drivers.

The application of the deductive method has allowed suggesting a solution based on everything observed, diagnosed and described in this research work, making it possible to deduce that the problem arose due to the driver's recklessness in not respecting the red light of the traffic light. Since there is no traffic agent, a prototype of an electronic system is established to improve this situation and prevent traffic accidents.

In order to obtain the pertinent information regarding the cases of disrespect to the traffic lights, all the inhabitants of commercial establishments and homes located in the 4 blocks surrounding the traffic lights on Walter Andrade Avenue and 1st Street in the parish of 7 de Octubre were taken as a strategic population. It was strategically considered that from these premises and homes it is possible to visualize daily traffic at the traffic light, a total of 15 homes and premises, of which 8 commercial premises, 4 of them who do not work constantly were not considered, and the other 4 have little time working at the site, were not considered either. Therefore, interviews were conducted in the remaining 7 locations.

As a primary source, several interviews were conducted with the inhabitants of homes and businesses located in the 4 blocks surrounding the intersection of Walter Andrade Avenue and First Street in the parish of 7 de Octubre in the canton of Quevedo, with the purpose of having a reliable source to corroborate the disrespect to the traffic lights in this area, this population was selected because they are located in places from where traffic can be observed at the traffic lights.

A bibliographic research was conducted on the legal documentation of the "REGLAMENTO TÉCNICO ECUATORIANO RTE INEN 004 PART 5 SEÑALIZACIÓN VIAL PARTE 5 SEMAFORIZACIÓN" (Ecuadorian Institute of Standardization, 2012).The purpose of this study was to learn about the legal specifications regarding disrespect for traffic signals (secondary source). Similarly, several research projects conducted by various authors were reviewed, one of them called "Legal argumentation to sanction traffic disputes and its constitutional impact on due process" (Chiriboga, 2015), in which

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information was found on the current status of the cultural behavior of the citizens drivers of Quevedo, with respect to traffic laws and respect for traffic signals.

Results

These are the results of the interviews conducted with the residents of Walter Andrade Avenue and 1st Street in the parish of 7 de Octubre in the canton of Quevedo. The interviewees have been living in this sector for between 6 months and 20 years. As can be seen in the graph, 100% of the interviewees, that is, 7 people mentioned that many times there are cases of disrespect to the traffic lights in the place where the research was conducted, therefore, 0%, that is, no one mentioned the opposite or less than this. According to the answers obtained, it can be said that cases of disrespect to traffic lights occur very frequently.

As can be seen in the graph, 100% of those interviewed, i.e., all 7 people, said that they had been eyewitnesses to traffic accidents caused by disrespecting the traffic lights; none of them said the opposite. This shows that traffic accidents occur due to disrespect of this traffic light; one of the interviewees even added that he had witnessed an accident that resulted in the death of a person.

As can be seen in the graph, 100% of the interviewees, that is, 7 people said that the authorities do not take it into account, which is of concern because they have observed accidents in which some people were injured and others died, and they are also concerned because there is a park nearby and children and adults use the intersection of the traffic light to cross the street. For which they mentioned that it is necessary to do something to prevent any accident by the drivers to not respect the red light of the traffic light and to reduce the case of accident by 0.

As can be seen in the graph, 100% of the interviewees, that is, 7 people mentioned that it is necessary to have a control to prevent future accidents due to disrespect of the traffic lights because there is a park and children cross the street at the traffic lights, therefore, 0%, that is, no person mentioned the opposite. According to the answers obtained, it can be said that it is necessary to implement a control system to prevent future accidents.

As can be seen in the graph, 100% of those interviewed, that is, 7 people mentioned that citizens who disrespect traffic regulations should be monitored, detected and sanctioned, as this would raise awareness and prevent many traffic accidents in the locality.

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First stage : An analysis was carried out based on the considerations prior to the design of a prototype for an automatic detection system for disrespecting traffic lights.

