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EXPERIMENTAL STUDY ON THE USE OF SHARP INFRARED SENSOR FOR DISTANCE DETECTION IN PARKING ASSISTANCE APPLICATIONS IN AUTOMOTIVE SYSTEMS

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Abstract
In this study, experiments were conducted on the implementation of the Sharp Infrared Sensor, specifically the Sharp 0A4ISK model, for distance detection in parking assistance applications within automotive systems. The increasing complexity of modern vehicles and the need for enhanced parking safety have prompted the exploration of innovative sensor technologies. In this research, we focused on the application of the Sharp Infrared Sensor to improve parking assistance systems. The study involved calibration, testing, and performance evaluation of the sensor on a laboratory scale. The methodology included the design of electronic component circuits and program development. Subsequently, testing of the sensor's ability to accurately detect distances between a miniature vehicle and a wall was performed. The research results indicate that the Sharp Infrared Sensor offers the ability to detect distance, thus holding the potential for integration into automotive systems. These findings underscore the suitability of the Sharp Infrared Sensor for distance detection, making it a promising candidate for seamless integration into various automotive systems.

1.0 INTRODUCTION

In recent years, the automotive industry has witnessed a remarkable transformation, characterized by the increasing integration of advanced technologies to enhance vehicle safety, efficiency, and overall user experience [1], [2]. One critical aspect of this transformation is the development of parking assistance systems designed to assist drivers in facing the challenges of parking, especially in busy urban environments [3], [4]. These systems are intended to reduce stress and potential risks associated with parking, making them a valuable addition to modern vehicles [5], [6].

The complexity of modern vehicles, marked by their larger sizes and various blind spots, necessitates innovative solutions for parking assistance. The key to the success of these systems lies in the ability to detect distances between the vehicle and nearby obstacles accurately. Among the various sensor technologies available, Infrared (IR) sensors have proven to be effective tools for distance detection due to their reliability [7], [8]. In addition, this sensor also can work if it is connected to the microcontroller. A microcontroller is a compact, integrated circuit designed to perform a specific task or set of tasks [9], [10]. It serves as the brain of embedded systems, capable of processing data, interfacing with sensors and external devices, executing control algorithms, and managing power efficiently[11]. Whether it's controlling home appliances, managing automotive systems, or running medical devices, microcontrollers play a pivotal role in enabling automation and intelligence in a wide range of applications [12], [13], [14]. The lack of comprehensive research exploring the combination of using the Infrared Sharp sensor with LED lights as an indicator in the context of automotive parking assistance systems is evident. While the Infrared Sharp sensor has been identified as a potential tool for distance detection, and LED lights are used as visual indicators, in-depth and integrative research that combines these two elements has been limited. Therefore, further research needs to focus on how the Infrared Sharp sensor can be optimized with the use of LED lights as an effective indicator to provide visual information to the driver in various parking scenarios. This gap represents an opportunity to create a more holistic and efficient solution in automotive parking assistance systems that can enhance driver safety and convenience.

This experimental study focuses on the use of the Sharp Infrared Sensor, with particular attention to the Sharp 0A4ISK model, to address the increasing need for improved parking assistance within automotive systems. Additionally, the study involves the use of the Arduino UNO microcontroller and with the assistance of LED indicator outputs. The primary objective of this study is to investigate the performance of this sensor on a laboratory scale, with an emphasis on its ability to accurately measure distances between the vehicle and surrounding objects. By evaluating the reliability, precision, and response time of the Sharp Infrared Sensor under various conditions, we aim to determine its suitability for integration into automotive parking assistance systems, with the added LED output as a sensor reading indicator.

The findings of this research not only contribute to the field of automotive technology but also inspire further exploration of sensor-based solutions for advanced parking assistance. Ultimately, these advancements hold the potential to significantly improve the safety and convenience of parking in contemporary vehicles, benefiting both drivers and pedestrians alike.

