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# Obstacle Avoidance Robot - Using FPGA

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**ABSTRACT:**

Because real-time processing tasks are becoming increasingly popular, creating an obstacle avoidance robot utilizing FPGA looked like a decent idea. In real-time operations, FPGA chips are better at handling concurrent workloads. The same obstacle avoidance robot can be transformed into a productive robot. There are two things that must be accomplished. The FPGA chip can be used to handle jobs like ultrasonic distance reading and motor control, and the algorithm can be coded in SOC. The algorithms can then be improved to make them more clever and efficient. This obstacle avoidance system may be used in both outdoor and indoor robots, as well as for automation. Here, the robot will detect an impending obstruction in the way and alert us with a buzzer. We can also use ultrasonic sensors to measure the distance between the robot and the obstacle. Most of the time, the reading will be correct. As a result, constructing these types of robots will remove all of our roadblocks and point us in the right direction.

INDEX TERMS: Voltage Regulator, Motor drivers and Motors, Parallel Processing, Concurrency, Ultrasonic Sensors.

## INTRODUCTION:

In recent years, FPGAs (Field Programmable Gate Arrays) have been increasingly popular in real-time operations.The ability to manage concurrent operations is the major benefit of FPGA-based real-time systems. Programmers can think in a variety of ways thanks to hardware description languages. Only the hardware resources limit the number of concurrent tasks that can be executed. Concurrency is extremely useful in mobile robots.
With the use of a single FPGA chip, a robot with a large number of sensors and motors might be operated simultaneously. As a result, this is a little attempt to create a mobile robot that uses range sensors and wheeled motors to avoid obstacles. The robot platform has the ability to move forward, backward, left, and right. The robot avoids obstacles by using the three range sensors. Combinational logic is used to create the algorithm. While a microprocessor can be utilized for real-time systems, it cannot parallelize data processing in time-critical applications like an obstacle avoidance system. This is a frequently utilized real-time project involving FPGA technology in the area of avoiding obstacles and clearing the path that may be beneficial to everyone.

## SYSTEM REQUIREMENTS:

The system requirements includes Hardware and Software requirement, which are provided below:

## HARDWARE REQUIREMENTS:

- HC – SR04 Ultrasonic sensors * 03
- Spartan 6 Mini FPGA board
- L298N H-Bridge Motor Driver
- DC 12V Motors * 02
- LM2596 Voltage Regulator
- 2” Wheels * 04
- 12V Rechargable Battery Pack.

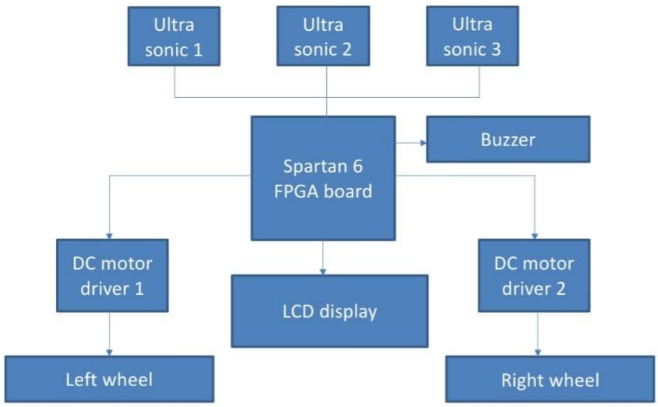
## SOFTWARE REQUIREMENTS:

VHDL Programming Editor

**SYSTEM DESIGN:**

This gives overview of architecture design

**Block Diagram:**




## LITERATURE SURVEY:

It has been observed that a significant amount of study is being conducted around the world to better comprehend obstacle avoidance and debate alternatives at an early stage so that negative consequences can be avoided. Here's the gist of the scientific community's key observations for a meaningful conversation on obstacle avoidance as soon as possible.

