American Journal of Botany and Bioengineering
https://biojournals.us/index.php/AJBP
ISSN: 2997-9331

Implementation and Optimization of a Smart Assistive Stick Using Ultrasonic Sensors for Enhanced Environmental Interaction and Obstacle Detection

Qutaiba Sabah Fadhil
Department of Biomedical Engineering, AL-Khwarizmi College of Engineering, University of Baghdad

Ali Adnan Ali, Noor Alhuda Falah Hassan, Abdullah Faris Salih
Department of Medical device engineering, College of Engineering Technology, University of Alkitab

Received: 2024 19, Sep
Accepted: 2024 28, Sep
Published: 2024 13, Oct

Annotation: The system has been successfully implemented and the aim is achieved without any complications. The results are realized in this project are genuine and are a product of sincerity and hard work. It is worth mentioning that such devices can be communicated in a perfect way, especially the Ultrasonic Sensor communicates well with the The surrounding environment is in several directions and is transmitted to the Arduino microcontroller successfully. It can be said that there are many obstacles and potholes and also going up or down stairs can be picked up involuntarily with this stick. There are many future prospects for the project, because the poor stratum of society needs support of all ages. The product can also be developed or modified according to the growing needs or requirements.

Introduction

According to the World Health Organization, 30 million people are permanently blind and 285 billion people suffer from low vision. One of the problems that people with visual impairment suffer in movement. Our project is to make an ultrasonic walking stick for the blind using Arduino.

This research aims to create a smart stick to help the blind movement through the use of microcontrollers and ultrasonic sensors. The search application is divided into a special aspect of the implementation of the system, where it used two microcontrollers, one of which is called the independent controller, which detects the obstacles that the user encounters and alerts him using the buzzer, and the other is called the dependent controller, which detects the pits that obstruct the user and alerts him through stick vibration. The system has been implemented and has achieved its objectives, as it has detected obstacles and alerted the blind by the whistle when there is an obstacle in front of it, and the stick vibrates if there are holes.

1.1 Converting the idea into a scientific reality.

We started with a continuous search for a department that works on solving a problem that many people suffer from, through which we can highlight the joy and happiness of a small group of people. The result of that research was that a circuit was reached, which is the electronic stick that works to guide the blind. Thanks to the efforts of the work team, this department was reached, as we are one hand. And now we have started the process of thinking about how to transform this circle from a theoretical reality into a reality Tangible action. But is necessary to break our fear barrier, since we, the work team, are one of the graduates of this institute, and this has been entered into the wide world of electronics. Indeed, we have transformed this circuit into a tangible practical reality, as we were able to compete in the labor market, and we worked on developing this circuit into a printed board, and this was the first step in our work

1.2 The importance of the project.

1. Using the electronic stick technology to run when passing in several places

2. Refining the student's skills in implementing electronic projects and gaining confidence in the work team

1.3 Objectives of the project.

There are goals that we have strived hard for, and we have tried by various means to reach the goal and goal that we have sought for. Among the most important goals of this project are the following:

1- Design and implementation of an electronic stick to guide the blind who can access it.

2- Learn how this electronic stick works and how to work with it by the same person.

3- Controlling the action of the stick by means of the sensor

4- It works to guide the blind while passing on the street without fear. 5- A solution to a problem that people were suffering from, and to show happiness, affection and familiarity with people.

6- One of the most important goals is to solve a problem that the community was suffering from.

1.4 Applications

There are many uses for the electronic stick. It is used by the blind in one or more of the following uses: *Knowing the type and characteristics of the land on which he is walking

1- Determining the type, size and area of obstacles or obstacles on the road and thus avoiding them and not colliding with them or falling into pits if they exist.

2- Determining the trajectory and direction in the place and determining the width or width of the road.

3- The ability to follow sidewalks and walls while walking and some special signs that are placed for the blind, such as those placed on sidewalks, trains or buses.

