
MICROCONTROLLER-BASED SMART MIRROR WITH E18-D80NK PROXIMITY SENSOR OBJECT DETECTION

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Abstract

Mirrors function as objects used to display the condition of an object in real time and to improve self-view. Because mirrors are not considered smart or their usefulness is limited to looking in the mirror. In addition, generally the mirror is placed in the room, then the incoming light is less. With this research, a new innovation in the form of a smart mirror is formed. Where this product focuses on sensors used to read objects in front of it and is equipped with LED as additional light. The method used in this research is the experimental method. Proven in the experimental process of making this smart mirror through a system and planned. The results showed that the E18-D80NK proximity sensor detects the presence of objects in front of it, then reflects infrared light. Furthermore, the signal is continued to the microcontroller and the I2C LCD reads information from the system. At the same time, the LED around the mirror lights up and the buzzer is automatically activated to provide sound effects to the user as part of the notification. Based on the research conducted, the E1-D80NK proximity sensor is able to automatically detect objects from the system, then can turn on the buzzer and LED. However, there are still obstacles in the form of detection distance readings that are still limited only when the object is in front of the sensor or when it is detected. So, it is expected that this needs to be developed even better.

Keywords: Microcontroller, Proximity Sensor, Smart Mirror.

INTRODUCTION

Transportation is one of the activities that plays a vital role in facilitating every aspect of life (Zahaja, Hidayati, Idris, & Mulyono, 2024). Transportation is very important for areas, be it rural or semi-urban or urban areas in developing countries, because it provides access for people to meet the needs of daily goods and services, and improves socio-economic life (Silondae, 2016). The existence of transportation is expected to eliminate the impression of isolation towards development in all areas of village life, both trade, industry and other sectors in rural areas (Rozaq, 2019). With the development and growth that occurs in an area, various problems arise, including transportation problems. One of the most prominent issues is the condition of traffic safety due to frequent accidents, both minor accidents and those that result in fatalities (Prastiyo, 2023).

Many traffic accidents occur due to human negligence in driving. The driver's unpreparedness in driving allows accidents to occur that can endanger the safety of other road users. Carelessness, drowsiness, lack of skill in driving, not maintaining distance, going too fast are examples of driver errors in general (Mubalus, 2023). Meanwhile, vehicle factors related to vehicles are rarely maintained by the driver, causing damage to the vehicle (Putra, 2019). In addition to driver negligence and vehicle factors, other factors that cause traffic accidents are the environment and road conditions that are damaged, potholes, geographical slopes, bends, dangerous climbs and descents and street lighting (Enggarsasi & Sa'diyah, 2017).

Cornering roads are the physical environment factor that causes the most traffic accidents. This is because cornering road conditions affect a person's visibility when driving a vehicle, the driver's visibility when on a cornering road is more limited than when on a straight road (Heply & Siahaan, 2022). In addition, some subjects stated that narrow roads, many straight tracks, and bends after straight tracks affect accidents (Arif, 2016).

In an effort to prevent traffic accidents on sharp corners, one of the efforts to prevent accidents in driving is to utilize the use of convex mirrors on road bends. The convex mirror itself was discovered in the 10th century by an Arab physicist named Ibn Sahl. This convex mirror helps to reduce blind spots and the view becomes wider, so it is expected to reduce accidents by helping to detect vehicles in the opposite direction in the blind spot so that the driver can adjust the position and speed of the vehicle when on the bend (Subrata & Astriani, 2024). These convex mirrors are generally installed on the roadside at locations where the view of motor vehicle drivers is very limited or obstructed, especially in sharp turns (Hendriyani, Sianturi, Makatuuk, & Maslina, 2023).

The use of convex mirrors can be effective in increasing visibility, although it is noted that the image of the object in the mirror appears smaller (Karim, Akbarulah, & Katiah, 2024). This causes errors in estimating the distance of vehicles, and the speed of other vehicles (Suprianto & William, 2020). In addition, the presence or location of convex mirrors is often not detected by motorists traveling on the road. So in this research, a device is added to the convex mirror, a lamp that surrounds the mirror, an alarm buzzer, and an LCD screen.

