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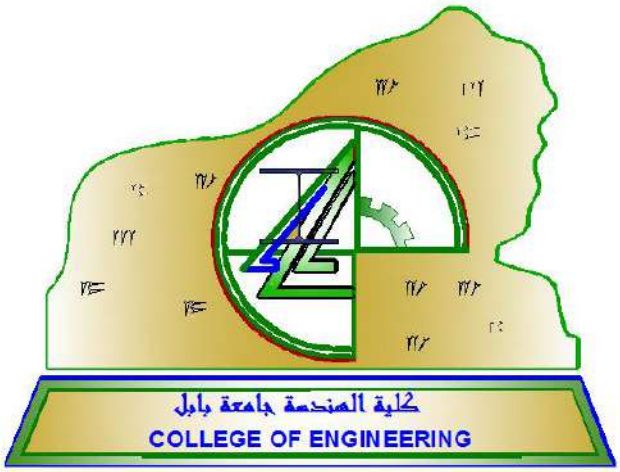
Faculty of Engineering

Electrical Engineering Department



Ultrasonic wireless communication system

By

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بسم الله الرحمن الرحيم

(اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ * خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ * اقْرَأْ وَرَبُّكَ الْأَكْرَمُ * الَّذِي عَلَّمَ بِالْقَلَمِ * عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ)

صدق الله العظيم

Dedication

To my family.....

To my supervisors....

To my teacher.....

To my friends....

With respect

Certificate

The project entitled:

Ultrasonic wireless communication system

Which is being submitted by:

Shamam faris hamza
Mohammed Sadiq namaa
Khairallah Ghanem mohammed
Amna Kareem ali

In the fulfillment of requirement for the award of the B.Sc. degree in Electrical and Electronic Engineering. This has been carried out under my supervision and accepted for presentation & examination.

Signature :

Supervisor's name : ADr . Hilal Al-Libawy

Date / / 2022

The Supervisor

CERTIFICATE

This project entitled

Ultrasonic wireless communication system

Which is being submitted by

Shamam faris hamza
Mohammed Sadiq namaa
Khairallah Ghanem mohammed
Amna Kareem ali

In the partial fulfillment of requirement for the award of the B.Sc. degree in Electrical Engineering has been discussed by us and all the suggested recommendations during the discussion are carried out.

1st Examiner (The supervisor)	2nd Examiner
Signature	Signature
Name:	Name
Date: / /	Date: / /
3rd Examiner	4th Examiner
Signature:	signature:
Name:	Name:
Date: / /	Date: / /
5th Exam	6th Examiner
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Abstract

We use this project to We use t Ultrasound communication system In this project
we can transfer data between two points where ultrasound sensors are used
(sending data from the transmitter and passing it through the ultrasonic sensors and receiving it from the receiver, and the results show that when the distance is less than 10 centimeters there is no reading For the receiver sensor, but when the distance is greater than 10 centimeters, the increase will be linear, that is, the greater the distance between the sensors, the greater the error rate, and the distance from 40 cm to 1 meter is the most appropriate distance for transmitting data without error (here when sending 34 characters), these percentages differ According to the number of characters sent, we do a test about various obstacles and note that the wipes and noise do not affect the transmitted data, and the wood prevents the transmitted data from reaching to the receiver .

CONTENTS

Chapter 1

Wireless communication system

1.1 Introduction

System using radio-frequency, infrared, microwave, or other types of electromagnetic or acoustic waves in place of wires, cables, or fibre optics to transmit signals or data. Wireless devices include cell phones, two-way radios, remote garage-door openers, television remote controls, and GPS receivers. Wireless modems, microwave transmitters, and satellites make it possible to access the Internet from anywhere in the world. A Wireless Markup Language (WML) based on XML is intended for use in such narrow-band devices as cellular phones and pagers for the transfer and display of text.[1]

1.2 Types of Wireless Communication

In the present days, the wireless communication system has become an essential part of various types of wireless communication devices, that permits the user to communicate even from remote operated areas. There are different types of wireless communication devices like mobiles. Cordless telephones, Zigbee wireless technology, GPS, Wi-Fi, satellite television, and wireless computer parts. Current wireless phones include 3 and 4G networks, Bluetooth, and Wi-Fi technologies.[2]

Figure (1-1) Types of wireless communication

1.3 History of wireless communication

The history of wireless communication is discussed below.

- The first telegraph was invented (1600 – 1833)
- The invention of the radio from the telegraph (1867-1896)
- The birth of radio (1897 – 898)
- Transoceanic Communication (1901 –1909)
- Voice over Radio and the First Television Transmissions (1914 – 1940)
- Commercial Television and the Birth of Mobile Telephony (1946 – 1976)
- Cellular Mobile Telephony and Steps toward Wireless Internet (1979 – 1994)
- The Wireless Data Era (1997 – 2009)
- PCS (1995-2008)[3]

1.4 Wireless Communication

We know that communication using wires can do most of the tasks like wireless communication, so what is the main use of wireless communication? The main advantage of wireless communication is mobility. This kind of communication provides flexibility and very easy to use excepting mobility. For instance, mobile telephony can be implemented anytime and anyplace through significantly high throughput performance.

One more point is its infrastructure because, for the wired communication systems, the fitting of infrastructure is a costly & time taking task whereas the installation of wireless communication infrastructure is very simple and less cost.

from the above information, finally, we can conclude that in remote areas as well as emergency situations, the wired communication setup is not easy but wireless communication is a possible choice. There are many reasons to employ wireless communication like liberty from wires, global coverage, flexibility & stay connected.[4]

1.5 Types of Wireless Communication

At present, the usage of mobiles has been increased for different requirements like the internet, talking, multimedia, gaming, photos, video capturing, etc. All these services are available on mobile. Using wireless communication services, we can transfer data, voice, images, videos, and many more. The different services provided by the wireless communication system is a cellular telephone, Radio, paging, TV, video conferencing, etc use different communication services, there are different wireless communications systems are developed based on the application. Some of them are discussed below. A wireless Communication system is classified into Simplex, Half Duplex & Full Duplex.[5]

The simple wireless communication system is one-way communication. In this type, the communication can be done in one direction only. The best example is the radio broadcast system.The half Duplex communication system is two-way communication, however, it is not simultaneous. The best example of this type of communication is walkie – talkie.