1.5 Attracting the attention of others and informing them that the person is blind and thus helping him or preventing him from hitting an obstacle or reducing the speed of driving the vehicle to enable him to cross the road and other things that the blind may need.

1.6 Kinds of stick.

The electronic stick has traditionally been divided into five categories based on its function or purpose and the form it takes. These types are:

1- The traditional white cane: It is known as (Hoover's stick), and it is a long stick used by the visually impaired and the blind and designed to facilitate the movement of the user. And the ground through which the blind can discover the obstacles or obstacles that stand in his way and avoid collision with them, and the ends of these sticks are made of nylon or aluminum.

2- The long stick: It is the most used stick for movement, and therefore its length varies from person to person. The blind can, with the long stick, detect obstacles that might come in their way before hitting them. The ends of these sticks are made of nylon, and these ends take several shapes, including pointed or spherical, or sometimes leaning on the rib cage or conical

3- Ordinary walking stick: It is used by the blind, the visually impaired and the sighted without special specifications, and it is usually made of a solid wooden material that can withstand.

4- Mountain stick: It is a curved stick that is very similar to a tennis racket. It is used in floors that are not suitable for long sticks, such as areas with rugged terrain and rocky roads, and its length must reach above the lower part of the rib cage.

5- Electronic stick: It is an electronic stick designed in the form of a long white stick, but it provides the curtain with the ultrasonic frequencies that he feels in his hand when it hits a certain obstacle in its path. You can explore obstacles in all directions at a distance of five meters, and the ends of this stick are made of lead

2.1 Smart Blind Stick Device

Visual impairment affects many lives globally, Walking stick, the most popular aid for blind people various assistive devices for the blind have been proposed. Today's assistive devices use a variety of sensors, specifically ultrasonic sensors (Elmannai & Elleithy,). These sensors appear to be appropriate in the context of this study as they can detect almost all types of materials, and are of low cost, This study was pursued to design an assistive device for the ultrasonic sensor, the research aims to determine the characteristics and limitations of the current ultrasonic assistive devices; development of a prototype for an auxiliary ultrasound sensor; Describe its efficacy. The results of this study will benefit the visually impaired community, as this study aims to develop a device that may increase their degree of independence so that they can navigate flat and rocky terrain without worrying about their safety. Also, the communities to which they belong will be more confident in the safety of the blind and will no longer need to avoid their way. Finally, this study will benefit future researchers as it may provide them with up to-date data on ultrasound assisted devices and low vision in the state.

2.2 The suffering of the blind

A number of people with visual disabilities emphasized that there are some challenges and difficulties they face in society, foremost of which is the issue related to movement and movement independently, and the urgent need for the presence of facilities, as well as some difficulties related to the lack of rehabilitation and preparation of buildings and public facilities for use by the blind, demanding the necessity of Work to prepare places such as universities and work so that he can move .freely and on his own without the help of others

2.3 Tools used in this device

1- Uitrasonic sensor HC-SR04 sensor

2- Arduino uno

3- Nine volt battery (Duracell)

4- Buzzer

5- L298N

6- Vibration motor – precision microdrives

2.3.1. Ultrasonic Sensor

Fig. (1) Ultrasonic Sensor

This is the HC-SR04 ultrasonic distance sensor. This economical sensor provides 2cm to 400cm of noncontact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground). You will find this sensor very easy to set up and use for your next range-finding project. This sensor has additional control circuitry that can prevent inconsistent "bouncy" data depending on the application

2.3.2. Battery

Fig. (2) Battery Unit

2.3.3. Buzzer

Fig. (3) Buzzer

Buzzer A device that converts electrical energy into audible sound. It is used for acoustic notification. There are different types of electric buzzer. A typical buzzer works on a voltage of 3-12 volts and carries a constant current of about 25 mA. The Buzzer is often used in electronic projects to produce a buzzing sound, and the intensity of the tinnitus can be controlled by programming, and it is distinguished by the use of a direct wave and it emits the sound itself.