This research presents a new approach in improving the effectiveness of convex mirrors by integrating the E18-D80NK proximity sensor and microcontroller technology. The proposed system is designed to detect objects in real-time and provide additional information. This is an innovative lift to make it easier for motorists to recognize the presence of convex mirrors and be more cautious in traveling on curvy roads. The author argues that although convex mirrors have shortcomings in producing accurate reflections and cannot be easily detected by motorists, these shortcomings can be minimized through the use of technology. The convex mirror, created with a combination of a microcontroller and a proximity detection sensor, serves not only as a visual reflection tool but also as a smart device that provides additional data to help make safer and more informed decisions.

This research aims to develop a technology-based solution using the E18-D80NK proximity sensor and microcontroller to help motorists obtain more accurate distance information in real-time, contributing to the research and development of convex mirrors that are more intelligent and responsive to user needs. In addition, it reduces the risk of accidents caused by visual perception errors, especially in complex traffic situations such as intersection areas and blind spots.

LITERATURE REVIEW

A. Sensor Proximity

A sensor is a type of transducer that is used to convert mechanical, magnetic, thermal, light and chemical quantities into voltage and electric current. Sensors are often used for detection when measuring and controlling. In this case the sensor is considered a black box whose characteristics are determined by the relationship between the output signal and the input signal (Eni Yuliza, 2015).

Proximity sensor is a component that functions to detect the presence or absence of an object. Inductive type proximity sensors are widely used to detect the presence of metal objects at a certain distance without having to touch the object. Inductive sensors use induced currents by magnetic fields to detect nearby metal objects. The working principle of this type of proximity sensor using

inductive and capacitive methods is based on an electromagnetic field around the sensor surface generated by a high frequency oscillator. The type of metal material that has an inductive influence and other capacitive materials will affect the amplitude of oscillations around the sensor (Novella Febriana, 2017). Thus, the calculation of distance results using the E18-D80NK proximity sensor can be formulated as follows:

$$v = \frac{2d}{t}$$

Where:

- d: Distance between sensor to object
- v: The speed of sound in air (about 343 m/s at 20°C)
- t: Travel time of ultrasonic waves (back and forth)

B. Arduino Uno R3



Figure 1. Arduino UNO

Arduino Uno is the most commonly used type of Arduino. Especially for beginners or learning media it is highly recommended to use Arduino Uno. In addition to the many references that discuss this type of Arduino, also because the microcontroller chip used uses the DIL / DIP (Dual In- Line Package) type. It is very easy for users to replace the microcontroller chip, in case of damage, and is also compatible with many additional shields such as Ethernet, SD-CARD, GSM, etc. The latest version is Arduino uno R3 (Revision 3), using the Atmel AVR ATMEGA328 microcontroller chip, has 14 digital I/O pins (6 of which are PWM pins) and 6 analog input pins. USB A to USB B (USB Printer) communication facilitates hardware communication with computer/laptop devices (Sasmoko, 2021).

C. Sensor Proximity E18-D80NK



Figure 2. Sensor Jarak Proximity Tipe E18 – D80NK

Source: www.rytechindo.com

E18-D80NK is an infrared proximity sensor, this tool has a distance detection range that can be adjusted from 3 cm to 80 cm with its output. This sensor does not need direct contact with the tool, but only with infrared shots to the object to be measured. Infrared sensors are electronic components that can identify infrared light. Currently, this infrared sensor is often used as a proximity sensor or distance sensor. In this design, an infrared sensor with type E18-D80NK is used. Specifications of infrared sensor type E18- D80NK: Detection distance: 3 cm to 80 cm, light source:

infrared, dimensions: 18 mm (D) x 45mm (L), connection cable length: 4.5 cm, input voltage: 5V DC, current consumption: 100 mA, output operation: Normally Open (NO), output: NPN (Jurnal Pendidikan Vokasional Teknik Elektronika, 2022).

