Parking Assistance System

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This thesis is submitted to the Department of Mathematics and Natural Sciences at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical Engineering. The thesis is equivalent to 10 weeks of full-time studies.

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In this modern era, it has been very difficult for a driver to judge the distance between a vehicle and obstacle while parking in a blind spot areas like garage. The driver should be aware of the surroundings in order to park a vehicle safely without any damage. But without any guidance it will be difficult for a driver to judge the distance manually which in most of the cases ends up in a collision. This causes damage of property and sometimes leads to the injuries to the people. In this proposed work, a Parking Assistance system is introduced to avoid the collision between a vehicle and an obstacle while parking in a blind spots. While parking, the System detects the presence of obstacles and alerts the driver accordingly.

The main objective of this project is to build a system which is used to avoid the collision between a vehicle and an obstacle while parking in a blind spot areas like garage. Parking Assistance System uses ultrasonic sensor to calculate the distance between a vehicle and an obstacle. Arduino board is used as the microcontroller. LED’s are used to indicate the respective zones of the vehicle while parking, LCD is used to display the distance between the vehicle and obstacle. A buzzer is used to warn the driver and the people present around the vehicle when the vehicle is too close to the obstacle. The proposed system makes the driver fully aware of the surroundings while parking a vehicle. Parking Assistance System is wall mounted device which is designed to guide and help the driver to park a vehicle safely without any damages while parking in a blind spot areas like garage. The manual efforts to calculate the distance can be avoided and helps in reducing the time consumption. This parking system can be useful and needed to avoid the collision while parking. It prevents accidents and damages caused during the parking.

**Keywords:** Avoid, Alert, Assistance, Collision, Garage, Parking.
Acknowledgements

We are extremely thankful and pay our sincere gratitude to Irina Gertsovich for her valuable guidance and support in developing this project. We extend our gratitude to Blekinge Institute of Technology for giving us this opportunity.

Saavan Vasantha
Jayanth Kunuthuru
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<tr>
<td>PAS</td>
<td>Parking Assistance System</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated Development Environment</td>
</tr>
<tr>
<td>AVR</td>
<td>Audio/Video Receiver</td>
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## List of Symbols and Units

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<td>Centimeter</td>
<td>Length</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
<td>Length</td>
</tr>
<tr>
<td>V</td>
<td>Volts</td>
<td>Voltage</td>
</tr>
<tr>
<td>KB</td>
<td>Kilobytes</td>
<td>Information</td>
</tr>
<tr>
<td>MHz</td>
<td>Megahertz</td>
<td>Frequency</td>
</tr>
<tr>
<td>g</td>
<td>Grams</td>
<td>Mass</td>
</tr>
<tr>
<td>mA</td>
<td>Milliamperes</td>
<td>Current</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
<td>Length</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
<td>Frequency</td>
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</table>
Chapter 1

Introduction

Over the past few decades transportation has become one of the most necessary and basic facility. The production of automobiles is growing rapidly due to the high demand [1]. About 91.3 percent of households have access to at least one automobile [12]. But one of the major problems is to park a vehicle safely. Generally, while parking we use the manual procedure to park a vehicle which is not totally effective. Around 40 percent of the vehicle accidents occur during parking incurring physical loss or damage [8]. Accidents during parking a vehicle can cause serious injury for both vehicle and person.

One of the main motivation that made us to work on this project is due to the accidents caused during parking a vehicle [8]. For many drivers even for the experienced drivers it is difficult to park a vehicle in a small and closed places like garage [10]. The lack of sufficient space and improper judgement of distance between the obstacle and the vehicle results in bumping the vehicle to obstacle. Therefore, to overcome this problem and make the parking safe we propose Parking Assistance System to avoid the damages occurred during a vehicle parking.