2.0 METHODOLOGY

2.1. Tools and materials

The purpose of designing this project is to implement an infrared sensor for a vehicle parking assistance system. Some of the tools and materials used include Arduino UNO, LED lights, a buzzer, a Sharp 0A4ISK IR sensor, a 100Ω resistor, a 30kΩ resistor, a computer/laptop, Arduino IDE software, jumper cables, and a protoboard. The function of the components used in this project:

1. Arduino UNO: The Arduino UNO is a microcontroller that serves as the brain of the system. It processes data from the IR sensor and controls the output components (LED lights and buzzer) based on the detected distance.
2. LED Lights: LED lights serve as a visual indicator to the driver. They are activated and deactivated to provide feedback on the proximity of the vehicle to obstacles. Different patterns of LED lighting can indicate different distance ranges.
3. Buzzer: The buzzer is an auditory indicator. It produces sound at varying frequencies to alert the driver about the proximity of obstacles. The frequency of the sound indicates the distance from the obstacle.
4. Sharp 0A4ISK IR Sensor: The IR sensor emits infrared light and measures the time it takes for the light to bounce off an obstacle and return to the sensor. Based on this time, it calculates the distance between the sensor and the obstacle.
5. 100Ω Resistor: Resistors are used to limit the current flowing through certain components. In this case, the 100Ω resistor may be used to protect the LED lights or the buzzer.
6. 30kΩ Resistor: Like the 100Ω resistor, the 30kΩ resistor may be used to control the current in the circuit. The specific use would depend on the circuit design.
7. Computer/Laptop: The computer or laptop is used for programming the Arduino using the Arduino IDE software. It's where the code for the system is created and uploaded to the Arduino UNO.

8. Arduino IDE Software: This software is used for writing, editing, and uploading the code to the Arduino UNO microcontroller.
9. Jumper Cables: Jumper cables are used to establish electrical connections between the components on the protoboard. They allow for easy and temporary connections.
10. Protoboard: The protoboard is a platform for building and testing electronic circuits. It allows for the easy connection of components and wiring.

2.2. System Design

One implementation of a system in a car that can enhance safety involves using an infrared sensor to detect the distance between the back of the car, which is used to assist in parking. The issue at hand pertains to difficulties drivers face when parking in reverse, as it can be challenging to estimate the distance between the vehicle and obstacles or walls, posing a risk of collision and accidents. Hence, this system is required. With this system, there is a way to help the driver determine this distance without having to directly look at the rear conditions. The output from the sensor we have designed can be in the form of flashing lights or sounds, indicating the proximity of the vehicle to obstacles or walls, with the frequency of flashing/sound indicating the closeness of the distance. Based on this, a prototype project for a vehicle distance sensor will be designed as a demonstration of the sensor's functionality in aiding parking. In this study, we will design the prototype and its computer program. The prototype construction is done to connect the pins of its electronic components.

Then, before conducting testing, computer programming also is done using the Arduino IDE for the Arduino Uno. Computer programming for the Arduino Uno in the Arduino IDE functions to control and manage various aspects of the Arduino Uno device [15]. This includes writing programs that execute instructions, collecting data from sensors, sending data to other devices, and managing outputs. Once both are completed, the system will be tested.

3.0 RESULTS

The purpose of this project is to implement an infrared sensor for a vehicle parking assistance system. The system uses a Sharp infrared sensor that emits infrared light, and when this light hits an object, it reflects toward the sensor. Based on the strength of the received infrared signal, the sensor generates different output responses. If the infrared signal has to travel a long distance, the signal will be weak, resulting in a low response. Conversely, if the signal travels a short distance, it remains strong, and the sensor produces a high response. With this characteristic, an infrared distance sensor can detect the distance from an object based on the strength of the received infrared signal.

To create the parking assistance system, an Arduino UNO microcontroller is required to process and control the sensor's response signals into the desired output. The code reference from the Arduino Cloud serves as the basis for processing the Sharp sensor's signals. The sensor is connected to a 5V pin as a power source, pin A0 as the analog input signal that goes to the controller, and ground to complete the sensor circuit. The output produced is a continuous numerical value that corresponds to the sensor's distance from an object, with low values for distant objects and high values for close objects. The desired output includes LED blinking and a buzzer sound with varying frequencies based on the sensor's distance from an object. Figure 1 is the electronic circuit diagram of the built system. It consists of hardware and software.