2.3.3. L298N

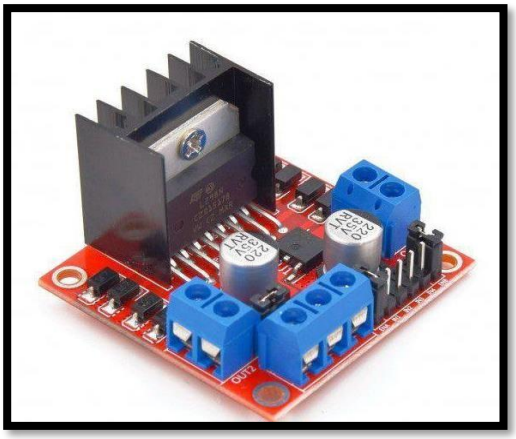


Fig. (4)---------- L298N

The L298 motor unit, which is called the L298N motor driver, is a driver unit for controlling high power DC motors such as the DC Motor and the Stepper Motor. This module consists of the L298 IC and the 5V 78M05 Regulator. The L298N can control the operation of up to 4 DC motors, or 2 DC motors with directional and speed control

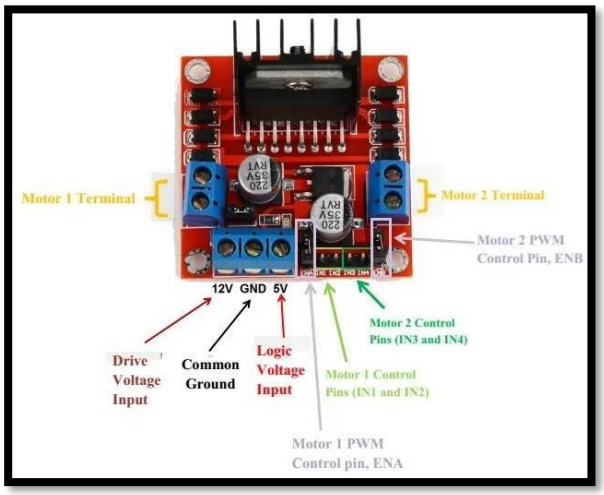


Fig. (5) L298N pinout

L298N Unit Specifications and Specifications

1- The module identification model is L298N 2A

2- The chip used to control Double H Bridge L298N

3- The motor's supply voltage (maximum) is 46volts

4- The motor's supply current (maximum) is 2 amperes 5- The logical voltage is 5 volts

6- The input voltage from the 12V terminal is from 5 to 35 volts-

7- The amount of current that the unit canwithstand to operate it is 2 Ampere

8- The logical current is from 0 to 36 mA

9- The maximum consumption of electrical energyis 25 Watts

10- voltage sensor in each motor

11- It includes a cooling piece for any Heat Sink cooler For better performance and efficiency.

2.3.3. Vibration Motor

Fig. (6) Vibration Motor

DC motor to generate strong vibrations with high strength and a current that does not exceed 120 mA and a flexible operating voltage of 3 to 6 volts. It is used in various projects to manufacture vibration-generating devices with very high efficiency, as it contains a shaft with a diameter of 2 mm attached to the vibration- generating piece. It is characterized by its resistance to heat, shock, mechanical tension, corrosion and rust, and it is surrounded by a vibration-absorbing material for high stability.

3.1. Handling with Arduino Micro Controller

Arduino is an electronic board that enables automatic control in an easy and simple way. It is characterized by an open source that allows the ability to view and modify the source code completely freely through the Arduino C programming language. Which in itself is simple considering that it is accessible to the user regardless of whether he is an amateur or a professional on the one hand. On the other hand, it is a middle line between the user and the machine, in addition to the fact that it is free-to- download programming, similar to other developmental environments.