PAS is a parking aid which guides the driver to park a vehicle safely and precisely [11]. The device helps to minimize the potential scratches and bumping while parking a vehicle in a small and closed places [11]. PAS uses Arduino, ultrasonic sensor, LCD, LED’s and a buzzer. While parking the ultrasonic sensor calculates the distance between the vehicle and obstacle. LED’s indicates the respective zones of the vehicle entering and the buzzer is activated when the vehicle is approaching too close to the obstacle. The distance measured by the ultrasonic sensor and calculated by the microcontroller is displayed on the LCD for the driver. The device is designed to assist the driver [10] and help the driver to gain confidence while parking a vehicle [11].

This thesis mainly deals with the parking system for garage or any small and closed places, which is used to avoid the accidents occur during parking a vehicle. The remaining of the paper is organized as following. Chapter 2 describes the related works, Chapter 3 explains the methodology of the project, Chapter
Chapter 1. Introduction

4 presents the experimental results of the project and Chapter 5 discusses the results of the experiments. Finally Chapter 6 summarizes the work and suggests possible development of this topic.
Chapter 2

Related Work

2.1 Background

PAS is based on distance controller for a automobile while parking in a tight and closed places like garage [2]. This device indicates to the driver when the automobile is close to an obstacle and helps to park a vehicle safely. This system will not park the car itself, instead it guides the driver to park a vehicle without any bumping and avoiding the damages while parking a automobile [2]. The system gives a warning to the driver about the distance between the vehicle and the obstacle. PAS works on principle of ultrasonic sonar distance measurement technology which is similar to the sonar systems used in deep sea fishing [2].

![Parking Assistance System](image)

Figure 2.1: Parking Assistance System [14]

The first PAS was installed in a car by Toyota in 2003 [3]. They used ultrasonic technology and the sensors are installed in the bumpers of the car [3]. The system
is initially designed to sense the surroundings and measure the distance between the car and the obstacles. The driver was warned by a beeping noise when the vehicle is too close to the obstacle [3].

According to the Department of Transportation, a considerable percentage of accidents occur while the vehicle is parking or reversing a vehicle [7]. The average car has been witnessing changing dimensions, making it increasingly difficult to park without causing physical damage to the vehicle [7]. These problems can be avoided by installing a PAS [7]. These systems proving to be particularly useful on account of efficiency and safety while parking a vehicle. One of the important benefits of this system is its ability to detect obstacles even when the vehicle is stationary [7]. Additionally, the system is also capable of detecting the obstacles even when the vehicle is in motion.

The major disadvantage is that this system may prove to be physically too deep for installation in the vehicle's bumper due to the presence of the crash protection bar [7]. If the vehicle is involved in an accident, then there is a high chance of sensors might damaged if the system is installed to the vehicle for which the sensors need to be replaced which is time taking and costly process. Therefore, we came up with an idea to install or attach the system to the wall instead of installing the system on the vehicle in the garage. The system is attached at a certain distance and location where it might not get damaged easily by any
vehicle bumping. These types of parking systems can be installed to the walls of garages or any small and closed places.

2.2 Existing Models

2.2.1 Garage Parking Sensor:

Garage is a small and closed room with less sufficient space to park a vehicle. It is very difficult to park a vehicle in such places without a proper guidance. There have been many models in this type of systems. The most common and frequently used system is Garage Parking Sensor to take the guess work out of parking a car in tight garage spaces. It features adjustable, ultrasonic range finding technology to accurately locate the car within the desired parking constraints [4]. There is no longer a need to dangle from the ceiling a stringed tennis ball techniques. It also eliminates the need to clutter the garage floor with parking blocks, or other trip hazards [4].

![Garage Parking Sensor Diagram]

Figure 2.3: Garage Parking Sensor [4]

The main drawback of this model is the entire parking is completely depends on the LED’s. As from the above picture, the system displays red, yellow and green LED’s to indicate the parking status of the vehicle [4]. The driver may not be able to judge the distance between the vehicle and the obstacle precisely and accurately. There will be no warning or buzzer from the system when the vehicle is too close to the obstacle. There is also a high risk of failure of LED’s which may lead to the damage of vehicle.
2.2.2 Garage Laser Parking System:

Laser Garage Parking System is a garage parking aid which uses laser to park the vehicle properly [5]. The device helps the driver to park the vehicle at exact same place every time when the vehicle is parked [5]. The system shoots a little beam of light towards a certain spot in the garage. As the driver pulls in slowly, the beam of light will work its way up to the dashboard of the vehicle which alerts the driver to stop pulling forward [5].