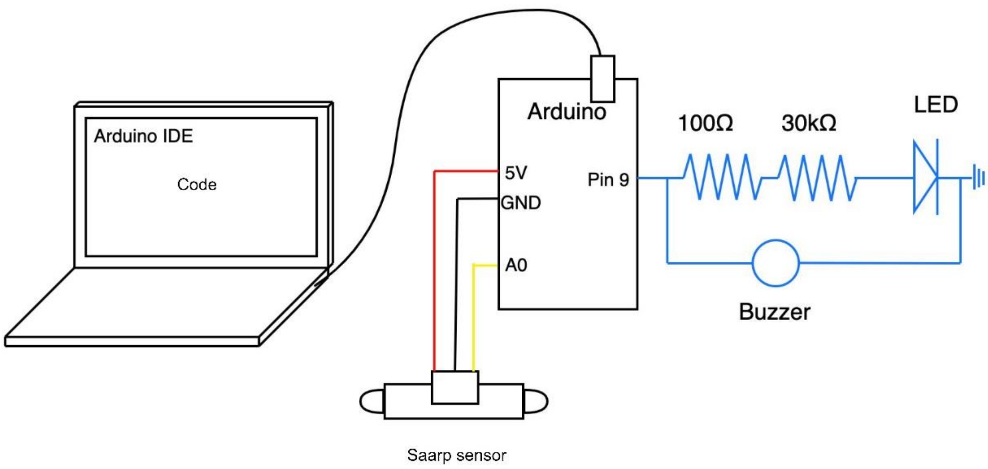

Figure 1. Electronic circuit of the system

To categorize signals based on distance, the input signal is divided into three categories as shown in the system diagram in Figure 2. For close range, a signal with a value > 600 is used, which results in a high-frequency output. For the medium range, a signal with a value of 600 > x > 370 is used, resulting in a medium-frequency output. For long-range, a signal with a value of 370 > x > 250 is used, which produces a low-frequency output. For objects that are even farther away and produce weaker signals, no output is generated. This mechanism is achieved using Arduino's if function with code references from the Arduino Cloud, with conditions for comparing signal strength against predefined thresholds.