The infrared sensor type E18-D80NK is a sensor to detect the presence or absence of an object. If the object is in front of the sensor and can be reached by the sensor, the output of the sensor circuit will be logic “1” or “high” which means the object is “present”. Conversely, if the object is in a position that is not reached by the sensor, the output of the sensor circuit will be “0” or “low” which means the object “does not exist” (P. Pujono dan H. P. Menang, 2017).

D. USB LED



Figure 3. USB LED
Source: id.my-best.com

Light Emitting Diode (LED) is an electronic component that can emit light. As the name implies, LED is a type of diode. As is known, a diode is a component that can only flow electric current in one direction. Electric current only flows when a positive voltage is connected to the leg called the anode and a negative voltage is connected to the leg called the cathode. This is different from a resistor, which can flow electric current even if the two legs are reversed. There are three general functions of using LED, namely as indicator lights for the transmission of modulated light signals within a certain distance and as a coupler for electronic circuits that are totally isolated (Kadir, 2014).

LED (Light Emitting Diode) is an electronic component that converts electrical energy into light energy. This component is included in the diode family because the basic ingredients are made of semiconductor materials. The color of the light emitted by the LED varies in color depending on the type of semiconductor material used in manufacturing. In addition, there are also types of LED types that emit light that cannot be seen by the eye, namely infrared LED (Kadir, 2014).

E. Convex Mirror



Figure 4. Convex mirror
Source: Indiamart.com

Convex Mirror or convex mirror is an additional equipment on the road that functions as a tool to increase the visibility of motor vehicle drivers. Convex mirrors are generally installed on the edge

of the road at locations where the view of the driver of a motor vehicle is very limited or obstructed, especially in sharp turns. The installation of convex mirrors can be used to reduce the number of accidents due to the limited view of motorists. (Dirjen Perhubungan Darat, 2011).

In general, there are two types of convex mirrors on the market, namely indoor and outdoor convex mirrors. Both have almost the same functions and specifications. The main thing that distinguishes the two is the convex cover of the outside rearview mirror. Apart from the type, this type of mirror also has different sizes, ranging from 60cm, 80cm, to 100cm in diameter. (Abdimas Universal 5, 202).

RESEARCH METHOD

A. Block Diagram of Research Stage

The method used in conducting this research is a development method with descriptive and quantitative data collection. Development method or research and development (R&D). The flow of the research process carried out is contained in the following figure.

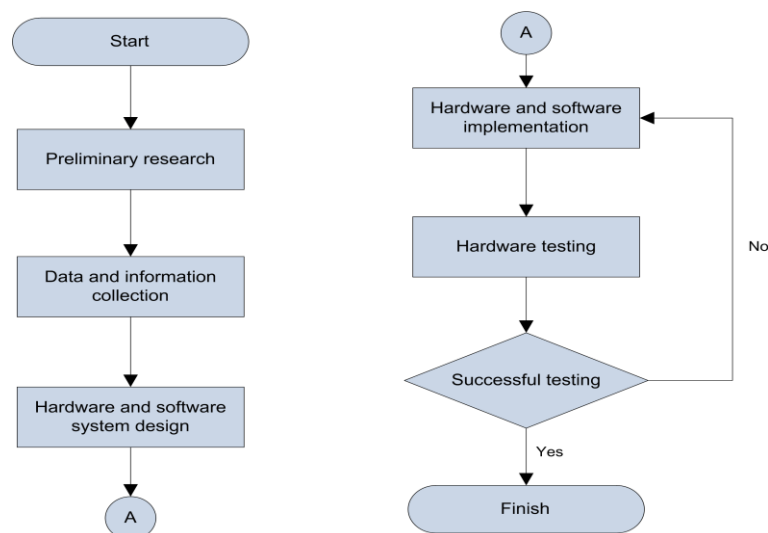


Figure 5. Block diagram of research stage

B. Initial Research

Before conducting further research, there are several basic concepts that need to be learned related to this research topic, including:

1. Basic Concept of Embedded System.
Embedded systems are computer systems designed to perform specific tasks in larger applications. In this research, a microcontroller is used to control the sensor and display information on the LCD.
2. Basic Sensor Concepts.
The sensor technology used in this research is an ultrasonic sensor, which works by sending out sound waves to detect vehicles. Understanding the working principle of sensors is essential for detection accuracy.