The full Duplex communication system is also two-way communication & it is simultaneous. The best example of this communication system is the mobile phone. In wireless communication, the devices which are used for communication may change from one service to others because these are available in different shape, size & data throughput. The region enclosed through this type of communication system is an essential factor. Here, some of the most essential wireless communication systems are discussed like IR wireless communication, satellite communication, broadcast radio, Microwave radio, Bluetooth, Zigbee, etc.[6]

1.6 some of the most essential wireless communication systems

1- Infrared Communication

Infrared wireless communication communicates information in a device or system through IR radiation. IR is electromagnetic energy at a wavelength that is longer than that of red light. It is used for security control, TV remote control, and short-range communications. In the electromagnetic spectrum, IR radiation lies between microwaves and visible light. So, they can be used as a source of communication.[7]

Infrared Communication

2- Broadcast Radio

The first wireless communication technology is open radio communication to seek out widespread use, and it still serves a purpose nowadays. Handy multichannel radios permit a user to speak over short distances, whereas citizen's band and maritime radios offer communication services for sailors. Ham radio enthusiasts share data and function emergency communication aids throughout disasters with their powerful broadcasting gear, and can even communicate digital information over the radio frequency spectrum.[8]

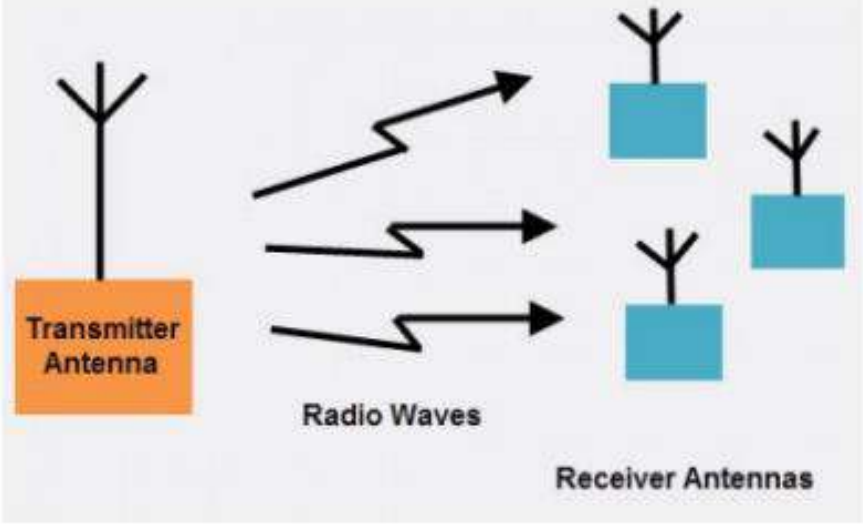


Figure (1-3) Broadcast radio

3- Microwave Communication

Microwave wireless communication is an effective type of communication, mainly this transmission uses radio waves, and the wavelengths of radio waves are measured in centimeters. In this communication, the data or information can be transfers using two methods. One is the satellite method and another one is a terrestrial method.[9]

Figure (1-4) Microwave communication

Wherein satellite method, the data can be transmitted through a satellite, that orbit 22,300 miles above the earth. Stations on the earth send and receive data signals from the satellite with a frequency ranging from 11GHz-14GHz and with a transmission speed of 1Mbps to 10Mbps.

In the terrestrial method, in which two microwave towers with a clear line of sight between them are used, ensuring no obstacles to disrupt the line of sight. So it is used often for the purpose of privacy. The frequency range of the terrestrial system is typically 4GHz-6GHz and with a transmission speed is usually 1Mbps to 10Mbps. The main disadvantage of microwave signals is, they can be affected by bad weather, especially rain. Please refer to this link to know more about Microwaves – Basics, Applications and Effects .[10]

4- Wi-Fi

Wi-Fi is a low power wireless communication, that is used by various electronic devices like smartphones, laptops, etc.In this setup, a router works as a communication hub wirelessly. These networks allow users to connect only within close proximity to a router. WiFi is very common in networking applications which affords portability wirelessly. These networks need to be protected with passwords for the purpose of security, otherwise, it will access by others.

Figure (1-5) WI-FI

5- Mobile Communication Systems

The advancement of mobile networks is enumerated by generations. Many users communicate across a single frequency band through mobile phones. Cellular and cordless phones are two examples of devices that make use of wireless signals. Typically, cell phones have a larger range of networks to provide coverage. But, Cordless phones have a limited range. Similar to GPS devices, some phones make use of signals from satellites to communicate[11]

. Figure (1-6) mobile communication

6- Bluetooth Technology

The main function of Bluetooth technology is that permits you to connect various electronic devices wirelessly to a system for the transferring of data. Cell phones are connected to hands-free earphones, mouse, wireless keyboard. By using the Bluetooth device the information from one device to another device. This technology has various functions and it is used commonly in the wireless communication market.

Figure (1-7) Bluetooth

7- Global Positioning System (GPS)

In satellite communication, GPS or global positioning system is a subcategory. This kind of system is used to help by providing different wireless services such as speed, location, navigation, positioning using satellites, and GPS receivers. Please refer to this link to know more about the Global Positioning System. [12]

8- Radar

is an electromagnetic sensor or detection system used to track, locate, detect & and identify objects of different types at significant distances. The operation of this detection system can be done by sending electromagnetic energy in the direction of objects, usually called targets, which observes the echoes. Here the targets may be ships, astronomical bodies, aircraft, spacecraft, automotive vehicles, insects, etc.

1.7 Advantages of wireless communication / disadvantages of Wireless Communication

- **Flexibility**: As wireless frequency penetrates the walls, wireless networks are easy to install anywhere based on choice. This flexibility is one of the great benefits of wireless network where wired cable can not be installed.
- **Easy Installation**: Wireless networks are easy to install and easy to maintain compare to messy wired counterparts. This will help when network grows and will have hundreds to thousands of customers.
- **Network Planning**: Wireless network planning is very easy compare to wired network due to wireless software configuration of frequency, power and other parameters.
- **Location**: Wireless communication helps in connecting remote inaccessible areas behind the walls or buildings or hilly terrains.
- **Mobility**: The great benefit of wireless communication is mobility of usage unlike wired communication.
- **Price**: The wireless communication end devices are available at very low cost due to competition in handset manufacturing segment.[13]

Disadvantages of Wireless Communication

- Wireless signals can be easily hacked and hence it will hamper privacy. To avoid this, security algorithms (AES, WEP, WAP2) and modulation techniques (FHSS, DSSS) are employed in wireless networks.
- The earlier wireless networks were slower. Now-a-days wireless LANs with advanced standards such as IEEE 802.11ac and 802.11ad are available which provides same performance as traditional ethernet based LANs.
- Wireless networks require careful radio frequency planning at the beginning of the installation.
- Wireless communication is subject to interference. There are various receiver techniques and modulation techniques which make wireless system robust against any kind of interference.[14][15]

1.8 Conclusions

Many industrial applications need transmission of information through metal barriers without physical penetrations. Conventional wireless communication is ineffective due to the Faraday shielding effect. Ultrasound can be used to convey information in this situation. To achieve lower power consumption and higher data rate simultaneously, an ultrasonic communication system based on single-carrier frequency domain equalization (SC-FDE) has been proposed. Compared with conventional ultrasonic communication systems based on orthogonal frequency division multiplexing (OFDM), it has a lower peak-to-average power ratio while maintaining a similar performance in anti-multipath fading. Unique word sequences are used to realize the frame synchronization and to estimate the communication channel characteristics. A prototype system has been implemented on a field programmable gate array and a digital signal processor. It gets an effective bit rate of 436 kbps through a steel barrier within the thickness of 70 mm, and higher data rate will be achieved by using higher frequency channels or higher order modulation methods. Due to the low-complexity merit of the transmitter, the proposed system could work for a long time even under battery-powered conditions, which makes it practical for many industrial applications.

