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## Using A Single Ultrasonic Sensor, A Mean-Based Approach To Omnidirectional Route Finding Algorithms

<sup>1</sup>Ch. Surya Babu, <sup>2</sup>Jupudi Dheeraj, <sup>3</sup>Ganga Bharath Chandu, <sup>4</sup>Muni Satish Chandra,

<sup>5</sup>Motipalli Kumar Jagadhiswar,

<sup>1</sup>Professor, Department of ECE, Rajamahendri Institute of Engineering & Technology.

<sup>2,3,4,5</sup>Student, Department of ECE, Rajamahendri Institute of Engineering & Technology.

### ABSTRACT:

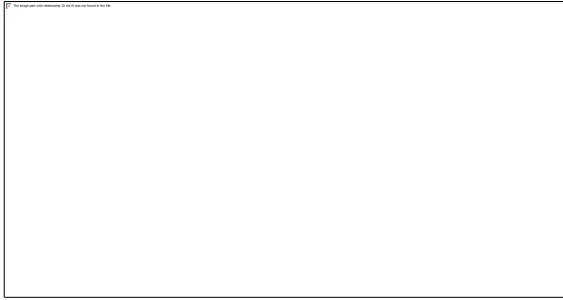
In order to navigate and recognize obstacles successfully in dynamic situations, autonomous robotic systems need to be highly developed. Limited detection range and erroneous route selection are common problems with traditional navigation techniques that use fixed ultrasonic sensors. In order to maximize the efficiency of robotic movement, this project suggests a system for omnidirectional navigation that utilizes an L293D motor driver, servo motors, and ultrasonic sensors. The ultrasonic sensor can scan a full 360 degrees thanks to its servo motor mount, which greatly enhances its accuracy when detecting obstacles. Using data collected in real-time from sensors, the L293D motor driver guides the robotic vehicle's movements for effortless navigation. The system optimizes pathfinding and minimizes false positives in obstacle recognition using a mean-based approach. This method is well-suited for use in autonomous vehicles, search-and-rescue missions, and industrial automation since it greatly enhances robotic efficiency.

### EMBEDDED SYSTEMS

A computer system that is purpose-built to carry out a single or limited set of tasks, often under the restrictions of real-time computing, is known as an embedded system. As with other physical and mechanical components, it is often integrated into a whole device. A personal computer or other general-purpose computer, on the other hand, may be programmed to do a wide variety of functions. These days, many of the everyday items we use rely on embedded systems to function. Design engineers may improve the embedded system to decrease product size and cost while boosting reliability and performance since it is devoted to certain functions. Because of their mass production, certain embedded systems are able to take advantage of cost savings. From small, handheld gadgets like digital watches and MP3 players to massive, permanently installed systems like those managing nuclear power plants, traffic lights, and industrial controls are all

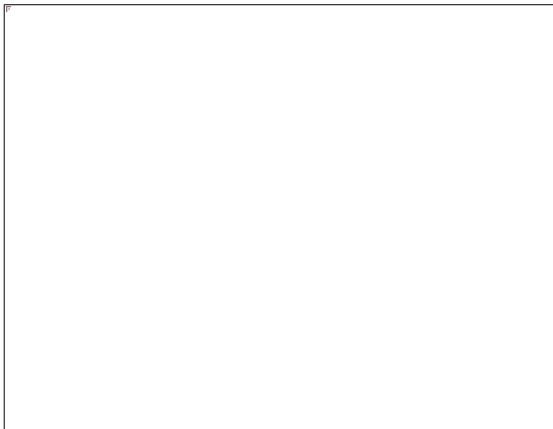
examples of physically embedded systems. From simple systems using a single microcontroller chip to complex systems housing several modules, peripherals, and networks in a massive chassis or enclosure, complexity may range greatly. The phrase "embedded system" lacks a precise definition because the majority of systems have programmability in some form. While they share some components with embedded systems, such operating systems and microprocessors, handheld computers are not technically embedded systems as they enable the loading of multiple programs and the connection of peripherals. Computer hardware and software, either fixed in capability or programmable, particularly intended for a certain sort of application device—this is what's called an embedded system. Embedded systems may be found in a wide variety of objects, including but not limited to: vehicles, medical devices, cameras, home appliances, aircraft, vending machines, toys, and, of course, cellular phones and personal digital assistants. A programming interface is given to programmable embedded devices, and programming for embedded systems is a niche field in and of itself. Embedded Java and Windows XP Embedded are two examples of embedded-specific operating systems and language platforms. On the other hand, certain budget consumer goods include integrated application and operating system components, employ very cheap microprocessors, and have limited storage space. Instead of being loaded into RAM (random access memory), as applications on personal computers are, in this situation the program is written permanently into the system's memory.