3. Programming Language.

The programming language used for the microcontroller in this system is C/C++, which allows efficient processing of sensor data and control of the LCD display.

C. Data and Information Collection

To support this research, some important data and information were collected from various relevant sources, including:

1. Data on Traffic Conditions and Accidents on Sharp Bends.

Based on previous studies (Heply & Siahaan, 2022), road conditions in the form of sharp bends are often the main cause of traffic accidents. Data related to accidents in sharp curve areas and their contributing factors, such as limited visibility, vehicle speed, and poor road conditions, were collected from existing accident reports and traffic safety studies.

2. Information on the Use of Convex Mirrors.

The use of convex mirrors as vision aids at sharp curves is common in many areas. Data on the effectiveness of convex mirrors in improving visibility and reducing blind spots was obtained from literature discussing the use of these mirrors on highways (Subrata & Astriani, 2024). However, studies have also shown that there are difficulties in distance and vehicle speed estimation due to the smaller appearance of objects in the mirror (Karim *et al.*, 2024).

3. Proximity Sensor Technology (E18-D80NK).

The proximity sensor technology used in this research is E18-D80NK, which is an infrared sensor capable of detecting objects within a certain distance. The technical specifications of this sensor, such as detection range and accuracy, were obtained from the datasheet and related studies of sensors for traffic applications (Suprianto & William, 2020). This information is important to understand how the sensor can more accurately detect vehicles and provide real-time data to the driver.

4. Use of Microcontroller and LCD System.

A microcontroller, such as an Arduino, is used to process the data from the proximity sensor and control the information display system on the LCD. Data on microcontroller programming and interfacing with sensors and LCDs were collected from various references on embedded systems and the use of LCD modules for traffic applications (Hendriyani *et al.*, 2023).

5. Study on Accidents and Their Causal Factors.

Previous research shows that traffic accidents are often caused by human factors, such as driver negligence and excessive speed, as well as environmental factors such as sharp turns and lack of street lighting (Mubalus, 2023; Enggarsasi & Sa'diyah, 2017). This data on accidents provides an overview of the potential risks that could be minimized by the use of sensor technology in high-risk areas such as sharp bends.

D. Research Tools and Materials

In building a system that is in accordance with the functions that have been designed, there are several components needed, including research tools and materials.

1. Tools required

- a. Scissors
- b. Cardboard
- c. Glue Burn
- d. Korean Glue
- e. Laptop

2. Materials required

- a. Sensor proximity (E18-D80NK)
- b. Microcontroller (Arduino UNO)
- c. Modul LCD (16x2 LCD Display)
- d. Convex mirror
- e. Buzzer alarm
- f. LED light
- g. Jumper cable
- h. Breadboard
- i. Power supply
- j. Arduino IDE software

E. Component Configuration Block Diagram

Before making the system, a Block Diagram is needed to describe a configuration of the tool system design. The block diagram is shown in Figure 6 below.

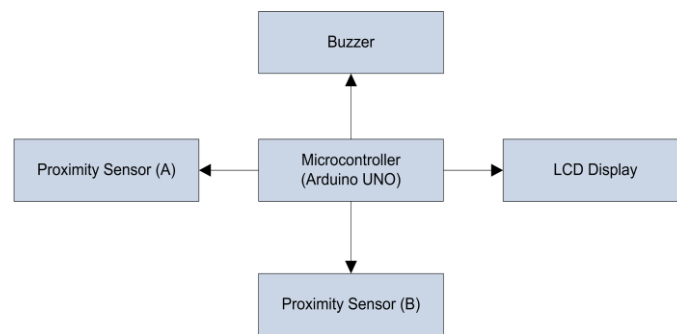


Figure 6. Component configuration block diagram

The following is an explanation of the function of each of the following section block diagrams.