- Avoiding Obstacles The robot uses ultrasonic sensors to automatically detect obstacles in its path and move based on the user's actions. At the polytechnic level, research on obstacle avoidance robots can assist students in developing communication, technical abilities, and teamwork. For data processing, the robot is built on the Arduino platform, and its software counterpart assisted in communicating with the robot to send parameters for guiding movement. It can be used in future cameras.
- This work describes the design and development of FPGA robot computational hardware and software. The introduction of reconfigurable FPGAs has boosted the popularity of a new platform for comprehensive robot control systems. Readability has improved as a result of co-designing software-hardware tasks that are utilized to create robotic systems. It presents the Verilog programming language for use in real-time applications.
- One of the important difficulties in the successful deployment of mobile Robot systems is real-time obstacle avoidance. This work introduces a number of algorithms that not only detect obstacles, but also provide quantitative measures of their dimensions. This method addresses the disadvantages of edge detection approaches, allowing for more precise measurements.
- In this research, we use a stereo vision sensor to construct a real-time obstacle avoidance system for an autonomous mobile robot. This method is fast enough for mobile robots with limited image processing capabilities to perform. The primary goal of this paper is to provide autonomous obstacle avoidance in an unfamiliar environment.
- Aamir Attar built and constructed a line follower and obstacle avoidance bot using Arduino to create an autonomous robot that intelligently identifies obstacles in its path and navigates according to the actions that the user sets for it. As a result, this system offers an alternative to the current system by substituting experienced labor with robotic gear, which can manage more patients in less time, with greater precision, and at a lower per capita cost.
- At the polytechnic level, research on obstacle avoidance robots can aid students in developing communication, technical abilities, and teamwork. For data processing, the robot is built on the Arduino platform, and its software counterpart assisted in communicating with the robot to send parameters for guiding movement. It can be used in future cameras.
- Designed and built FPGA robot computational hardware and software. In this paper, an FPGA-based prototype of a robot for obstacle detection employing an infrared proximity sensor is shown. The design includes adapting a motor-driven circuit with L293D to power the robot's motors.
- The design is implemented on an ALTERA DE1 board using Verilog HDL coding. Co-designing software and hardware to create more reliable robotic systems.
- ·One of the important difficulties in the successful use of mobile robot systems is real-time obstacle avoidance. This work introduces a number of algorithms that not only detect obstacles, but also provide quantitative measures of their dimensions. For more accurate measurements, the strategy overcomes the limitation of edge-detection algorithms. The detection approach is a more general and widely used method for obstacle avoidance. The algorithm in this method attempts to calculate the position of the obstacle's vertical edges and, as a

result, attempts to direct the robot around either edge. One of the obstacle's bounds is represented by the line connecting the two edges.

- A computerized Travel Aid for the Blind uses real-time obstacle avoidance. A mobile robot obstacle avoidance system has been successfully converted to a navigation aid for the blind in this research. Instead of sending electronic signals to the robot's motion controllers, the obstacle avoidance system uses stereophonic signals to transfer information to the user. These signals give spatial information on the position of things in space, as well as guiding information about the best travel direction and speed.
- Stereo vision sensor-based real-time obstacle avoidance system for autonomous mobile robots. The main goal of this research is to use a stereo camera to achieve autonomous obstacle avoidance in an unfamiliar environment. It allows for real-time obstacle recognition without the need to look for related points on each image. There are no impediments if the brightness of equivalent locations on the right and left are nearly identical. The difference in brightness indicates that something is close to the spot. This method is quick enough for mobile robots with limited capabilities to perform acceptable image processing.
- Ernesto Cividances spoke about a clever low-power obstacle avoidance system that uses infrared and sonar sensors, as well as radio frequency identification, GPS, and Wi-Fi, to provide numerous technologies to the blind and visually impaired. Microprocessor-based technologies are increasing the power consumption of electronics. This project proposes a handheld gadget constructed in Verilog HDL that automatically guides a visually impaired user through an obstacle-free path. The goal is to reduce power consumption by using a component that can improve the speed of the microcontroller instead of the traditional microcontroller. The handheld gadget, which uses six infrared sensors, is modeled after contemporary technologies that use IR and Sonar sensors, which are discussed in this project. An algorithm for obstacle avoidance and production of the obstacle-free path is reduced using a K-map and implemented using a multiplexer employing behavioural modeling.