### CHARACTERISTIC OF EMBEDDED SYSTEM



## APPLICATIONS OF EMBEDDED SYSTEMS

Here, in the Embedded World, we are living. The smooth operation of the various embedded goods that surround you is crucial to your day-to-day existence. In your living room, you have a TV, radio, and CD player; in your kitchen, you have a washing machine or microwave oven; and at your office, you have card readers, access controllers, and palm devices that let you do a lot. In addition to all of this, your automobile has a plethora of built-in controls that handle functions between the bumpers, most of which you probably don't give a second thought to.



## MICROCONTROLLER VERSUS MICROPROCESSOR

When comparing microprocessors and microcontrollers, what are the key differences? Any general-purpose microprocessor, such as an 8086, 80286, 80386, 80486, or a Pentium from Intel, or a 680X0 from Motorola, etc., is considered a microprocessor. In addition to lacking on-chip I/O ports, these microprocessors also lack random-access memory (RAM). Because of this, they are often called general-purpose microprocessors. Designing a working system around a general-purpose CPU like the 68040 or Pentium requires the addition of extra components like as RAM, ROM, I/O ports, and timers. Though these systems are more costly and cumbersome due to the

inclusion of external RAM, ROM, and I/O ports, they provide the benefit of being versatile in that the designer may choose the quantity of RAM, ROM, and I/O ports required for the work at hand. Microcontrollers are an exception to this rule. On a single chip, you'll find a microprocessor, random access memory (RAM), read/write (ROM), input/output (I/O) ports, and a timer in a microcontroller. So, since the CPU, random access memory (RAM), read/write memory (ROM), input/output (I/O) ports, and timer are all integrated into a single chip, the designer is unable to include any more memory, I/O ports, or timer into the product. Because of its set quantity of on-chip ROM, RAM, and number of I/O ports, microcontrollers are perfect for many applications where space and cost are important considerations. It is not necessary to have a 486 or even an 8086 CPU for many applications; for instance, a TV remote control. Typically, these programs will need some kind of input/output function in order to read signals and toggle bits.

## INTRODUCTION

Section A. Context: Nowadays, pathfinding algorithms are indispensable in the realm of automation and robotics. The one-way nature of ultrasonic sensors limits the pathfinding algorithms that are often utilized with these devices. Their reliance on incorrectly simplistic left-and-right directional judgments is common [1]. Improved algorithms are the focus of this work. When navigating, these algorithms are vital for detecting and evading obstacles. They serve several military purposes, including accessing hazardous or inaccessible locations. In addition, they may be used in atmospheric extraterrestrial obstacle avoidance systems. A. Suresh Kumar Gawre sgawre28@gmail.com is an assistant professor in the electrical engineering department of MANIT Bhopal. Circuit Diagram (Fig. 1) Part B: What Drives Us The constraints of the ultrasonic sensor's unidirectional operation are the driving force behind this endeavor. As discussed in the section on algorithms, this method produces false positives, rendering it useless for determining the optimal route. There are other wide-angle approaches, but they may be rather expensive and intricate. For this reason, we decided to build a hybrid sensor with a servo motor and an ultrasonic sensor. We also developed an algorithm to identify obstacles and provide omnidirectional pathfinding using this sensor. Section C: Paper Structure Section II details the necessary hardware and design, and Section III provides an overview of our project. After that, we learn the algorithm and how it works in Section III. Part IV will go over the necessary software and the

control mechanism, highlighting their significance. Section V concludes our discussion by outlining the project's benefits, practical uses, and future prospects; Section VI provides a comprehensive synopsis of our findings and contributions. For the block diagram, see Figure 12, and for the finished model, see Figure 13. Our main approach is based on a single ultrasonic sensor doing omnidirectional pathfinding using a mean-based algorithm.