- a. Sensor A (Sensor Proximity).
The first sensor detects the vehicle as it passes by. This sensor sends a signal to the microcontroller to start timing.
- b. Sensor B (Sensor Proximity).
The second sensor detects the vehicle when the vehicle passes the second point. This sensor sends a signal to the microcontroller to stop timing and calculates the vehicle speed based on the travel time between the two sensors.
- c. Microcontroller (Arduino UNO).
The Arduino microcontroller is responsible for receiving signals from both sensors, calculating the travel time between sensor A and sensor B, and then calculating the vehicle speed. The microcontroller also controls the LCD to display the vehicle speed and activates the buzzer if the speed exceeds the specified limit.
- d. LCD Display.
The LCD is used to display vehicle speed information detected by the system. In addition, the LCD will also display a warning message if the vehicle is traveling faster than the specified safe limit.
- a. Buzzer.
The buzzer gives an audible warning if the vehicle speed exceeds the safe limit. The buzzer is activated by the microcontroller based on the calculation of the vehicle speed.

F. Flowchart of How the Tool System Works

Before making the program, first there is a flowchart planning about the work system so that the system can run as desired. The system flowchart can be seen in the following figure.

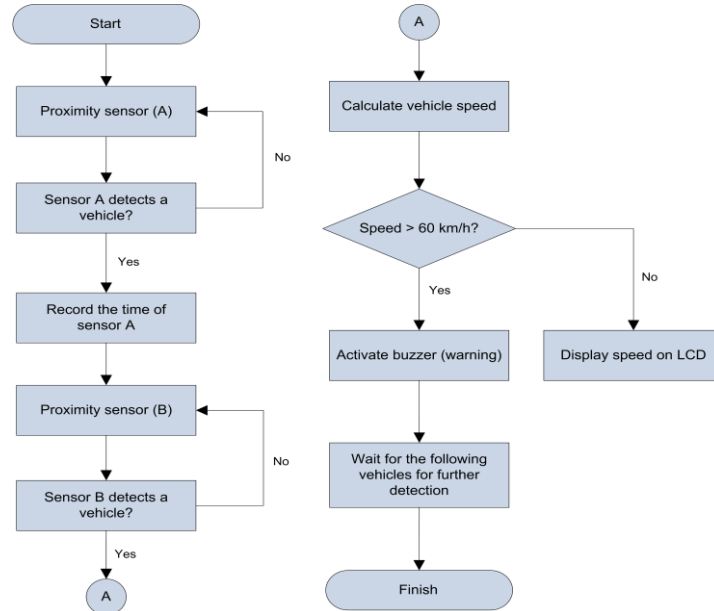


Figure 7. Flowchart of how the tool system works

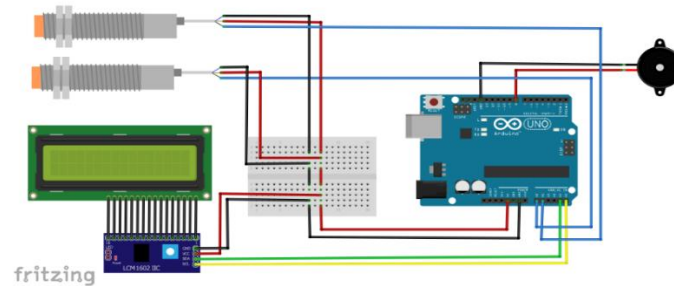
The vehicle speed detection system on sharp bends uses two proximity sensors mounted on convex mirror poles to measure the time it takes for the vehicle to pass the two sensors. The workflow is as follows:

- a. **Vehicle Detection with Sensor A.**
The system starts working when Sensor A detects a vehicle approaching the sensor. Once the vehicle passes Sensor A, the microcontroller records the first detection time using the `micros()` function. This time will be used to calculate the vehicle speed.
- b. **Vehicle Detection with Sensor B.**
Once Sensor A detects the vehicle, the system then waits until the vehicle passes Sensor B, which is located after the sharp bend. Once the vehicle passes Sensor B, the microcontroller records the detection time of both.
- c. **Display Speed on LCD.**
The calculated vehicle speed will be displayed on the LCD screen. The system will display information such as "Speed: 55 km/h", which gives the driver immediate information about the speed of the vehicle that has just passed by.
- d. **Buzzer Warning (If Speed > 60 km/h).**
After calculating the vehicle speed, the system checks whether the speed exceeds the safe limit (e.g., 60 km/h)
 - If the vehicle speed is more than 60 km/h, the buzzer will activate for 1 second to alert the driver to reduce the speed.
 - If the vehicle speed is less than 60 km/h, the system only displays the speed without activating the buzzer.

e. Waiting for the Next Vehicle.