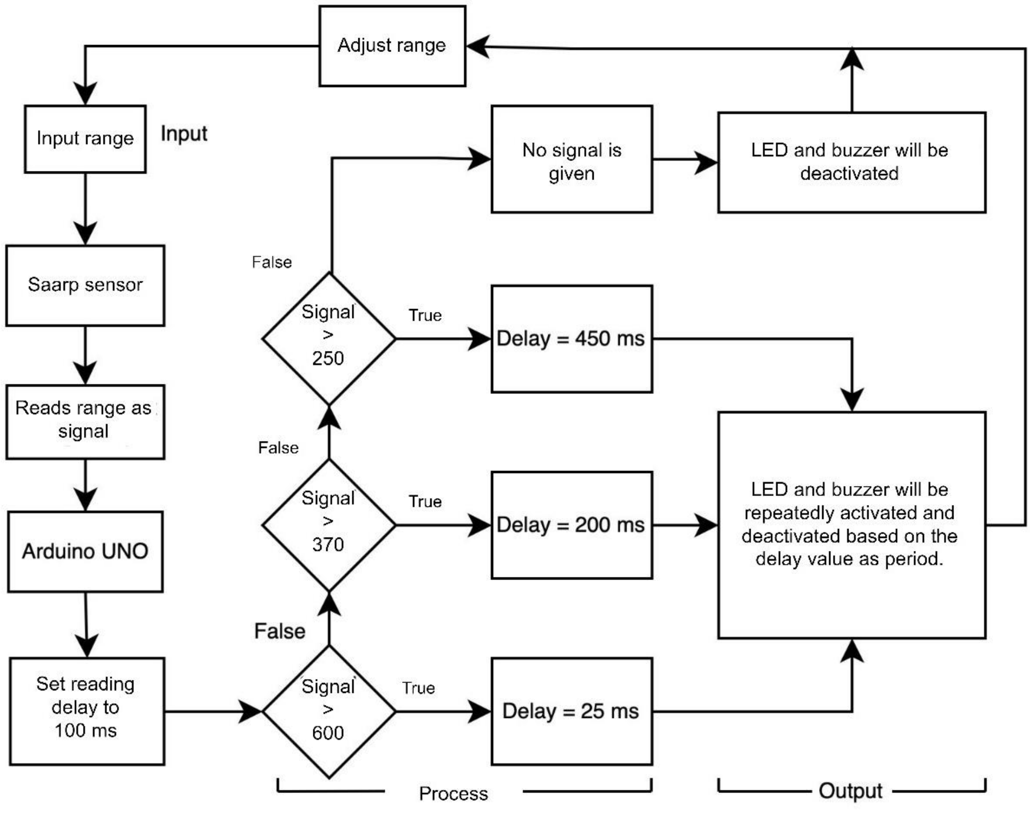

Figure 2. Conceptual diagram of the built system's operation

To produce different frequencies, the digitalWrite and delay functions are used in Arduino. In sequence, the digitalWrite HIGH and LOW functions activate and deactivate the digital pin specified in the code, while delay creates a time delay before executing the next command. By adjusting the delay time for turning on and off digital pins, different frequencies can be generated for each condition. A delay time of 25ms is set for close range, 200ms for medium range, and 450ms for long range, with no delay for other distances. These treated pins are connected to LED lights and a buzzer to produce output activation and component synchronization according to the predefined activation conditions.