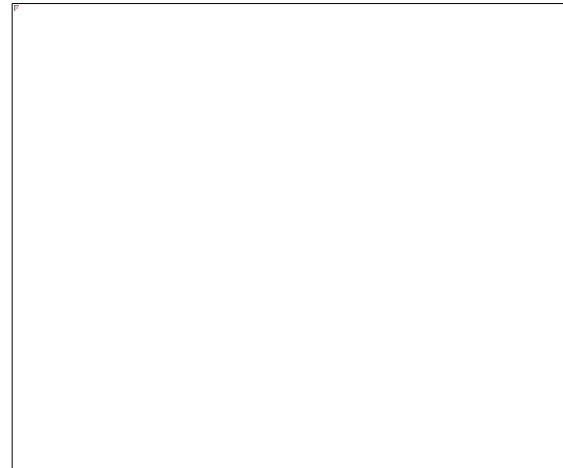
## EXISTING SYSTEM

Traditional robotic navigation systems have significant limitations in complicated situations due to their reliance on static ultrasonic sensors that only detect obstacles in one direction. Inefficient movement, frequent route recalculations, and blind spots caused by signal reflections plague these systems. Furthermore, adaptive obstacle identification is not possible with conventional robotic platforms due to the absence of servo motor-driven scanning. Imperfect movement due to lack of a motor control mechanism (such the L293D driver) leads to navigational inefficiencies and less-than-ideal route execution. Due to their shortcomings, these older systems call for an upgrade to robotic navigation that incorporates real-time obstacle recognition with fine-grained motor control.

## PROPOSED MODEL

The L293D motor driver, servo motor, and ultrasonic sensor all work together in the suggested system to improve robotic navigation. The ultrasonic sensor can scan a full 360 degrees thanks to its servo motor mount, which greatly improves its obstacle detecting capabilities. A mean-based method is used to analyze the obtained data in order to improve route selection and eliminate false positives. Accurate control of the robotic vehicle's movement is provided by the L293D motor driver, allowing for seamless transitions and efficient route execution. This system is well-suited for autonomous robotic applications, industrial tasks, and rescue missions because to its enhanced obstacle detection accuracy and better motor control.

## BLOCK DIAGRAM



**Figure 1: Block Diagram**

### Microcontroller:

A tiny controller, or microcontroller, as the name implies. Often used as a processing or controlling unit, they are similar to single-chip computers. For instance, microcontrollers that do decoding and other regulating operations are likely integrated into the control you are using. They find further use in vehicles, home appliances, microwaves, toys, and any other area requiring automation.

### Arduino Uno Microcontroller:

One such microcontroller board is the Arduino Uno, which uses the Atmega328 (datasheet). It has a 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (6 of which may be used as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller. A key difference between the Uno and all previous boards is the absence of the FTDI USB-to-serial driver chip. Rather of that, it has an Atmega8U2 that has been configured to convert USB to serial. To celebrate the impending release of Arduino 1.0, the name "Uno"—which means "One" in Italian—has been chosen. The Uno and Arduino version 1.0 will serve as the foundational versions for future Arduino releases. For a comparison with prior generations, see the index of Arduino boards. The Uno is the newest in a series of USB Arduino boards and the standard model for the Arduino platform.