Once the speed warning or display is complete, the system again waits for the next vehicle to detect and calculate the speed in the same way. This process will continue to repeat.

G. Component Circuit Design



Gambar 8. Skematik rangkaian

This schematic uses an Arduino UNO microcontroller connected to a proximity sensor, I2C LCD and Buzzer. below is the configuration between the circuits.

Table 1. Pin configuration of proximity sensor with Arduino Uno

No	Arduino Uno	Sensor Proximity E18-D80NK
1.	Pin ~ A0 and A1	OUT (Black)
2.	5V	VCC (Blue)
3.	GND	GND (Brown)

Table 2. Pin configuration of I2C LCD with Arduino Uno

No	Arduino Uno	LCD Display
1.	5V	VCC
2.	GND	GND
3.	SDA	Pin ~ A4
4.	SCL	Pin ~ A5

Tabel 3. Pin configuration of buzzer with Arduino Uno

No	Arduino Uno	Buzzer
1.	Pin ~ 8	Positif (+)
2.	GND	Negatif (-)

H. Simulation of Vehicle Speed Calculation

In the speed detection system using two E18-D80NK proximity sensors, the formula used to calculate vehicle speed is based on the time difference required for the vehicle to pass the distance between sensors. Speed (v) is calculated with the basic formula:

$$v = \frac{2d}{t} \times 3,6 \quad (1)$$

Where:

- d: Distance between two sensors (in meters)
- v: Vehicle speed (in meters per second, m/s)
- t: The time it takes for the vehicle to pass the distance between sensors (in seconds)

Steps to Calculate Speed:

- a. Distance Between Sensors.

The system starts working when Sensor A detects a vehicle approaching the sensor. Once the vehicle passes Sensor A, the microcontroller records the first detection time using the `micros()` function. This time will be used to calculate the vehicle speed.

- b. Vehicle Travel Time.

The time it takes for a vehicle to pass the distance between sensors is measured by subtracting the detection time at sensor B and sensor A. This time can be calculated by the formula:

$$t = \text{time B} - \text{time A} \quad (2)$$

- c. Vehicle Speed

After getting the time `t`, we can calculate the vehicle speed with the formula $v = \frac{d}{t}$, but the result is in meters per second (m/s). Then we convert it to km/h.

RESULTS AND DISCUSSION

A. Desain Hardware

This device is designed to detect the speed of vehicles traveling on sharp curves using an E18-D80NK proximity sensor mounted on a convex mirror pole. This tool aims to provide real-time vehicle speed information to the driver and provide a warning if the vehicle is traveling at a dangerous speed. Here is the hardware design.



Figure 9. Desain hardware

The two proximity sensors are mounted on the right and left sides of the convex mirror. The sensors are positioned to face towards both sides of the road. Each sensor will detect vehicles traveling from different directions (one sensor to detect vehicles coming from one side of the road and the other sensor for the opposite side of the road).

The LCD display is placed on top of the convex mirror, in a location that is easily visible to passing drivers. The LCD will display the speed of the passing vehicle in km/h. If the vehicle is traveling at a speed that exceeds the safe limit (e.g. 60 km/h), the LCD display will show a warning message such as "Reduce Speed".

The buzzer is mounted on the convex mirror pole or near the mirror area, so that the warning sound can be clearly heard by the driver. The buzzer will sound if the vehicle is traveling at a speed higher than the predetermined limit (e.g. 60 km/h). This audible warning will help draw the driver's attention to reduce speed.

B. Design Result

In designing a vehicle speed detection system on sharp turns using proximity sensors and convex mirrors, the tool that has been designed consists of several important components that are integrated with each other. Here are the finished results of the tool.