Chapter 2
The microcontroller (Arduino)

2.1 Introduction

A microcontroller (sometimes called an MCU or Microcontroller Unit) is a single Integrated Circuit (IC) that is typically used for a specific application and designed to implement certain tasks. Products and devices that must be automatically controlled in certain situations, like appliances, power tools, automobile engine control systems, and computers are great examples, but microcontrollers reach much further than just these applications.

Essentially, a microcontroller gathers input, processes this information, and outputs a certain action based on the information gathered. Microcontrollers usually operate at lower speeds, around the 1MHz to 200 MHz range, and need to be designed to consume less power because they are embedded inside other devices that can have greater power consumptions in other areas.[16]

Figure (2-1) A Microcontroller

2.2 A Microcontroller

It (also called Embedded Computer) is a mini(but powerful) computer, embedded in a compact IC(Integrated Circuit) chip, contains on-chip processor(one or more), memory(i.e. RAM, ROM, EEPROM etc.) & programmable I/O Ports(used for multiple functions). Microcontroller is used in embedded projects i.e. security systems, laser printers, automation system, robotics and a lot more. Microcontroller was first designed by Michael Cochran and Gary Boone.

The (C) and assembly languages are used for programming a microcontroller but the HEX File is in machine langue which actually gets uploaded in Microcontroller.

There are also other language available for programming a microcontroller but if you are a beginner, you should start with assembly language as it provides a clear concept about microcontroller's architecture. Below image shows few of the most commonly used Microcontrollers.[17]

Figure(2-2); the most commonly used Microcontrollers.

The simplest microcontroller architecture consists of a microprocessor, memory, and input/output. The microprocessor consists of a central processing unit (CPU) and the control unit (CU). The CPU is the brain of a microprocessor and is where all of the arithmetic and logical operations are performed. The control unit controls the internal operations of the microprocessor and sends control signals to other parts of the microprocessor to carry out the required instructions. Memory is an important part of a microcomputer system. Depending upon the application we can classify memories into two groups: program memory and data memory. Program memory stores all the program code. This memory is usually a read-only memory (ROM). Other types of memories, e.g. EPROM and PEROM flash memories, are used for low-volume applications and also during program development. Data memory is a read/write memory (RAM). In complex applications where there may be need for large amounts of memory it is possible to interface external memory chips to most microcontrollers. Input/Output (I/O) ports allow external digital signals to be connected to the microcontroller. I/O ports are usually organized into groups of 8 bits and each group is given a name. For example, the 8051 microcontroller contains four 8-bit 1/O ports named P_0, P_1, P_2, and P_3. On some microcontrollers the direction of the I/O port lines are programmable so that different bits of a port can be programmed as inputs or outputs. Some microcontrollers (including the 8051 family) provide bi-directional I/0 ports. Each I/0 port line of such microcontrollers can be used as inputs and outputs. Some microcontrollers provide 'open-drain' outputs where the output transistors are left floating (e.g. port P_O of the 8051 family). External pull-up resistors are normally used with such output port lines.

Essential Components Of A Microcontroller :-

A microcontroller can be seen as a small computer, and this is because of the essential components inside of it;

- Central Processing Unit (CPU),
- Random-Access Memory (RAM),
- Flash Memory,
- Serial Bus Interface,
- Input/Output Ports (I/O Ports),
- and in many cases, the Electrical Erasable Programmable Read-Only Memory (EEPROM).

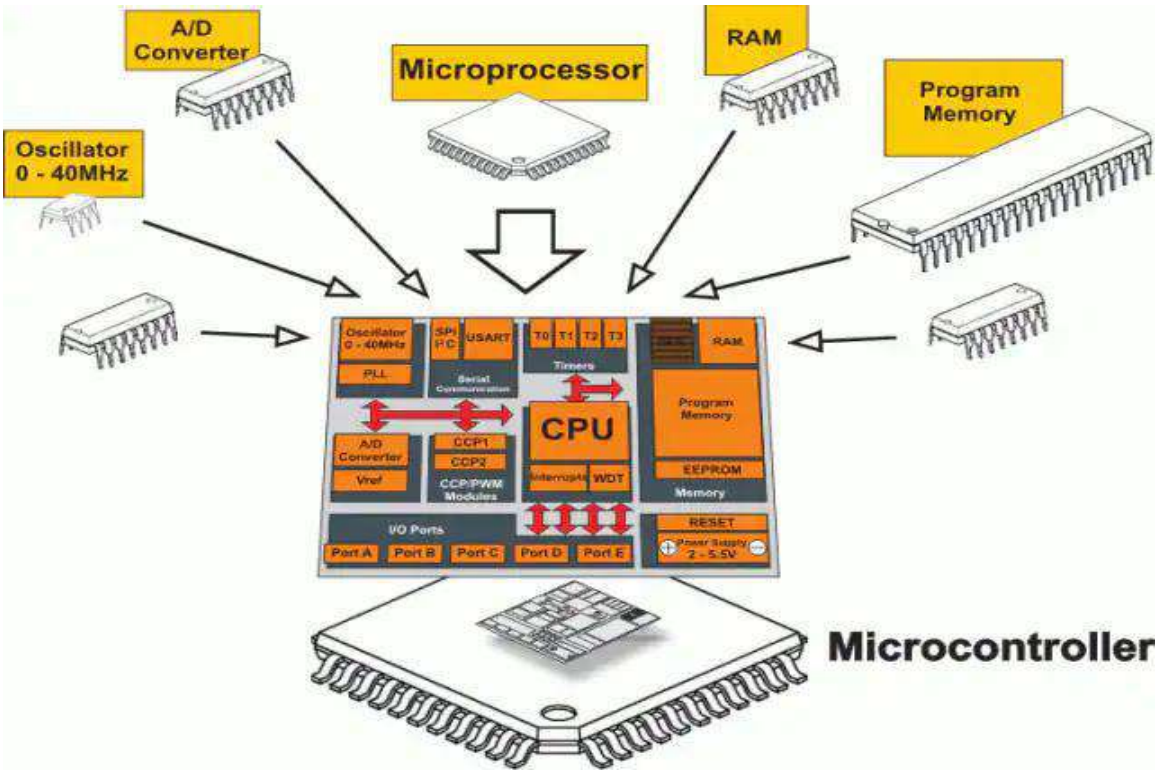
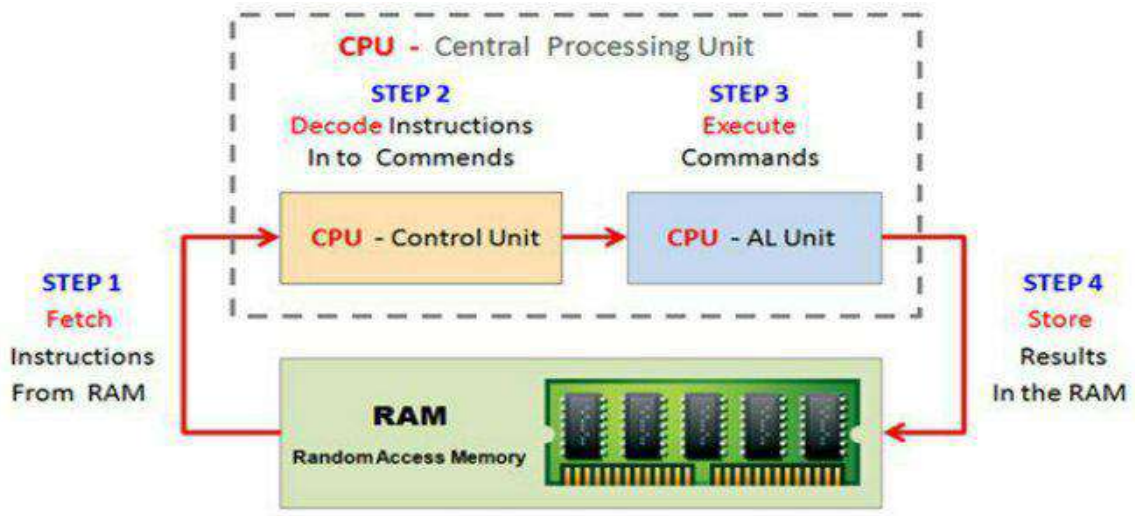