### ARDUINO UNO BOARD:

One board that uses the Atmega328 microprocessor is the Arduino Uno. A 16 MHz ceramic resonator, 6 analog inputs, 14 digital I/O pins (including 6

PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

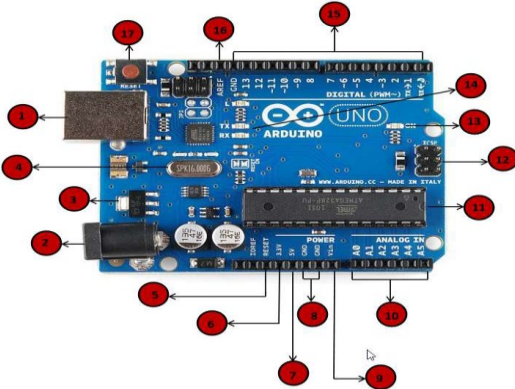


Figure 2: Arduino uno board

In contrast to all of its predecessors, the Uno does not have the FTDI USB-to-serial driver chip. As an alternative, it makes use of USB-to-serial converters coded into the Atmega16U2 (Atmega8U2 up to version R2).

**HARDWARE COMPONENTS**

**POWER SUPPLY UNIT**

The power supply for this system is shown below.



Figure 3: power supply

**Diodes:**

Only one path of electrical current may pass through a diode. Current may flow in either direction, as shown by the arrow in the circuit symbol. Originally termed valves, diodes are essentially an electrically enhanced version of the mechanical component.



Figure 4: Diode Symbol

One kind of electrical component that restricts current flow is the diode. A voltage loss of around 0.7V will be the sole influence on the signal when the diode is "forward-biased" in this way. No current will flow through a diode that is "reverse-biased" when the current is applied in the other direction.

**Rectifier**

A rectifier's job is to change the phase of an alternating current (AC) waveform so that it appears as a direct current (DC) waveform. Both "half-wave" and "full-wave" rectifiers are used for rectification. Diodes are used in both devices to convert AC current into DC current. The Half-Wave Rectifiable The graphic shows that the half-wave rectifier is the simplest rectifier type since it only employs one diode.

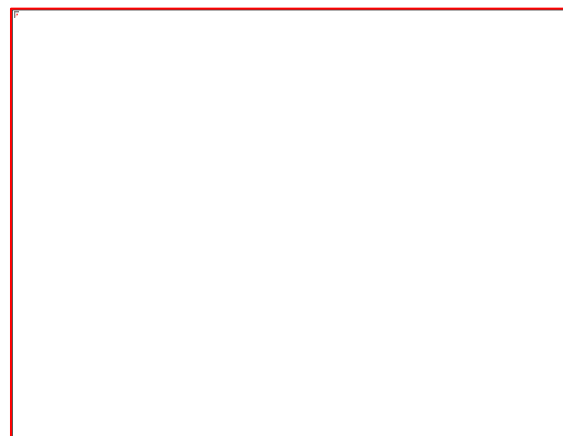


Figure 5: Half Wave Rectifier

**LIQUID CRYSTAL DISPLAY**

An array of color or monochrome pixels arranged in front of a light source or reflector makes up a liquid crystal display (LCD), a thin, flat display device. Two polarizing filters, with their polarity axes perpendicular to one other, and a column of liquid crystal molecules hanging between two transparent electrodes make up each pixel.

Light would not be able to travel through them if the liquid crystals weren't interposed. To make light flow through two filters, the liquid crystal changes the polarization of the light entering the first filter.

A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. 16x1, 16x2, and 20x2 LCDs are among the most popular types of displays that are often linked to the controllers. Which works out to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line. The use of "smart LCD" displays allows for the visual output of information by many microcontroller devices. Affordable, user-friendly, and capable of producing a readout utilizing the display's 5X7 dots plus cursor, LCD displays built on the LCD NT-C1611 module are a great choice. They use mathematical symbols and the usual ASCII set of characters. The display needs a +5V power and 10 I/O lines (RS, RW, D7, D6, D5, D4, D3, D2, D1, D0) for an 8-bit data bus. The only additional lines needed for a 4-bit data bus are the supply lines and six more (RS, RW, D7, D6, D5, D4). The data lines are tri-state and do not affect the microcontroller's function when the LCD display is disabled.