Table 1. *Comparison of microcontrollers for processing*

PLATE	ADVANTAGES	DISADVANTAGES
Arduino Uno	• Low cost compared to other microcontrollers. • Its programming environment is flexible and easy to use for beginners and professionals.	• It does not have its own operating system. • It does not have a port to connect to Ethernet.
Raspberry Pi.	• You can run multiple programs at the same time. • It has a port for Ethernet connection. • You can use a version of the Linux operating system, in this case Raspbian.	• It is normally used for programming. • Its operating system is more complete and complicated for beginners.

Source: Authors

The Arduino Uno was chosen for its easy to use interface, therefore, it is ideal for working in an electronic system, because in the environment we are going to work we need to connect components and this board makes our work easier because it is compatible with the ESP32-CAM module and the ultrasonic sensor HC-SR04.

The sensors were chosen taking into account the image capture as the detection of vehicle when the red light is passed in a certain area, in this case the Walter Andrade Avenue in the canton Quevedo, because of the disrespect to the traffic light, for which there are constantly accidents, leaving injured people and sometimes death. The sensors that can measure the detection of object as the capture of image or video that is compatible with the Arduino Uno board:

The HC-SR04 ultrasonic sensor was selected and 2 of these detect vehicle movement when the red light is passed.
The power supply of the vehicle detection system will be through a direct current connection, because we will be working on a model that simulates the street of Walter Andrade Avenue in the canton of Quevedo, this current will be 5V at 2A.

In using the alarm for prevention, we used two passive buzzers for reason that they are compact with the Arduino one board and is of a compact size and easy to handle.

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This stage is dedicated to the development and implementation of the prototype, so it will be divided into other substages, the first substage corresponds to the design of the electronic circuit as such, the next substage corresponds to the design of the mockup for testing, and the third substage corresponds to the implementation of the prototype within the mockup. The block diagram that uses the automatic detection system for traffic light disrespect is shown.

As you can see the ultrasonic sensor HC-SR04 sends a signal to the Arduino Uno board to process it and at the same time sends an instruction to the two buzzers, where it indicates that it should turn on and then receives another signal from the second sensor HC-SR04 to the buzzers to turn off, otherwise the buzzers are turned off after a period of time to be programmed in the Arduino Uno.

As shown in the image above, the speakers or sound alarms are connected to the board with the microcontroller, as well as the object sensors HC-SR04, the LEDs represent the red and green lights of the traffic light, in this case the orange light is not used for resource saving reasons, it is considered not necessary because the sensors and alarms are activated only while the red light will be on.

The development of the automatic detection system of disrespect to the traffic lights was obtained considering the following code, the Arduino Uno board is in charge of processing the signals obtained from the different sensors for the proper functioning of the circuit.

With the commands shown in the image, the HC-SR04 ultrasonic sensors can be configured to detect the movement of a vehicle at the moment of running a red light.

Once the HC-SR04 ultrasonic sensors are configured, the traffic light configuration is raised, which is important for the execution of the ultrasonic sensors and the buzzers that will help us as an alarm. The commands in the HC-SR04 sensors that helps to detect when a vehicle passes the red light, which sends a pulse through the Arduino board one, for processing to the alarms.

The following shows the command lines used for the configuration of the buzzers, which allows us to activate and deactivate the alarm to warn other drivers and pedestrians of the event.

The third stage is in charge of obtaining the results through the tests performed, and correcting errors that occur at the time of executing the circuit.

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Observations were made to the system to verify its operation. In the tests carried out using the prototype, it shows the following results with different perspectives.