![Garage Laser Parking System](image)

Figure 2.4: Garage Laser Parking System [5]

Though it is useful for a safe parking it has many drawbacks. As the system is laser motion activated, there will be a larger rate of battery drain [6]. The laser is highly susceptible to variation of laser beam which makes the parking inconsistent [6]. The laser emitted from the system can be highly dangerous [6].

The above two mentioned systems are the current existing models in the market. There are number of similar models from different companies. Both the models have contributed to assist and guide the driver while parking a vehicle in a garage [4][5]. But due to their drawbacks they are not as effective as they should be and cause some problems while parking. So keeping the drawbacks of the existing models in mind we came up with PAS. We are using the same approach but we have added few extra features to our system. We proposed a wall mounted system which consists of ultrasonic sensors to measure the distance between the obstacle and the vehicle, LEDs to indicate the respective zones of the
vehicle in garage while parking. An LCD is used to display the distance between the vehicle and the obstacle. It will easy to judge the distance accurately with both LEDs and LCD. A buzzer is used to warn the driver and the people present around the vehicle while parking through beeping noise when the vehicle is too close to the obstacle.
3.1 Model

PAS is a parking aid which is used to assist the parking of a vehicle safely without any collisions or damages in a blind spot areas like garage. PAS is a wall mounted device which is attached to a wall of the garage or any blind spot areas. The device is user friendly and can be installed easily.

![Parking Assistance System](image)

**Figure 3.1: Parking Assistance System**

The figure 3.1 represents the physical model of our project. From the picture, one can see the green, orange, red LED’s, LCD and buzzer are attached at the top of the wall. The ultrasonic sensor is attached at the bottom of the wall. The
system is used to avoid the collision between the vehicle and a obstacle which is wall in this case and guides the driver for a safe parking.

### 3.2 Functionality

![Flowchart](image)

Figure 3.2: Flowchart

The figure 3.2 represents the functionality of the system in the form of flowchart. When the power supply is ON, the ultrasonic sonic sensor measures the distance
between the wall and the vehicle when it is entering into a garage and it sends the data to the microcontroller. The microcontroller then calculates the distance by the given data and sends the calculated distance to the LCD. Then the LCD displays the distance between the vehicle and the wall. The LED’s act according to the distance displayed. If the distance between the vehicle and wall is between 40-30 cm then the green LED is activated which indicates that the vehicle is in safe position to park. If the distance is between 29-20 cm then the yellow LED is activated which indicates that the vehicle is in moderate position to park. Finally, if the distance is between 19-10 cm then the red LED is activated which indicates the vehicle is approaching too close to the wall. Later, the buzzer is activated between the distance 9-0 cm which indicates the vehicle is about to collide with the wall. The buzzer is helpful to warn the driver or the people present surrounding to the vehicle while parking.

### 3.3 Circuit

![System Circuit](image)

The figure 3.3 represents the system circuit. The 9v battery positive end charge is connected to Vin of Arduino nano. The switch is connected to 5v of Arduino nano, Vcc of ultrasonic sensor and the LCD display. The data points of Arduino nano D2 and D3 are connected to LCD’s RS (register select) and E(able) and D4, D5, D6, D7 data pins of Arduino nano is connected to data pins D4, D5, D6, D7 of LCD display. Then D8, D9 data pins are connected to...
trigger and echo pins of ultrasonic sensor. D10, D11, D12 data pins are connected to green, orange and red LED’s respectively. Also 1.5kΩ resistors are used for all the LED’s to limit the current through LED’s. D13 data pin of Arduino nano is connected to positive end of the buzzer. These are the basic and most important connections for the system.