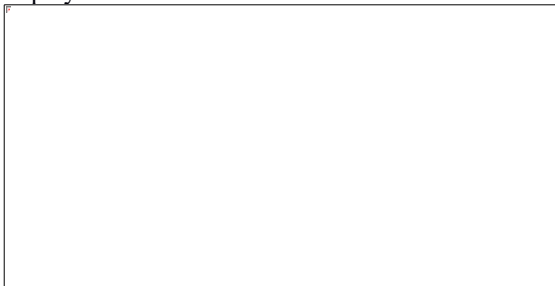
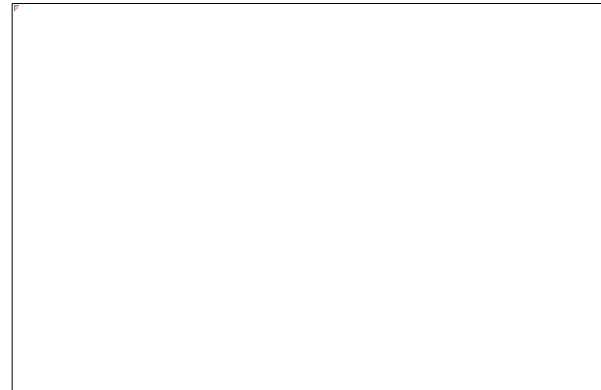


Figure 6: 2x16 LCD Display

**BUZZER**

In a magnetic transducer, the circuitry includes an iron core, a yoke plate, a wound coil, a permanent magnet, and a vibrating diaphragm that can be moved. The magnet's field gently draws the diaphragm up nearer the core's surface. A positive alternating current (AC) signal causes the diaphragm to move up and down, which in turn vibrates the air. This is achieved by the current passing through the excitation coil, which forms a fluctuating magnetic field. A resonator, which is composed of a cavity and one or more sound holes, may amplify vibrations in order to generate a loud sound.



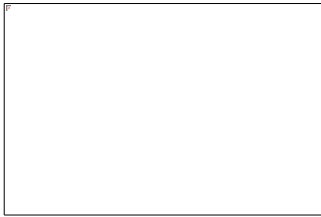
**ESP8266 Wi-Fi Module**

This project revolves on this. Because the project relies on WIFI control of appliances, the module is a crucial part of it. One remarkable feature of this tiny board is the integrated MCU (Micro Controller Unit), which allows for the control of I/O digital pins via a simple programming language that is almost pseudo-code like. Another benefit is that the ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Espressif Systems is situated in Shanghai and makes this gadget. In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-party company AIThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. His tiny size and cheap pricing (1.7–3.5\$) enticed a lot of hackers and geeks to look into it and utilize it for all sorts of projects. Because of its enormous success, Espressif now offers a wide variety of models with varying size and technological specs. Its replacement includes ESP32.

**RELAYS:**

Industrial controls, automotive systems, and home appliances all make extensive use of electrically controlled switches called relays. By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