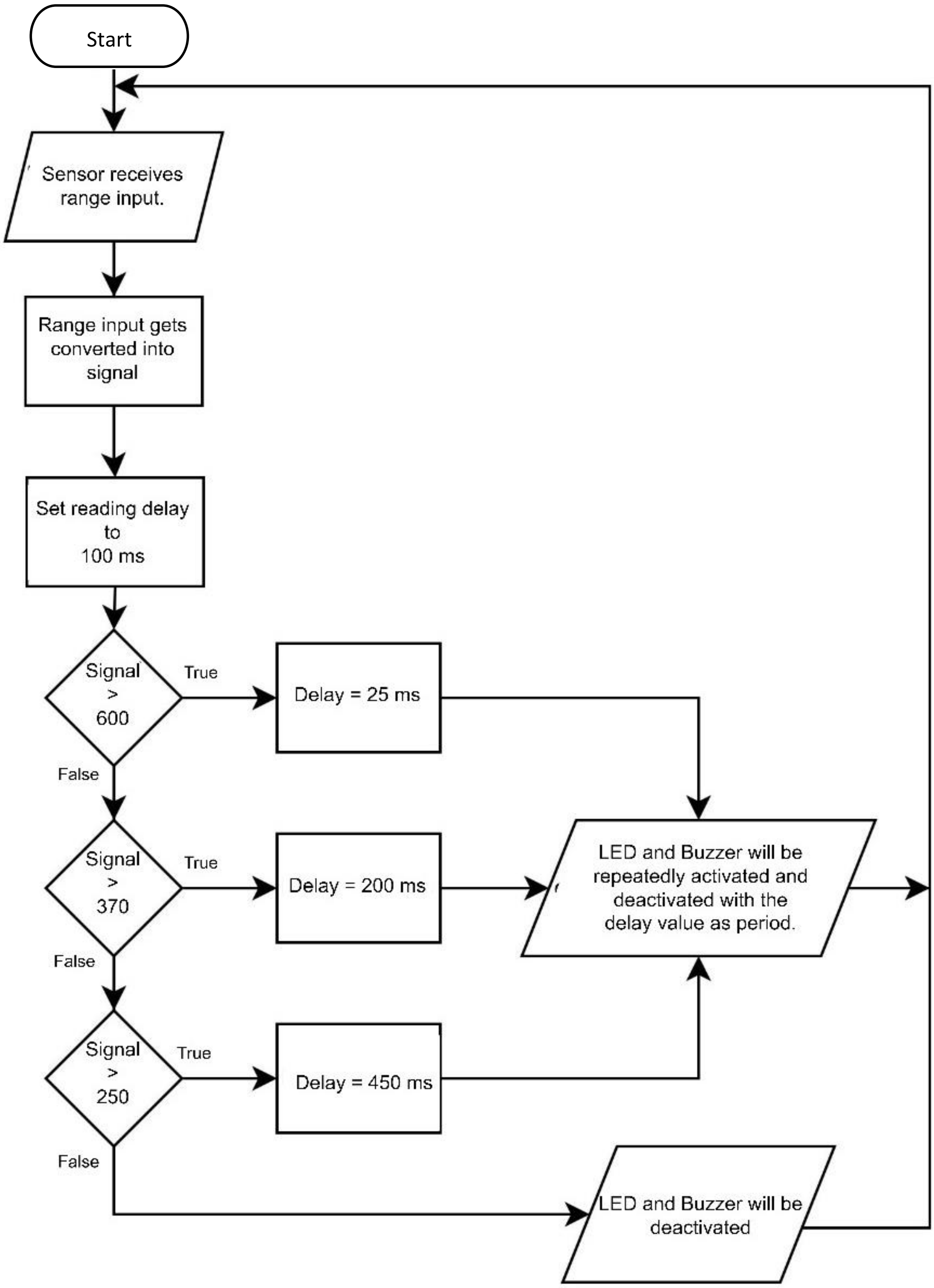

Figure 3. The programming system flowchart

In the designed system, the sensor is mounted on the back of a miniature car. When the car is positioned far from a wall or obstacle, the sensor detects a weak signal below the threshold of 250, so the system remains inactive. As the car approaches the wall, the received signal becomes stronger. When it reaches a signal strength above 250, a command is given to activate and deactivate the pins connected to the buzzer and LED with a long delay. This process continues at medium range for signals above 370 with a medium delay and signals above 600 with a fast delay, resulting in faster activation and deactivation as the car gets closer to the wall. In its operation, random activations may occur due to external signals affecting the readings. To address this in practical applications, a filtering system can be used to ensure that the received signals originate only from the Sharp IR sensor's transmitter or to reduce background noise. Additionally, in real-world applications, calibration of the distance/signal strength for component activation is needed to ensure that the parking distance is not too close to the wall. Finally, the installation of lights and a buzzer in the car can be done on the steering wheel area, the car's speedometer, or the radio with a louder buzzer to make it more audible.

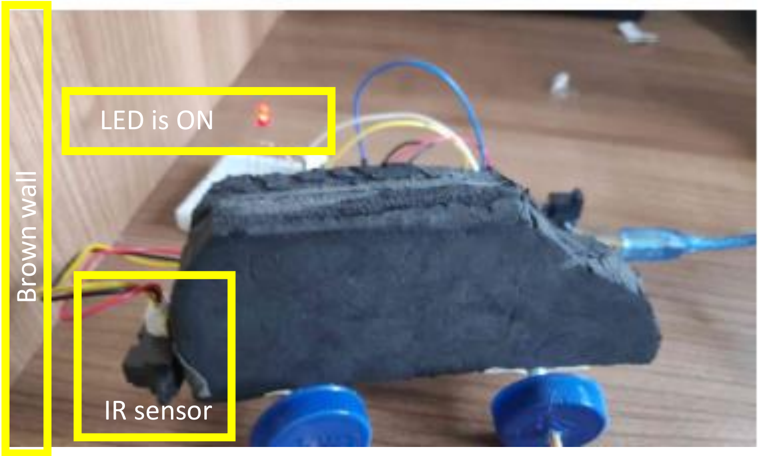

Figure 4. The system is activated

Based on the Figure 4, the red LED light is on. This indicates that the system senses a short distance between the infrared sensor and the wall behind the miniature car. In addition, the other output is the buzzer, which will sound according to the pre-set frequency. When the red LED light is on, it provides a visual signal to the driver that the car is in close proximity to a wall or obstacle. This is highly valuable information in parking situations that often involve blind spots and visual challenges.

Meanwhile, the buzzer sound provides an auditory response that can assist the driver in crowded parking scenarios, helping to avoid unwanted collisions or contacts. With these two types of outputs, the system offers dual information to the driver to enhance safety and accuracy during the parking process. In this research, testing has already been conducted on a miniature car or prototype. In future studies, it is expected that the system can be directly applied to actual full-sized vehicles.

4.0 CONCLUSION

The development of a parking assistance system using the IR Sharp 0A4ISK sensor and Arduino UNO microcontroller demonstrates the potential for enhancing vehicle parking safety. This system measures the distance between the miniature vehicle and a wall, responding to the activation and deactivation of LED lights and a buzzer with varying frequencies. This research makes a positive contribution to the advancement of automotive technology, particularly in the realm of parking safety, helping to reduce the risk of accidents and vehicle damage. Consequently, parking assistance systems like this one represent a positive step in supporting safety in the use of motor vehicles in the modern era.

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