3.4 Components

3.4.1 Hardware Components

1. Arduino Nano:

Arduino Nano is a microcontroller based on the ATmega328. It is small and breadboard friendly. It has similar functionality to the normal Arduino boards. It works with a mini-B USB cable instead of a standard one. The main reason for opting Arduino Nano instead of normal board is due to its compact size and flexibility. It is also budget friendly.

![Arduino Nano](image)

Figure 3.4: Arduino Nano [15]

Arduino Nano acts as the CPU of the project. It controls the other connected components and manages the entire operation by giving the signals. The Arduino Nano can be programmed with the Arduino software. It communicates using the original STK500 protocol [15].
Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>microcontroller</td>
<td>ATmega328</td>
</tr>
<tr>
<td>Architecture</td>
<td>AVR</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>5 V</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>32 KB</td>
</tr>
<tr>
<td>SRAM</td>
<td>2 KB</td>
</tr>
<tr>
<td>Clock Speed</td>
<td>16 MHz</td>
</tr>
<tr>
<td>Analog I/O Pins</td>
<td>8</td>
</tr>
<tr>
<td>EEPROM</td>
<td>1 KB</td>
</tr>
<tr>
<td>DC Current per I/O Pins</td>
<td>40 mA</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>7-12 V</td>
</tr>
<tr>
<td>Digital I/O Pins</td>
<td>22</td>
</tr>
<tr>
<td>PWM Output</td>
<td>6</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>19 mA</td>
</tr>
<tr>
<td>Weight</td>
<td>7 g</td>
</tr>
</tbody>
</table>

Table 3.1: Arduino Nano Specifications [15]

2. Ultrasonic sensor HC-SR04:

An ultrasonic sensor is a distance measuring device by emitting the ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic sensor is commonly used measuring distance or sensing objects with both microcontroller and microprocessor platforms.

![Ultrasonic Sensor](https://via.placeholder.com/150)

Figure 3.5: Ultrasonic Sensor [16]

Working:

The sensor works with the simple formula that is Distance = Speed \times Time in both directions [16]. The ultrasonic transmitter transmits an ultrasonic wave,
this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the ultrasonic receiver module.

![Ultrasonic Sensor Working](image)

**Figure 3.6: Ultrasonic Sensor Working [16]**

**Specifications:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>5V</td>
</tr>
<tr>
<td>Practical Measuring Distance</td>
<td>2-80 cm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>3mm</td>
</tr>
<tr>
<td>Measuring angle covered</td>
<td>&lt;15°</td>
</tr>
<tr>
<td>Operating Current</td>
<td>&lt;15mA</td>
</tr>
<tr>
<td>Operating Frequency</td>
<td>40Hz</td>
</tr>
</tbody>
</table>

Table 3.2: Ultrasonic Sensor Specifications [16]

**3.16*2 LCD:**

An LCD containing thin flexible sheets of an organic electro-luminescent material, used mainly in digital display screens.

![16*2 LCD](image)

**Figure 3.7: 16*2 LCD [19]**
Specifications:

<table>
<thead>
<tr>
<th>Operating voltage</th>
<th>5V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen resolution</td>
<td>2-lines x 16 characters</td>
</tr>
<tr>
<td>Character resolution</td>
<td>5 x 8 pixels</td>
</tr>
<tr>
<td>Module dimensions</td>
<td>80 x 36 x 12 mm</td>
</tr>
<tr>
<td>Viewing area dimensions</td>
<td>64.5 x 16.4 mm</td>
</tr>
</tbody>
</table>

Table 3.3: LCD Specifications [19]

4. Buzzer HXD:

A buzzer is a audio signalling device which is small yet effective to add a sound feature. Buzzers can be either mechanical or electromagnetic or piezoelectrical [18]. The buzzer is normally associated with a switching circuit to turn ON or OFF at required time and intervals.