3.2. Integrated Development Environment (IDE)

The Arduino integrated development environment (IDE) is the program in which the Arduino board is coded in the C language and uploaded to it. The development environment is simple and easy to handle, and contains everything a programmer needs to write code, It works on different operating systems: Linux, Mac OS X, Windows. Programs written using the Arduino. IDE are known as sketch, and are stored on the computer as an ino file

Figure (6) shows the Arduino IDE interface, which consists of the ollowing parts:

1. Menu toolbar.

2. The common functionality toolbar.

3. Text editor.

4. Message area.

5. Text console.

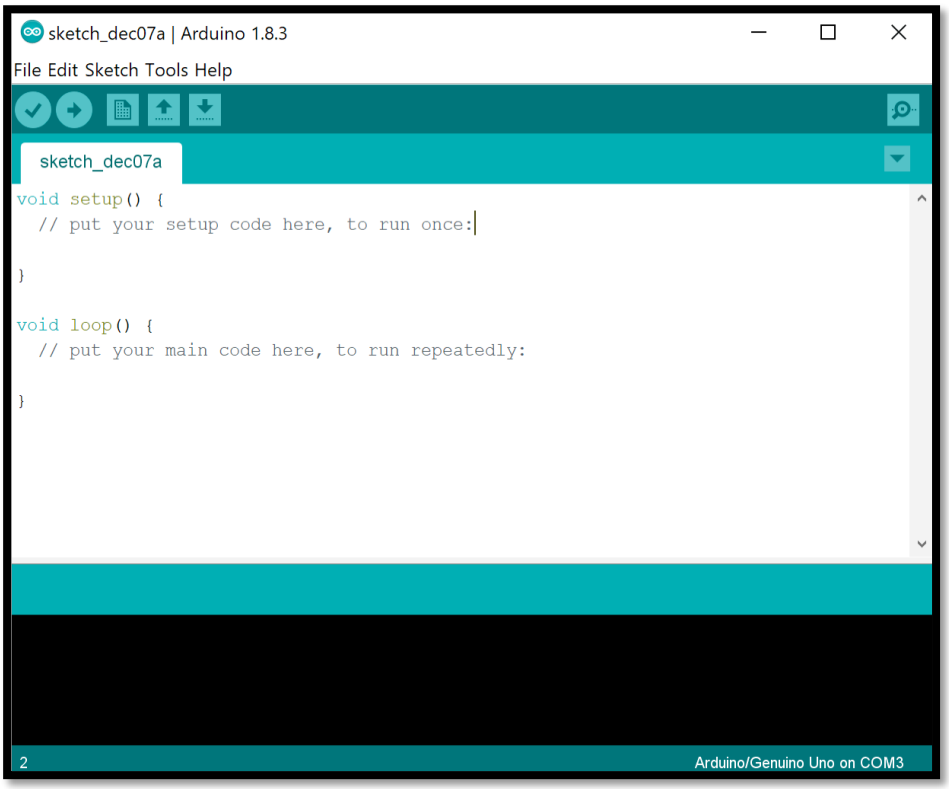


Fig. (7) Arduino IDE

3.3 Digital Pins

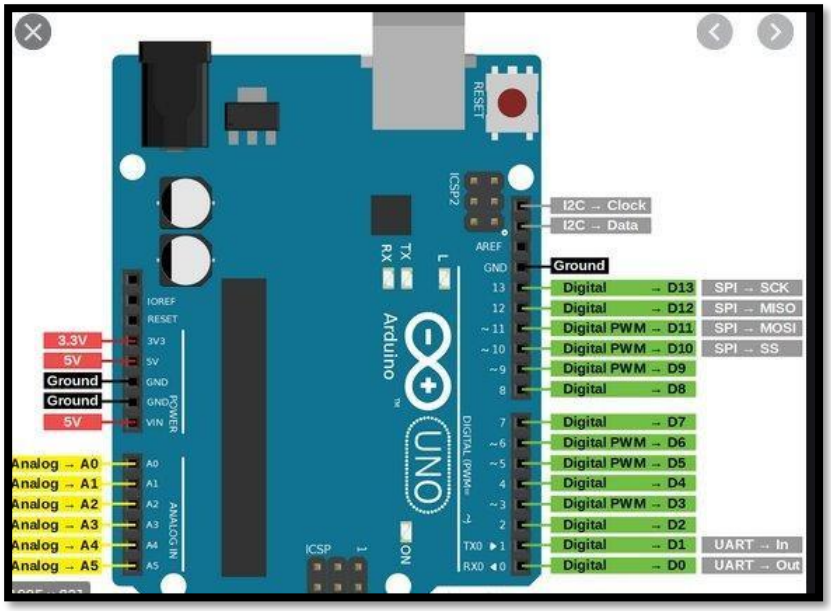
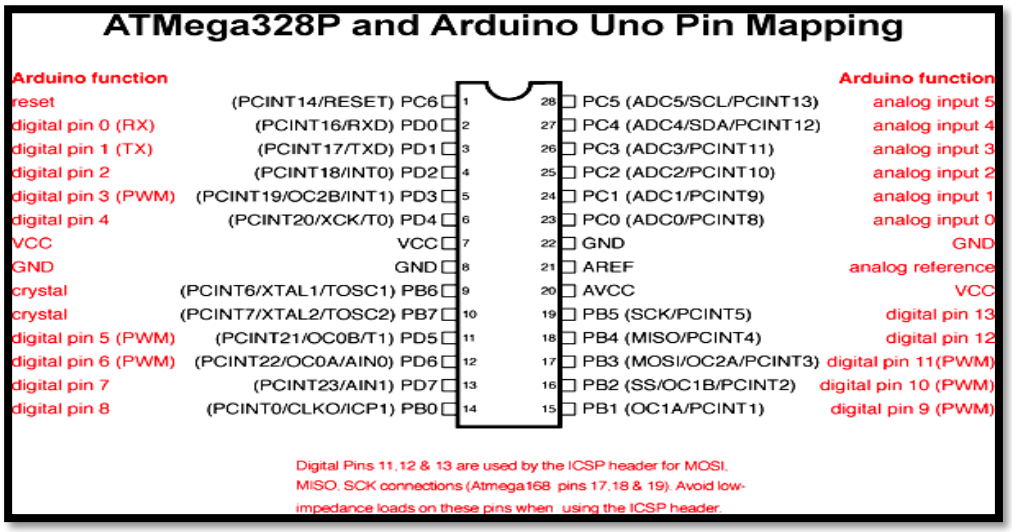


Fig. (8)Digital pins

The pins on the Arduino can be configured as either inputs or outputs. This document explains the functioning of the pins in those modes. While the title of this document refers to digital pins, it is important to note that vast majority of Arduino (Atmega) analog pins, may be configured, and used, in exactly the same manner as digital pins.



3.4 Atmega328P Pin Mapping

Fig. (9) -------Digital pins Atmega328P Pin Mapping

3.5 Properties of Pins Configured as INPUT

Arduino (Atmega) pins default to inputs, so they don't need to be explicitly declared as inputs with pinMode() when you're using them as inputs. Pins configured this way are said to be in a high-impedance state. Input pins make extremely small demands on the circuit that they are sampling, equivalent to a series resistor of 100 megohm in front of the pin. This means that it takes very little current to move the input pin from one state to another, and can make the pins useful for such tasks as implementing a capacitive touch sensor, reading an LED as a photodiode, or reading an analog sensor with a scheme such as RCTime. This also means however, that pins configured as pinMode(pin, INPUT) with nothing connected to them, or with wires connected to them that are not connected to other circuits, will report seemingly random changes in pin state, picking up electrical noise from the environment, or capacitively coupling the state of a nearby pin.

3.6. Pullup Resistors with pins configured as INPUT

Often it is useful to steer an input pin to a known state if no input is present. This can be done by adding a pullup resistor (to +5V), or a pulldown resistor (resistor to ground) on the input. A 10K resistor is a good value for a pullup or pulldown resistor.