Figure (2-3) shows a great diagram of the main parts and also other parts in the microcontroller..

- **The CPU:-**

sometimes called a processor or microprocessor, controls all of the instructions/data flow that it receives. You can think of it as the brains of the system, processing all the data input it receives and executes the required instructions. Its two main components are the Arithmetic Logic Unit (ALU), which performs arithmetic and logical operations, and the Control Unit (CU), which handles all of the processor's instruction executions. In Figure down shows a usual "machine cycle" that the CPU goes through. Generally, PIC microcontrollers come with some built-in EEPROM which is used to store data permanently.[18]



Figure(2-4) A typical machine cycle that the CPU executes

- **RAM (Random-Access Memory)**

RAM is a component that temporarily stores data, and can be accessed quickly. It provides quick read-and-write access to the storage device. This differs from most other memories as it takes longer for data to be extracted since the data isn't readily available. You can see it as RAM having access to the surface of data – easily reachable – but anything that dives deeper will require a different type of memory. RAM improves total system performance because it allows the microcontroller to work with more information at the same time. Since RAM is temporary data, its content is always erased when the microcontroller is shut down.

- **Flash Memory in Microcontrollers**

Flash Memory is a type of non-volatile memory that, unlike RAM, retains its data for an extended period, even if the microcontroller is turned off. This keeps the saved program that you might have uploaded to the microcontroller. Flash Memory writes to a "block" or "sector" at a time, so if you need to just re-write one byte, Flash Memory will need to re-write the whole block that the byte is in, which can wear out quicker.

- **Serial Bus Interface**

A Serial Bus Interface is the serial communication in the microcontroller, sending data one bit at a time. With microcontroller boards, it connects ICs with signal traces on a printed circuit board

(PCB). For ICs, they use serial bus to transfer data to reduce the number of pins in a package making them more cost effective. Examples of serial buses in ICs are SPIs or I2Cs.

- **Input /Output Ports**

I/O ports are the microcontroller uses to connect to real-world applications. Inputs receive changes in the real-world, from temperature sensing, to motion sensing, to push buttons, and much more. The input then goes to the CPU and decides what to do with that information. When it's time to do a certain command based on a certain value from the input, it sends a signal to the output ports, where it can range from a simple LED light going off, to running a motor for a certain part.

- **Read-Only Memory (EEPROM)**

An EEPROM is a non-volatile memory that means it can store the data permanently without any power supply. EEPROM stands for Electrically Erasable Programmable Read-Only Memory. We can erase the EEPROM data by the UV eraser.

The FLASH memory is faster than EEPROM. In flash memory, we have to erase the whole sector at a time but in the case of EEPROM, we can erase a single byte at the time.

A good example to use EEPROM is a digital lock system. In the digital lock, we can store access code in the EEPROM of the microcontroller. The access code will remain intact even after the power supply has been removed.

2.3 Microprocessor V/S Microcontroller:-

A microcontroller differs form a microprocessor in several important ways. Early name for a microcontroller was micro computer. The main difference between a microprocessor and microcontroller is the completeness of the machine each represents. In order to put a microprocessor into use the designer required memory peripheral chips and serial and parallel ports to make completely funtional computer. On the other hand a complete computer based system could be build using a single chip microcontrollers, with a minimum of external components. The block diagram of a microprocessor consists of an arithmetic and logic unit (ALU), general purpose registers, stack pointer (SP), program counter (PC), clock timing circuit and interrupt circuit. To make a complete microcomputer system only microprocessor is not sufficient, but it is required to add other peripherals such as read only memory (ROM), read/write memory (RAM), decoders, drivers, number of input/output devices to make a complete microcomputer system. In addition, special purpose devices, such as interrupt controller, programmable timers, programmable 1/0 devices, DMA controllers may be added to improve the capacity and performance and flexibility of a microcomputer system.

The microcontroller incorporates all the features that found in microprocessor, apart it has also added features to make a complete microcomputer system on its own.[18]

Table(1);Comparision between Microcontroller and Microprocessor

	Microcontroller	Microprocessor
1-	Microcontroller contains the circuitry of micro- processor and in addition it has built-in ROM, RAM, I/O devices, timers and counters.	Microprocessor contains ALU, general purpose register, stack pointer, pro- gram counter, clock timing circuit and interrupt circuit.
2-	It has one or two instructions to move data between memory and CPU.	It has many instructions to move data between memory and CPU.
3-	It has many bit handling instructions.	It has one or two bit handling instructions.
4-	Less access times for built-in memory and I/0 devices.	Acess times for memory and I/0 de- vices are more.
5-	Microcontroller based system requires less hardware reducing PCB size and increasing the reliability.	Microprocessor based system requires more hardware.
6-	Less flexible in design point of view.	Microprocessor based system is more flexible in design point of view.
7-	It has separate memory map for data and code.	It has single memory map for data and code.
8-	More number pins are multifunctioned.	Less number of pins are multifunc tioned.

2.4 Microcontroller (Arduino):-

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. Arduino was introduced back in 2005 in Italy by Massimo Banzi. Then The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Arduino hardware and software are designed for designers, inventors, and anyone interested in creating interactive environments.The Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, and the Internet.This flexibility is coupled with the fact that the Arduino software is free, the boards are very cheap, and the software is easy to learn. This led to the formation of a large community of Arduino users to provide programming support and exchange experiences.[19]

Arduino is used in almost any electronics project, from robots to all interactive projects .and it is connected to sensors to communicate with the physical world and then converts the reading of these sensors into data that it analyzes and based on the codes it has programmed into. Then he makes decisions such as turning on the engines, turning on the lights, sound sources, etc.