![Buzzer Image](image)

Figure 3.8: Buzzer [18]

Specifications:

<table>
<thead>
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<th>Rated Voltage</th>
<th>6V</th>
</tr>
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<tbody>
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<td>Operating Voltage</td>
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<tr>
<td>Rated current</td>
<td>&lt;30mA</td>
</tr>
<tr>
<td>Resonant Frequency</td>
<td>2300 Hz</td>
</tr>
</tbody>
</table>

Table 3.4: Buzzer Specifications [18]
5. LED:
An LED or a Light Emitting Diode is semiconductor device that emits light due to Electroluminescence effect [17]. An LED is basically a PN junction Diode, which emits light when forward biased.

![LED's](image)

Figure 3.9: LED’s [17]

Specifications:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Wavelength</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>620 - 645 nm</td>
<td>72 lm/W</td>
</tr>
<tr>
<td>Green</td>
<td>520 - 550 nm</td>
<td>93 lm/W</td>
</tr>
<tr>
<td>Orange</td>
<td>610 - 620 nm</td>
<td>98 lm/W</td>
</tr>
</tbody>
</table>

Table 3.5: LED Specifications [17]

3.4.2 Software Implementation

Arduino IDE:
Arduino Integrated Development Environment commonly known as IDE is generally used for writing the code and compiling the code into Arduino module. It is official Arduino Software. Arduino IDE contains a text editor for writing the code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino/Genuino hardware to upload programs and communicate with it.
Figure 3.10: Ultrasonic Sensor Values

The figure 3.10 represents the distance readings appeared in the serial monitor of Arduino IDE which are detected by the ultrasonic sensor sensor.
A prototype for the PAS has been developed. The results acquired by the PAS are presented below.

![PAS Setup](image)

**Figure 4.1: PAS Setup**

The figure 4.1 represents the PAS setup which shows that the object is moving towards the obstacle which in our case are the vehicle and a wall.
Chapter 4. Experimental Results

The figure 4.2 represents the device when the vehicle is 50 cm away from the wall while parking, no LED lights are ON, please see the flowchart in the figure 3.2 for the reference.

The figure 4.3 represents the device when the vehicle is 40 cm away from the wall while parking, only green LED light will be ON, please see the flowchart in
the figure 3.2 for the reference.

Figure 4.4: Parking at 20 cm

The figure 4.4 represents the device when the vehicle is 20 cm away from the wall while parking, both green and orange LED lights are ON, please see the flowchart in the figure 3.2 for the reference.

Figure 4.5: Parking at 9 cm
Chapter 4. Experimental Results

The figure 4.5 represents the device when the vehicle is below 10 cm away from the wall while parking, all the LED lights green, orange and red will be ON along with buzzer, please see the flowchart in the figure 3.2 for the reference.

The figure 4.6 represents the setup for the accuracy measurement of the ultrasonic sensor used in the system. Different distance points have been marked on the floor with the ruler to find the difference between the manual measurement and PAS estimated distance. The table of these differences will be presented in the next chapter.
Chapter 5

Discussions

Based on the results acquired by the prototype, the system is effective and user friendly. Ultrasonic sensor used in the project to measure the distance between the vehicle and the wall is accurate. The accurate distance measured is displayed on the LCD display. The ultrasonic sensor used is accurate up to 200 cm. There will no delay in the activation of LED’s as the LED’s and LCD display work simultaneously. The buzzer is effective in avoiding the collision by warning the driver or any other people present around the vehicle.

The results acquired by the prototype are divided into 6 stages which are provided in the previous chapter. Based on the testing of prototype from the figure 4.6, the 6 stages of results are as followed.

**Case 1:**
This case represents the system when the distance between the vehicle and the wall is 50 cm. In this case, there will be no activation of LED’s as the vehicle is still not yet in a place to park. Just the distance between the vehicle and the wall is shown in the LCD display.

**Case 2:**
This case represents the system when the distance between the vehicle and the wall is 40 cm. In this case, only green LED is activated indicating that the vehicle is in safe position to park and the other two LED’s remain inactive. The distance between the vehicle and the wall is displayed on LCD.