Inductor



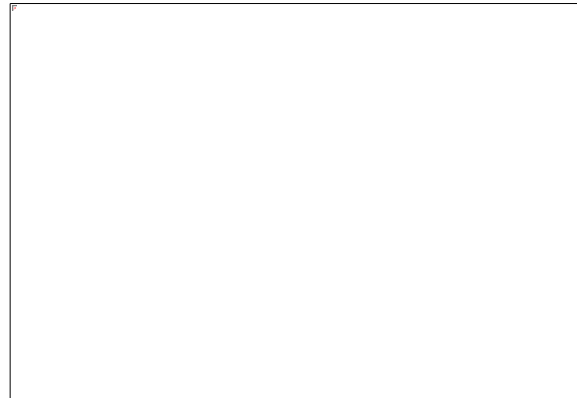
**Fig7 : Circuit symbol of a relay**

**DRIVING A RELAY:**

Two of the SPDT relay's five pins are used by the magnetic coil, one serves as the common terminal, and the other two are typically closed and normally connected. The coil is activated when a current passes across it. At the beginning, when the coil is deenergized, the usually closed pin and common terminal will be connected. A new connection will be formed between the common terminal and usually open pin when the coil is activated, breaking this connection. Therefore, the relay will be activated whenever the microcontroller sends an input signal to it. You may drive the loads connected between the common terminal and typically open pin while the relay is on. Consequently, the high-current loads are driven by the relay, which receives 5V from the microcontroller. This means the relay may be used as a means of isolation. The microcontroller and digital systems do not have enough current to operate the relay. In contrast to the 10 milliamps required to activate the relay's coil, the microcontroller's pin can only provide 1 or 2 milliamps. This is why the microcontroller and the relay are separated by a driver, like ULN2003, or a power transistor. By connecting ULN2003 to the relay and microcontroller, it is possible to activate many relays simultaneously.

**Bluetooth communication between Devices**

One use case is communicating between a smartphone and an HC-05 Bluetooth module; the other is seeing the data from the module on a PC serial terminal. A Bluetooth terminal app is necessary for data transmission and reception on smartphones in order to connect them to the HC-05 Bluetooth module. Apps for Bluetooth terminals are available in the app stores for both Android and Windows.



**Bluetooth Module Serial Interface**

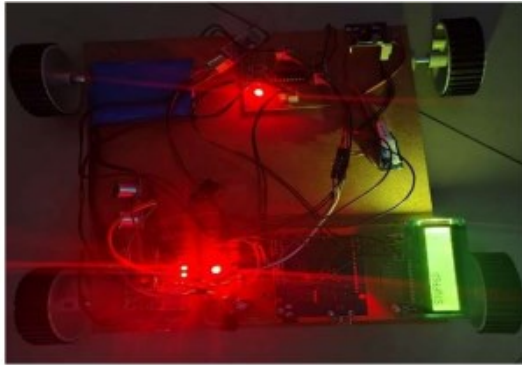
Therefore, in order to establish a connection between the HC-05 Bluetooth module and a smartphone, we must first connect the module to a personal computer using a serial to USB converter. We need to pair the HC-05 module with the smartphone before we can set up Bluetooth communication between the two devices.

**SOFTWARES**

The Arduino platform is an open-source, user-friendly hardware and software environment for prototyping. It is comprised of a programmable circuit board (also called a microcontroller) and an Integrated Development Environment (IDE) called Arduino that is pre-made for writing and uploading code to the physical board. The main characteristics are:

- Many sensors can send signals in digital or analog formats to Arduino boards, which may then be used to activate motors, control LEDs, establish connections to the cloud, and much more.
- The Arduino IDE (also called "uploading software") allows you to command your board's operations by communicating with the microcontroller on the board.
- A separate device, known as a programmer, is not required to load fresh code into an Arduino board, in contrast to most prior programmable circuit boards. The usage of a USB connection is all that is required.
- The Arduino IDE employs a streamlined version of C++, which facilitates programming learning. Last but not least, Arduino offers a standardized form factor that simplifies the microcontroller's tasks. Now that we know what the Arduino UNO board is and how it works, we can go on to setting up the Arduino IDE. As soon as we figure this out, we can upload our software to the Arduino board.

## RESULTS



Model

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## CONCLUSION

One state-of-the-art approach to autonomous robotic navigation is the combination of servo motors, ultrasonic sensors, and L293D motor drivers. In contrast to conventional systems, our method guarantees accurate movement control, reduces navigational mistakes, and greatly improves obstacle detection coverage. In order to reduce false positives and increase overall efficiency, a mean-based method is used to guarantee reliable route selection. Additional sensor integration for enhanced robustness, adaptive machine learning-based navigation, and AI-driven obstacle identification are all potential future developments. Numerous fields may benefit from this cutting-edge, budget-friendly technology, including industrial automation, navigation for autonomous vehicles, and exploration of dangerous regions.

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