## PROPOSED SYSTEM:

An FPGA-based system is used to control a robot with a large number of sensors and motors. Sensors and actuators controlled by FPGA operate without delay and are used in both medical and industrial applications.

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## ADVANTAGES & APPLICATIONS:

- **Advantages:**
- 1. FPGAs are capable of handling several jobs at the same time and are best known for parallel processing, which gives them an edge when identifying impediments with a mobile robot.
- 2. FPGA can manage a huge number of sensors and motors at once without causing any delays.
- 3. FPGA is a low-cost platform for moving robotics.
- 4. It has the ability to adjust its path on its own in response to the objective.
- 5. A circuit that is both flexible and dependable.
- Industrial monitoring is one of the applications.
- 2. Robots that can navigate both outside and indoors.
- 3. Used in the development of smart car technology.
- 4. Monitoring of public behavior.
- 5. Farming animal surveillance.

**Applications:**

1. Industrial monitoring.
2. Outdoor/ Indoor navigation robots.
3. Used in smart vehicle technologies.
4. Public behavioral monitoring.
5. Animal monitoring in farming.

## SAMPLE IMAGES:

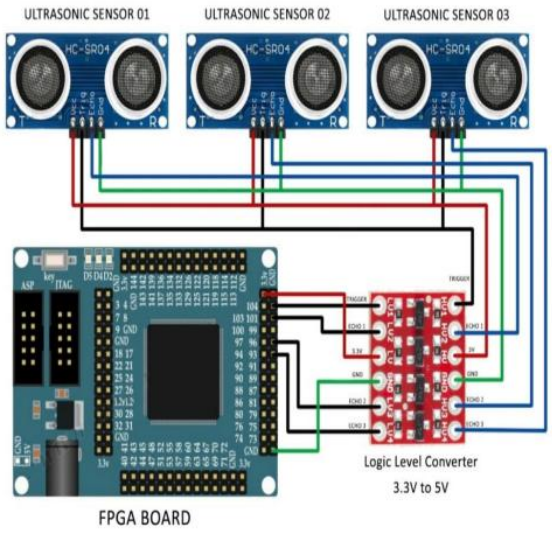


**Image A.**

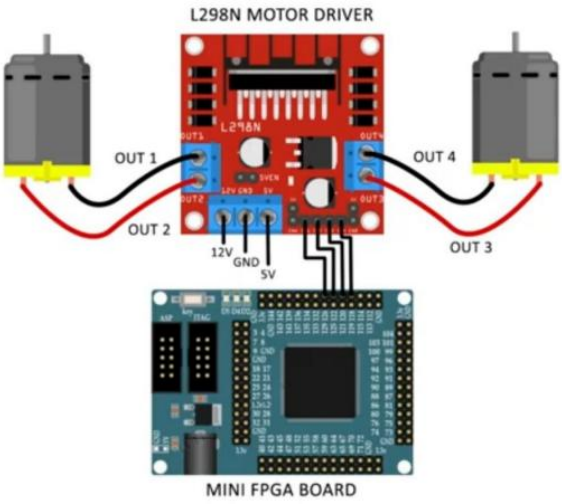


**Image B.**

## CONCLUSION :

The photos presented here are intended to serve as examples of the various processes involved in the creation of a robot. This project will identify an impediment that appears in front of the robot and will prevent it from colliding with it. This robot is entirely automated and can operate without the need for human intervention. This robot may be improved in the future by adding new types of sensors, allowing it to be used in a variety of disciplines such as automation, navigation, and many more applications. This robot has a high level of accuracy and efficiency

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