2.5 Types Of Arduino Boards

The basic reason why we have so many Arduino boards is "function". As technology advances, the need to achieve newer things and do things better arises, hence, the need to make more new Arduino boards with improved features and functionalities. Again, as more and more types of Arduino boards are made, makers are provided with choices that are laden with trade-offs. In such trade-offs, the following are considered: 1-Functionality 2-Price 3-Robustness 4-Versatility 5-Compatibility ..Hence, before you choose any of the Arduino boards listed below for your Arduino, projects, make sure to carry out your study and take into consideration the factors listed [5]above.the Types of Arduino Boards are:-

Arduino Uno, Arduino Nano, Arduino Micro,Arduino Due, Arduino Leonardo Board, Arduino Robot, Arduino Ethernet, Arduino Zero, Arduino Pro Mic, Arduino Esplora, Arduino Mega (R3) Board, Arduino Diecimila, LilyPad Arduino Board ,RedBoard Arduino Board, Arduino Shields

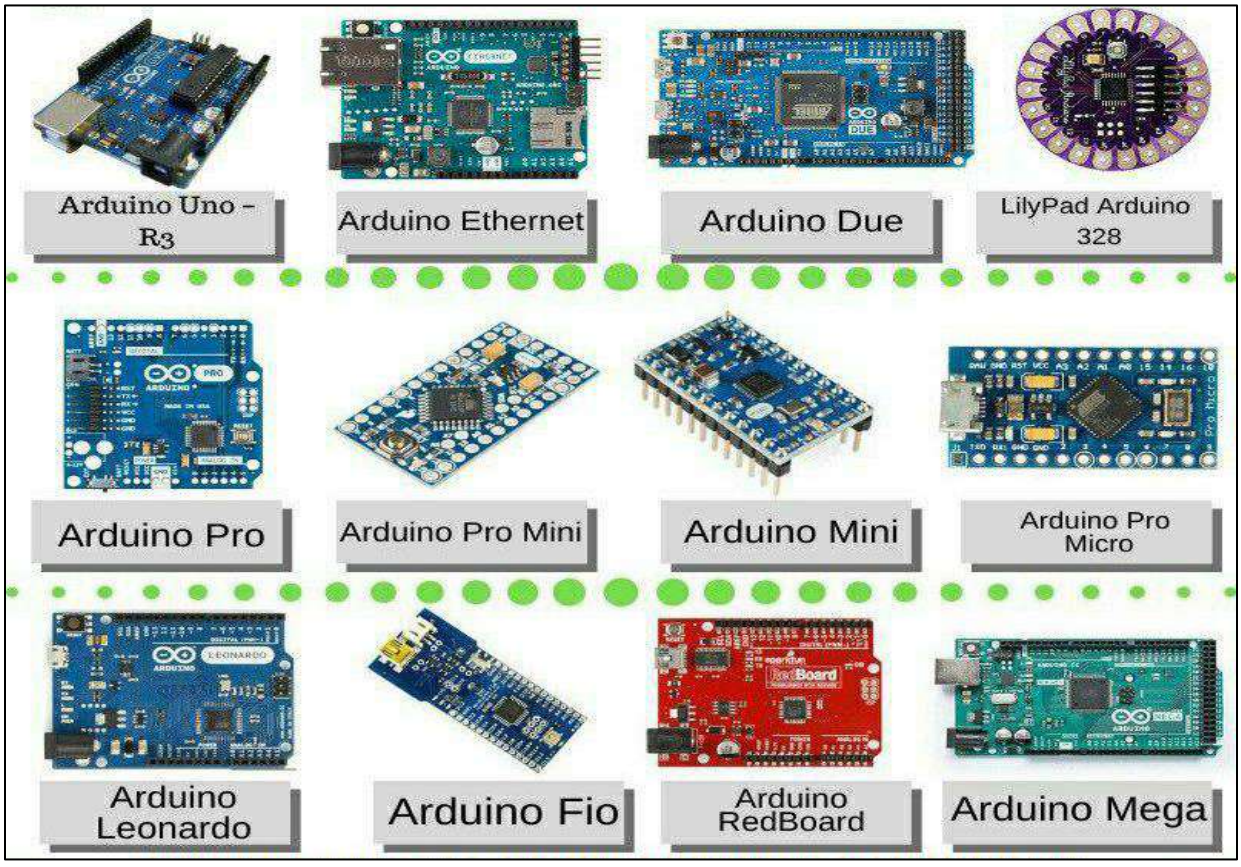


Figure (2-5)Types of Arduino Boards

1-Arduino Nano

As the name implies, Arduino Nano is another version of the Arduino microcontroller, but it is very small in size. If you want to design an Arduino project where size is a concern, then go for Arduino Nano.

2-Arduino micro

Arduino micro is a bit big bigger than the Arduino Nano, but is as efficient as other Arduino boards

3-Arduino Due

The Arduino Due is a microcontroller board uses the Atmel SAM3X8E ARM Cortex-M3 CPU. This board was the first Arduino board based on a 32-bit ARM core microcontroller. It has 54 digital input/output pins (of which 12 can be used as PWM outputs), 12 analog inputs, 4 UARTs (hardware serial ports), a 84 MHz clock, an USB OTG capable connection, 2 DAC (digital to analog), 2 TWI, a power jack, an SPI header, a JTAG header, it also has a reset button and an erase button. The Due is compatible with all Arduino shields that work at 3.3V and are compliant with the 1.0 Arduino pinout. Unlike most Arduino boards, the Arduino Due board runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. connecting voltages higher than 3.3V to any I/O pin could damage the board.

4-Arduino Leonardo

The Arduino Leonardo is a microcontroller board based on the ATmega32u4 . It has 20 digital input/output pins, 7 out of these pins can be used as PWM outputs and 12 as analog inputs. It uses a 16 MHz crystal oscillator, a micro USB connection, a power jack, an ICSP header, and a reset button. The Leonardo differs from all other Arduino boards we listed above in the sense that the ATmega32u4 has built-in USB communication, hence, there is no need for a secondary processor. This allows the Leonardo to appear to a connected computer as a mouse and keyboard, in addition to a virtual (CDC) serial / COM port.

5-Arduino Robot

The first Arduino board on wheels is the Arduino Robot. It has two processors and two boards with one processor on each board. The Motor Board controls the motors, and the Control Board reads sensors and decides how to operate. Each of the boards is a full Arduino board programmable using the Arduino IDE. Both Motor and Control boards are microcontroller boards based on the ATmega32u4 . The Robot has many of its pins mapped to on-board sensors and actuators. Programming the robot is similar to the process with the Arduino Leonardo. Both processors have built-in USB communication, eliminating the need for a secondary processor.