Figure 10. Design result

C. Testing the Tool Design Result

The purpose of this test is to determine the extent of the performance of the tool that has been designed, namely the vehicle speed detection system on sharp turns using proximity sensors and convex mirrors, and to evaluate the factors that affect the imperfections or performance of the tool. The design of this system is based on an Arduino microcontroller that integrates a proximity sensor with a convex mirror to improve traffic safety on sharp corners by providing visual and audio warnings to drivers. This test aims to identify the strengths and weaknesses of the tool, so that it can be used as a reference for further improvement and conclusion making.

Table 4. Tool Testing Results

No	Vehicle	Detection Distance (cm)	Distance Traveled (s)	Speed (km/ hour)	LCD Status	Buzzer Status
1	Vehicle A	80	0.02	54.0	Normal	No sound
2	Vehicle B	75	0.022	50.4	Normal	No sound
3	Vehicle C	70	0.015	90.0	Reduce speed	Sound
4	Vehicle D	65	0.018	66.7	Normal	No sound
5	Vehicle E	60	0.014	102.9	Reduce speed	Sound
6	Vehicle F	80	0.021	57.1	Normal	No sound
7	Vehicle G	70	0.016	96.4	Reduce speed	Sound
8	Vehicle H	75	0.020	75.0	Reduce speed	Sound
9	Vehicle I	80	0.020	54.0	Normal	No sound
10	Vehicle J	75	0.022	50.4	Normal	No sound

11	Vehicle K	70	0.015	90.0	Reduce speed	Sound
12	Vehicle L	65	0.018	66.7	Normal	No sound
13	Vehicle M	60	0.014	102.9	Reduce speed	Sound
14	Vehicle N	80	0.021	57.1	Normal	No sound
15	Vehicle O	70	0.016	96.4	Reduce speed	Sound
16	Vehicle P	75	0.020	75.0	Reduce speed	Sound

Column Explanation:

- Vehicle: Identification of the vehicle being tested (e.g. Vehicle A, Vehicle B, etc.)
- Detection Distance (meters): The distance detected by the E18-D80NK proximity sensor (the distance of the vehicle from the sensor).
- Travel Time (seconds): The time taken by the ultrasonic waves to be reflected by the vehicle and return to the sensor.
- Vehicle Speed (km/h): Vehicle speed calculated by the formula $v = \frac{2d}{t} \times 3,6$
- LCD Status: Displays a message on the LCD ("Normal" if the vehicle speed is safe, "Reduce Speed" if exceeding the speed limit).
- Buzzer Status: Indicates whether the buzzer sounds ("Sounds" if the speed exceeds the limit, "Does Not Sound" otherwise).
- LED Status: Indicates whether the LED is on ("On" if the vehicle is traveling at excessive speed, "Not On" otherwise).

Note:

- Normal speed if the vehicle speed is below 60 km/h, the LCD status displays "Normal", the buzzer does not sound, and the LED does not light.
- Reduce speed if the vehicle speed exceeds 60 km/h, the status LCD will display "Reduce Speed", the buzzer will sound, and the LED will light up.

CONCLUSION

This research successfully designed and implemented a microcontroller-based smart convex mirror system with the integration of E18-D80NK proximity sensor, LED, buzzer, and LCD display. The test results show that the E18-D80NK proximity sensor is able to detect objects within a maximum distance of 80 cm and measure vehicle speed with fairly good accuracy. The system displays real-time vehicle speed information on the LCD and provides a warning in the form of a buzzer sound and LED flame when the speed exceeds the safe limit (60 km/h).

Test data showed that some vehicles were traveling at excessive speeds, such as 90 km/h, 96.4 km/h, and 102.9 km/h, so the system provided a "Reduce Speed" warning on the LCD and activated the buzzer. Vehicles with speeds below the safe limit, such as 50.4 km/h and 54 km/h, received "Normal" status without buzzer activation.

Although the system is effective in detecting vehicle speed and providing warnings, the limitations of the sensor's maximum detection distance of 80 cm and sensor sensitivity are still a challenge. For future development, it is recommended to increase the detection range of the sensor, improve accuracy in various environmental conditions, and add features such as remote monitoring or IoT-based data analysis to improve traffic safety more effectively.

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