- Case 1: Vehicle does not respect the red light and continues on its way.
- When a driver crosses the red traffic light, the HC-SR04 ultrasonic sensor sends a signal to activate the two prevention alarms, which will be in operation for a certain period of time.
- Case 2: Vehicle does not respect the red light and stops further ahead when it hears the alarms
- If the driver runs the red light, the HC-SR04 sensor will send an alert to the Arduino Uno so the alarms will turn on, if later the driver stops for the sound, the alarms will turn off automatically.
- Case 3: Pedestrian crosses zebra crossing when the traffic light is red
- When a pedestrian crosses the street at the crosswalk, the HC-SR04 sensor will not detect the pedestrian because the sensor will be in a place that is not detected by the pedestrian.
- Case 4: Vehicle does not respect red light and turns to right side
- In this case, if the driver goes through the red light, the first sensor HC-SR04, which will be placed next to the traffic light, will detect it, therefore, the alarms will turn on, but when the driver turns right, the second sensor will not detect it, because it only detects vehicles going straight ahead, therefore, the alarms will be on for a certain time before they turn off.
- Case 5: Vehicle does not respect red light and turns to left side
- The first sensor HC-SR04 that will be placed next to the traffic light will detect that the driver ran the red light, therefore, the alarms will turn on, but when the driver turns left the second sensor will not detect it, because it only detects vehicles going straight ahead, therefore, the alarms will be on for a certain period of time before it turns off.
- Case 6: Cyclist crosses the red light of the traffic light
- The moment a cyclist crosses the red light, the HC-SR04 sensor detects it, therefore, the alarms will automatically turn on until the cyclist stops or turns off after a period of time.

The results of the research allowed obtaining information and knowledge for an appropriate design of a prototype of an automatic detection system for the automatic detection of traffic light disrespect, after the implementation of a scale model of the mentioned place and in operation together with the circuit. Different tests and error corrections were carried out to obtain a final prototype that achieves the proposed objectives. The verification of the different cases

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observed in the tests and results part of this document allowed verifying that when vehicles do not respect the red light of the traffic light, the alarms emit an outrageous sound which manages to capture the attention of passers-by and the drivers themselves, and when the vehicle stops the alarms are turned off. These results were obtained by simulating the prototype system in a mockup, the data obtained from the cases of disrespect were displayed on the serial monitor of the Arduino interface, the same that were collected manually by the researchers, this simulation was performed considering that, in real circumstances, these data would be obtained automatically and constantly.

In order to verify the correct operation of the system prototype and the fulfillment of the hypothesis that states that this prototype allows detecting vehicles that disrespect the traffic lights, it was necessary to perform a simulation with the prototype, some data that will be presented are not real, unreal time frequencies were considered but the records were actually obtained from the system, observing the operation in real time through the serial monitor of the Arduino interface.

The following are the records of cases of disrespect to the traffic lights through the serial monitor of the Arduino, as a simulation, these data have been obtained by simulated checks of non-real vehicles in the model, the sensors and alarms worked as expected.

The Arduino serial monitor showed the results indicating the time when the red light was on and each time there was a case of disrespect to the traffic light, the case number, date, time and confirmation of whether the vehicle stopped or not, thus saving the data in the log.

The data obtained in the Arduino interface shows a summary of the detected cases of vehicles that disrespected the red light, the "Number" column indicates how many times this case occurred, each number represents a vehicle that went through the red light, followed by the "Date" column, which indicates the date on which the case occurred, as well as the time indicated in the "Time" column, the last column called "The vehicle stopped" allows to know if the vehicle stopped after disrespecting the red light, if the data is "no" it means that the vehicle continued its journey and did not stop despite having heard the sound of the alarms.

By simulating the prototype in the mockup and the Arduino interface, it has been possible to detect and record every time a vehicle did not respect the red light of the traffic light, this data can be used to make any decision , in real life, if the

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system were to be implemented, the data could be used by the traffic authorities to follow up in the places where most of these types of problems occur.

Conclusions

Through the implementation and strategic programming of the object sensors, it was possible to detect moving vehicles that are disrespecting the traffic lights, i.e., if the vehicle has crossed beyond the zebra crossing lines while the red light is on, the sensors immediately process a signal that is transmitted to the microcontroller.

The devices selected as prototypes for the sound alarms provided a correct operation and favorable response in interaction with the sensors, the response was sent at the right time, since the programming of the sound alarms was geared towards the concept of preventive warning in real time, the alarms sounded at the right time.

The alarms were activated the moment a vehicle ran the red light, however, these alarms were kept on for a period of time of 30 seconds while the vehicle continued with its journey, however, on the occasions when the prototype vehicle stopped within the detection area of sensor 2, the alarms were deactivated, thus sending a positive message to drivers who do not respect the red light.

With the implementation of this prototype, it is possible to create an environment in which the municipal government, through the traffic department, and the citizens participate in order to achieve sustainable development.

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