This allows the Robot to appear to a connected computer as a virtual (CDC) serial / COM port. The Arduino Robot is the result of the collective effort from an international team looking at how science can be made fun to learn

6-Arduino Ethernet

Arduino Ethernet connects an Arduino board to the internet in a matter of minutes. Plug the module onto your Arduino Board, connect it to your network with an RJ45 cable (not included) and follow a few simple steps to start controlling your world through the internet.

The Arduino Ethernet Shield 2 allows an Arduino Board to connect to the internet. It is based on the Wiznet W5500 Ethernet chip. The Wiznet W5500 provides a network (IP) stack capable of both TCP and UDP. It supports up to eight simultaneous socket connections. The Ethernet Shield 2 connects to an Arduino Board using long wire-wrap headers extending through the Shield. This keeps the pin layout intact and allows another Shield to be stacked on top of it.

The Wiznet W5500 of the board provides a network (IP) stack capable of both TCP and UDP. It supports up to eight simultaneous socket connections. Use the Ethernet library to write sketches that connect to the Internet using the Shield. The Ethernet Shield 2 connects to an Arduino Board using long wire-wrap headers extending through the Shield. This keeps the pin layout intact and allows another Shield to be stacked on top of it. Ethernet Shield 2 has a standard RJ-45 connection, with an integrated line transformer and Power over Ethernet enabled.

7-Arduino Zero

Arduino Zero is a simple and powerful 32-bit extension of the UNO platform. The Zero board expands the family by providing increased performance, enabling a variety of project opportunities for devices, and acts as a great educational tool for learning about 32-bit application development. The board is powered by Atmel's SAMD21 MCU,The Zero runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I/O pin could damage the board.

8-Arduino Pro Micro

The Arduino Pro Micro board is the same as the Arduino Mini board apart from the ATmega32U4 Microcontroller. This pro mic board includes digital I/O pins-12, pulse width modulation (PWM) pins-5, serial connections of Tx & Rx &10-bit ADC.

9-Arduino Pro Mini

the Arduino Pro Mini which was designed and is manufactured by SparkFun Electronics is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable or Sparkfun breakout board to provide USB power and communication to the board. The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-

mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino Mini. There are two version of the Pro Mini. One runs at 3.3V and 8 MHz, the other at 5V and 16 MHz.

10-Arduino Esplora

The Arduino Esplora is a fun microcontroller board derived from the Arduino Leonardo. The Esplora is unique because it provides a number of built-in, ready-to-use set of onboard sensors for interaction. The Esplora has onboard sound and light outputs, and several input sensors, including a joystick, a slider, a temperature sensor, an accelerometer, a microphone, and a light sensor. You can expand its capabilities with two Tinkerkit input and output connectors, and a socket for a color TFT LCD screen.Like the Leonardo, the Esplora uses an Atmega32U4 AVR microcontroller with 16 MHz crystal oscillator and a micro USB connection capable of acting as a USB client device, like a mouse or a keyboard. In the upper left corner of the board there is a reset push button, that you can use to restart the board. The board contains everything needed to support the microcontroller. Simply connect it to a computer with a USB cable to get started with its built-in USB communication; it can appear to a connected computer as a mouse or keyboard, in addition to a virtual (CDC) serial / COM port.

11-Arduino Mega

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

12-Arduino Diecimila

The Arduino Diecimila is a microcontroller board based on the ATmega168 . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

13-LilyPad Arduino

The LilyPad Arduino Main Board is based on the ATmega168V (the low-power version of the ATmega168) or the ATmega328V. It is a wearable e-textile technology expanded by Leah " Buechley" and considerately designed by "Leah and SparkFun". Each board was imaginatively designed with huge connecting pads & a smooth back to let them to be sewn into clothing using

conductive thread. This Arduino also comprises of I/O, power, and also sensor boards which are built especially for e-textiles

14-Arduino Redboard (Sparkfun)

The SparkFun RedBoard combines the simplicity of the UNO's Optiboot bootloader , the stability of the FTDI and the R3 shield compatibility of the latest Arduino UNO R3.

The RedBoard can be programmed over a USB Mini-B cable using the Arduino IDE; Just plug in the board, select "Arduino UNO" from the board menu and you're ready to upload code. RedBoard has all of the hardware peripherals you know . 14 Digital I/O pins with 6 PWM pins, 6 Analog Inputs, UART, SPI and external interrupts. it also has a breakout SDA, SCL and IOREF pins that showed up on the UNO R3. This version adds an SMD ISP header for use with shields.

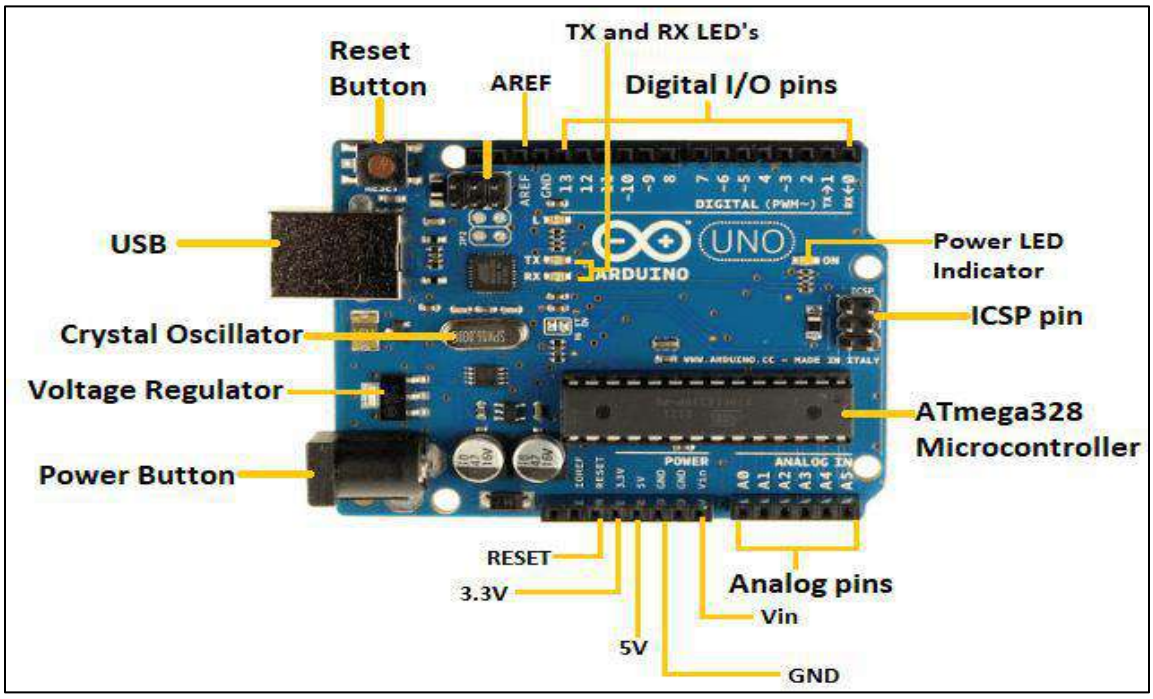
15-Arduino Uno

The arduino uno is a standard board of arduino and we use it in this project . here uno means 'one' in italian. it was named as uno to label the first release of arduino software. it was also the first usb board released by arduino. it is considered as the powerful board used in various projects.