3.7. Properties of Pins Configured as INPUT_PULLUP

There are 20K pullup resistors built into the Atmega chip that can be accessed from software. These built-in pullup resistors are accessed by setting the pinMode() as INPUT_PULLUP. This effectively inverts the behavior of the INPUT mode, where HIGH means the sensor is off, and LOW means the sensor is on. The value of this pullup depends on the microcontroller used. On most AVR-based boards, the value is guaranteed to be between 20kΩ and 50kΩ. On the Arduino Due, it is between 50kΩ and 150kΩ. For the exact value, consult the datasheet of the microcontroller on your board. When connecting a sensor to a pin configured with INPUT_PULLUP, the other end should be connected to ground. In the case of a simple switch, this causes the pin to read HIGH when the switch is open, and LOW when the switch is pressed. The pullup resistors provide enough current to dimly light an LED connected to a pin that has been configured as an input. If LEDs in a project seem to be working, but very dimly, this is likely what is going on. The pullup resistors are controlled by the same registers (internal chip memory locations) that control whether a pin is HIGH or LOW. Consequently, a pin that is configured to have pullup resistors turned on when the pin is an INPUT, will have the pin configured as HIGH if the pin is then switched to an OUTPUT with pinMode(). This works in the other direction as well, and an output pin that is left in a HIGH state will have the pullup resistors set if switched to an input with pinMode().

3.8. Properties Of Pins Configured As Output

Pins configured as OUTPUT with pinMode() are said to be in a low- impedance state. This means that they can provide a substantial amount of current to other circuits. Atmega pins can source (provide positive current) or sink (provide negative current) up to 40 mA (milliamps) of current to other devices/circuits. This is enough current to brightly light up an LED (don't forget the series resistor), or run many sensors, for example, but not enough current to run most relays, solenoids, or motors. Short circuits on Arduino pins, or attempting to run high current devices from them, can damage or destroy the output transistors in the pin, or damage the entire Atmega chip. Often this will result in a "dead" pin in the microcontroller but the remaining chip will still function adequately. For this reason it is a good idea to connect OUTPUT pins to other devices with 470Ω or 1k resistors, unless maximum current draw from the pins is required for a particular application.

3.9. Arduino Related Program Code

RESULTS

The proposed project is considered an example for robotic fabrication, aiming to design an sort of Arduino tool and understand how Arduino works.

4.1-The Proposed Work

Fig. (10) Result

Fig. (11) The result with a patient

4.2 Discussion

The results show the accuracy of the external design of the device and the efficiency of the device, as it is able to work in several directions simultaneously. It is able to sense the objects that are in front of the stick from a distance of 30 cm, and the holes and others that are under the stick from a distance of 15 cm. This distance was chosen because it is considered Dangerous for the blind patient as such distances can stumble through them the results also showed the importance of the project in ascending and descending stairs with high accuracy.

5.1. Conclusion and principle of action

The principle of the device installed on the stick depends on sending ultrasound waves through which it measures the dimensions of the obstacles in the way of the blind. If there is any obstacle in front of me, the distance in front is 30 cm, and if any foreign body is found, its height starts from 18 cm above the ground. It sends a signal to the smart chip known as the microcontroller, which we programmed in a special programming language to become qualified to analyze the signals and give the appropriate commands in the form of sound or vibration. As for the vibration of the stick, it means that the obstacle is very close. As for the resistors, in order to regulate the electric current coming from the battery, we accomplished it with a 9-volt battery to power the device.

FUTURE WORKS

In the future, we will develop the device and add modifications, such as alerting the blind with sound and warning him if the device's battery runs out in order to charge it. It is also possible to add "Bluetooth" or GSM technology and connect it to the stick to facilitate the process of controlling and directing it. It can also be integrated with the voice assistant software if built-in speakers are used to inform the user of nearby stores and details of major buildings that they may not be able to see. In addition, the battery can be replaced with a solar panel.

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