**Case 3:**
This case represents the system when the distance between the vehicle and the wall is 30 cm. This case is similar to the previous case mentioned. Only green LED is activated indicating that the the vehicle reached the safe place to park a vehicle. The distance is is displayed on LCD.

**Case 4:**
This case represents the system when the distance between the vehicle
and the wall is 20 cm. In this case, the orange LED is activated indicating that the vehicle is approaching little bit closer to the wall and it is not so safe for a vehicle to park beyond that place. The remaining LED will be inactive. The distance is displayed on LCD.

**Case 5:**
This case represents the system when the distance between the vehicle and the wall is 10 cm. In this case, the red LED is activated indicating that the vehicle is too close to the wall and it is not safe to park the vehicle in that distance. The distance is displayed on LCD.

**Case 6:**
This case represents the system when the distance between the vehicle and the wall is less than 10 cm. In this case, a buzzer is activated along with the red LED to warn the driver or any other people present around the vehicle. This case will be activated when the vehicle is about to collide with the wall. Similarly the distance is displayed on LCD.

<table>
<thead>
<tr>
<th>CASE</th>
<th>MEASURED WITH A RULER</th>
<th>ESTIMATED BY PAS (cm)</th>
<th>DIFFERENCE (cm)</th>
<th>BIAS,%</th>
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<tr>
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<td>50</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>39.9</td>
<td>40</td>
<td>0.1</td>
<td>0.25</td>
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<tr>
<td>3.</td>
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<td>10</td>
<td>0.5</td>
<td>4.76</td>
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<td>6.</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>100</td>
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</tbody>
</table>

Table 5.1: Ultrasonic Sensor Accuracy
Chapter 5. Discussions

The table 5.1 represents the difference of accuracy between the distance measured by ruler and the distance measured by the ultrasonic sensor. These results are acquired by the markings of the distance on the floor as shown in the figure 4.6.

From the table 5.1, one can observe the slight variations in the values between the manually measured and PAS estimated distance which is the smaller is the distance between the vehicle and the wall, the greater is the difference between measured manually and PAS estimated distances. This is because of the change in ambient conditions in the measuring range [23]. The distance to the object will also appear to change due to the altered speed of sound. As temperature increases, the sound waves travel faster to and from the target [23]. While the target may not have shifted, it will seem to the sensor that the target is closer.

There will be a minimum distance that ultrasonic sensor can measure which in our case is mentioned in the table 5.1. This is because the difference between measured manually and estimated by PAS distance is large, because the vehicle is in the so-called "dead zone" of the sensor. A dead zone refers to the area directly in front of the transducer face where the sensor cannot reliably make measurements. This is due to a phenomenon called ringing [24]. Ringing is the continued vibration of the transducer after the excitation pulse [24]. The energy must dissipate before the transducer can listen for a return echo. Make sure to locate your target outside of the specified dead zone of your ultrasonic sensor.
In this project, we have developed a prototype of PAS. Based on the results, it can be concluded that the system, which is explained in the paper is user friendly and can be easily installed in the blind spot areas like garage. The efficiency of the system to avoid the collision between a vehicle and an obstacle during parking is high and effective. The ultrasonic sensor detects the objects and measures the distance accurately by the results based on the table 5.1. The distance displayed on the LCD screen helps the driver to reduced the manual efforts to judge the distance. While parking, the LED’s are useful in guiding the driver about the respective zones of the vehicle. The buzzer plays an important as the anti-collision object as it warns the driver or the people present around the vehicle through a loud noise when the vehicle is too close to the obstacle. Hence, Parking Assistance System is effective in guiding and assisting the driver to park a vehicle safely without any collisions or damages while parking in a blind spot areas like garage.

In the future, the parking system developed in this project can be extended by making the brakes of the vehicle automated by making a connection between the parking system and brake system. The system should be designed in such a way that if the vehicle is still in motion even when the buzzer is activated, then the brakes should be applied automatically when it receives a signal from the parking system.
References


References