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.

The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

The IDE is common to all available boards of Arduino[20][21]



Figure(2-6)Arduino uno and it components

Let's discuss each component in detail.

- **ATmega328 Microcontroller**- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines **Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.**
- **ICSP pin** - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.
- **Power LED Indicator**- The ON status of LED shows the power is activated. When the power is OFF, the LED will not light up.
- **Digital I/O pins**- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.
- **TX and RX LED's**- The successful flow of data is represented by the lighting of these LED's.
- **AREF-** The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply.
- **Reset button**- It is used to add a Reset button to the connection.
- **USB**- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.
- **Crystal Oscillator**- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
- **Voltage Regulator**- The voltage regulator converts the input voltage to 5V.
- **GND**- Ground pins. The ground pin acts as a pin with zero voltage.
- **Vin**- It is the input voltage.
- **Analog Pins**- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

2.6 Arduino Applications

Below are the Arduino Applications:

1-Home Automation

This application makes use of the Arduino Uno board, Bluetooth interface for connectivity, and smartphones. Software loaded boards are connected to the home devices like lamps, A/C, TV, Refrigerator, and Bluetooth software is interfaced with the board. The app loaded in the smartphone talk to the processor through Bluetooth connectivity and inputs from the phone are used to control the operation of the devices.

Operations like switch on, switch off, increasing or decreasing the intensity, volume, and other operating of parameters of these devices. Remote monitoring and operation is also enabled. These applications simplify the operation of household gadgets and enables better control.

2-Public Utility Automation

Applications to manage public utilities like street lighting, Dynamic traffic management systems are being implemented.Street lighting Street lights are fitted with Arduino boards and sensors. The microcontroller is programmed to read the inputs from the signal sent by the sensor on the light and temperature change and dynamically change the voltage supplied to the lights and control the intensity of the light. This system can be used to switch on and switch off the light also. Dynamic traffic Management Arduino controller along with infra-red sensors helps in managing the traffic dynamically. Input from the sensor helps the controller to measure the volume of traffic and accordingly control the timing of signals as per the traffic flow and its direction.

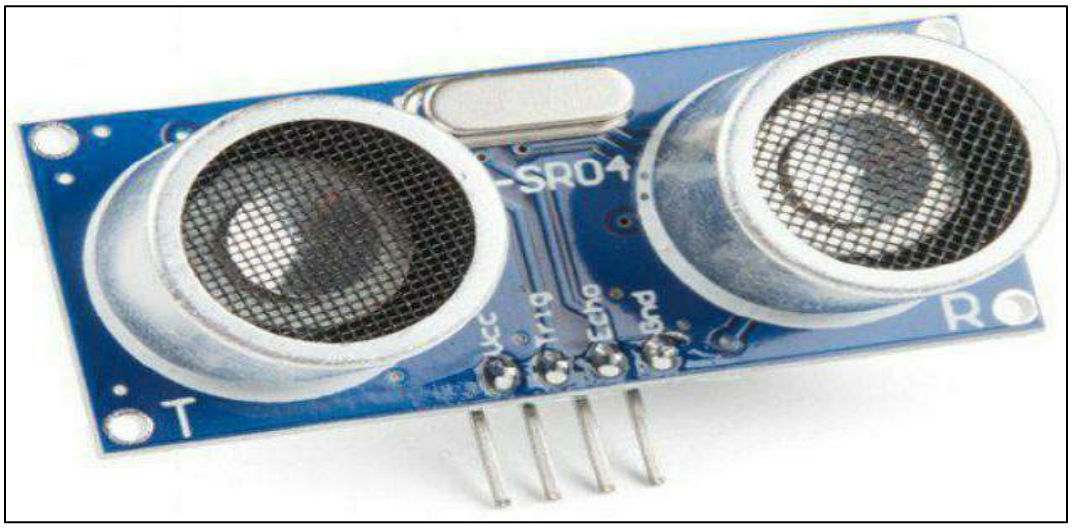
3-IoT

Poka-yoke This system suggests the right component be fitted at any stage in the assembly line. This system senses the product that is being assembled and refers ERP system and finds out the component to be fitted at that stage and accordingly illuminates the light of the compartment of that component. The operator picks up that component where the light glows and thus picking the right component is ensured and mistake-proofing is ensured. Arduino board based on the input from the central server send a signal to right bulb in the circuit and illuminates it.

Production counting Sensor placed in the conveyor is activated when the product being assembled moved from one stage to the next stage. Arduino board takes the signal from the sensor and adds to the count and sends the data back to the central server.[22]

2.7 Ultrasonic Senser

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver(which encounters the sound after it has travelled to and from the target).[23]



Figure(1-7) Ultrasonic sensor

An above image shows the HC-SR-04 ultrasonic sensor which has transmitter, receiver. The pin configuration is,

• VCC – +5 V supply

• TRIG – Trigger input of sensor. Microcontroller applies 10 us trigger pulse to the HC-SR04 ultrasonic module.

• ECHO–Echo output of sensor. Microcontroller reads/monitors this pin to detect the obstacle or to find the distance.

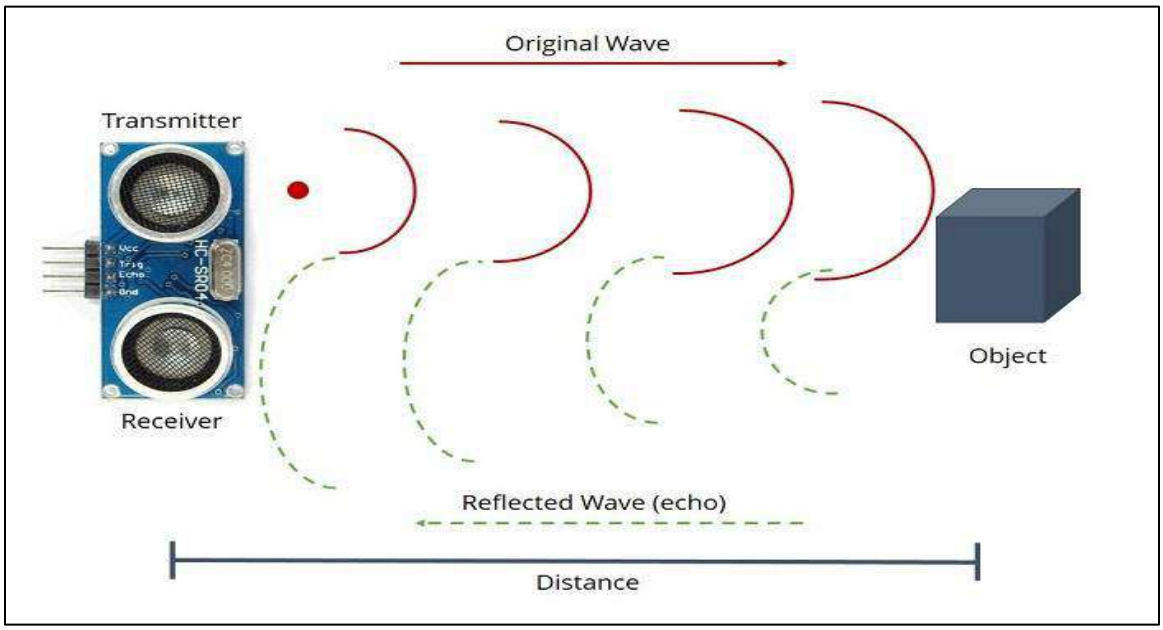
• GND – Ground.

Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other airborne particles (though the physical components are still affected by variables such as heat).

Ultrasonic sensors are also used as level sensors to detect, monitor, and regulate liquid levels in closed containers (such as vats in chemical factories). Most notably, ultrasonic technology has enabled the medical industry to produce images of internal organs, identify tumors.

2.7.1 Ultrasonic Sensor Working Principle

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they reflected back as an echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo.



An ultrasonic sensors are excellent at suppressing background interference. Virtually all materials ,which reflect sound can be detected, regardless of their colour. Even transparent materials or thin foils represent no problem for an ultrasonic sensor.

microsonic ultrasonic sensors are suitable for target distances from 20 mm to 10 m and as they measure the time of flight they can ascertain a measurement with pinpoint accuracy. Some of our sensors can even resolve the signal to an accuracy of 0.025 mm. Ultrasonic sensors can see through dust-laden air and ink mists. Even thin deposits on the sensor membrane do not impair its function.

2.7.2 Applications Of An Ultrasonic Sensor

• It Uses to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.

• It Used to measure the distance within a wide range of 2cm to 400cm.

• Used to map the objects surrounding the sensor by rotating it.

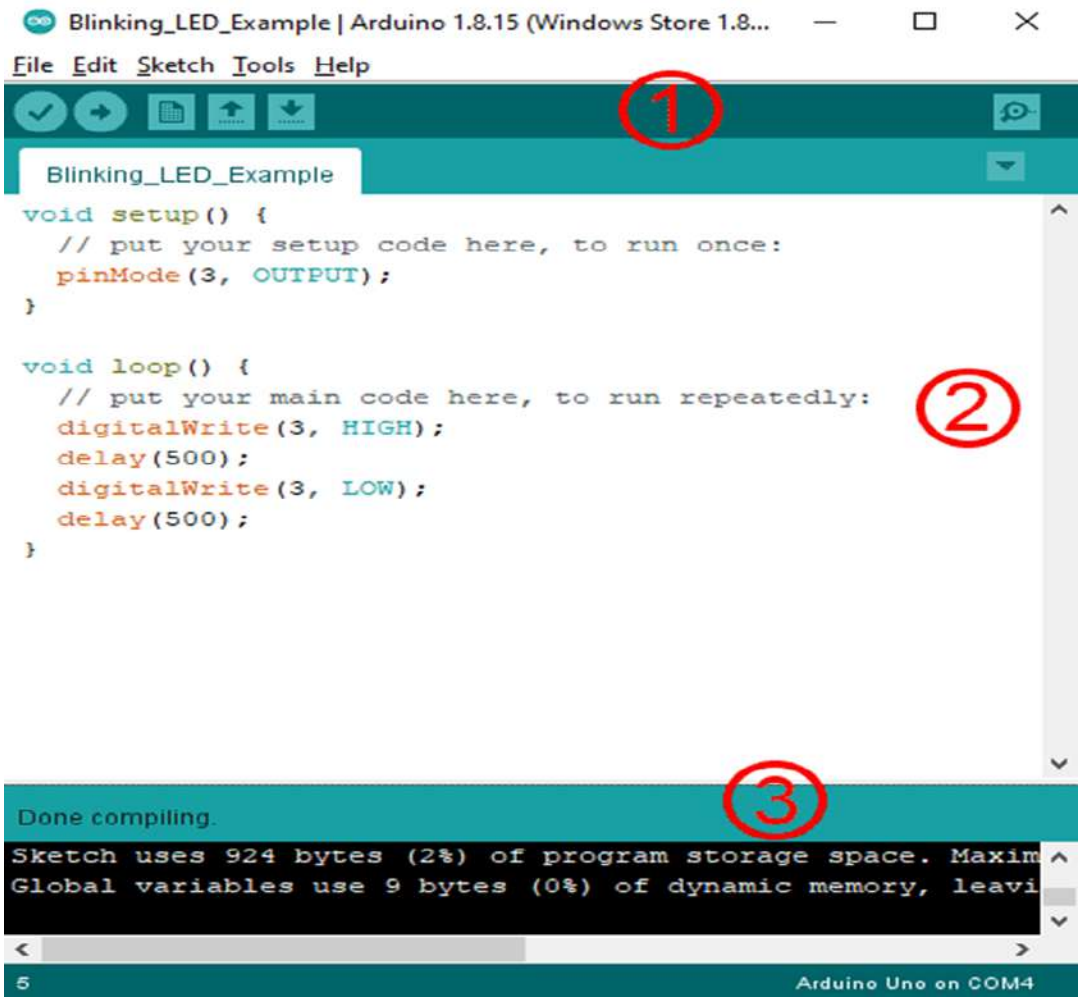
• Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water.[24]

2.8 Arduino Programme

After understanding the hardware of the Arduino UNO board ,now get started with Arduino programming. Arduino programs are written in the Arduino Integrated Development Environment (IDE). An integrated development environment (IDE) is a computer application designed to develop software applications or projects. It consists of different programming languages, frameworks, and code libraries for easy and rapid development. The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.The source code for the IDE is released under the GNU General Public License, The Arduino IDE supports the languages C and C++ using special rules of code structuring.The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.[25]

Figure(2-8):Arduino software application

Arduino IDE is features for writing, compiling, and uploading codes to Arduino boards. A wide range of operating systems is supported like windows, Linux, and Mac OS X. Programs that are written in Arduino IDE text editor are called sketches. These sketches are saved as a .ino extension file. Just like any other text editor, you can copy/paste and search/replace text within the text editor. At the top of the IDE, you can verify, upload, create, open, and save sketches. Any syntax errors of the codes will show right below the text editor.[26]



1- Toolbar

Verify: Check any errors in codes.
Upload: Compile and upload codes to boards.
New: Create a new sketches.
Open: Open saved sketches.
Save: Save sketches.
Serial Monitor: Open serial monitor.

2- Text Editor

Void setup(): Codes here will run one time only as soon as the program starts running.
Void loop(): Codes here will run over and over again as long as the boards is turned on.

3- Compiler

Messages: Show status/error messages.
Debugger: Show error of codes.

Chapter 3
proposed system and design Implentation

3.1 Introduction

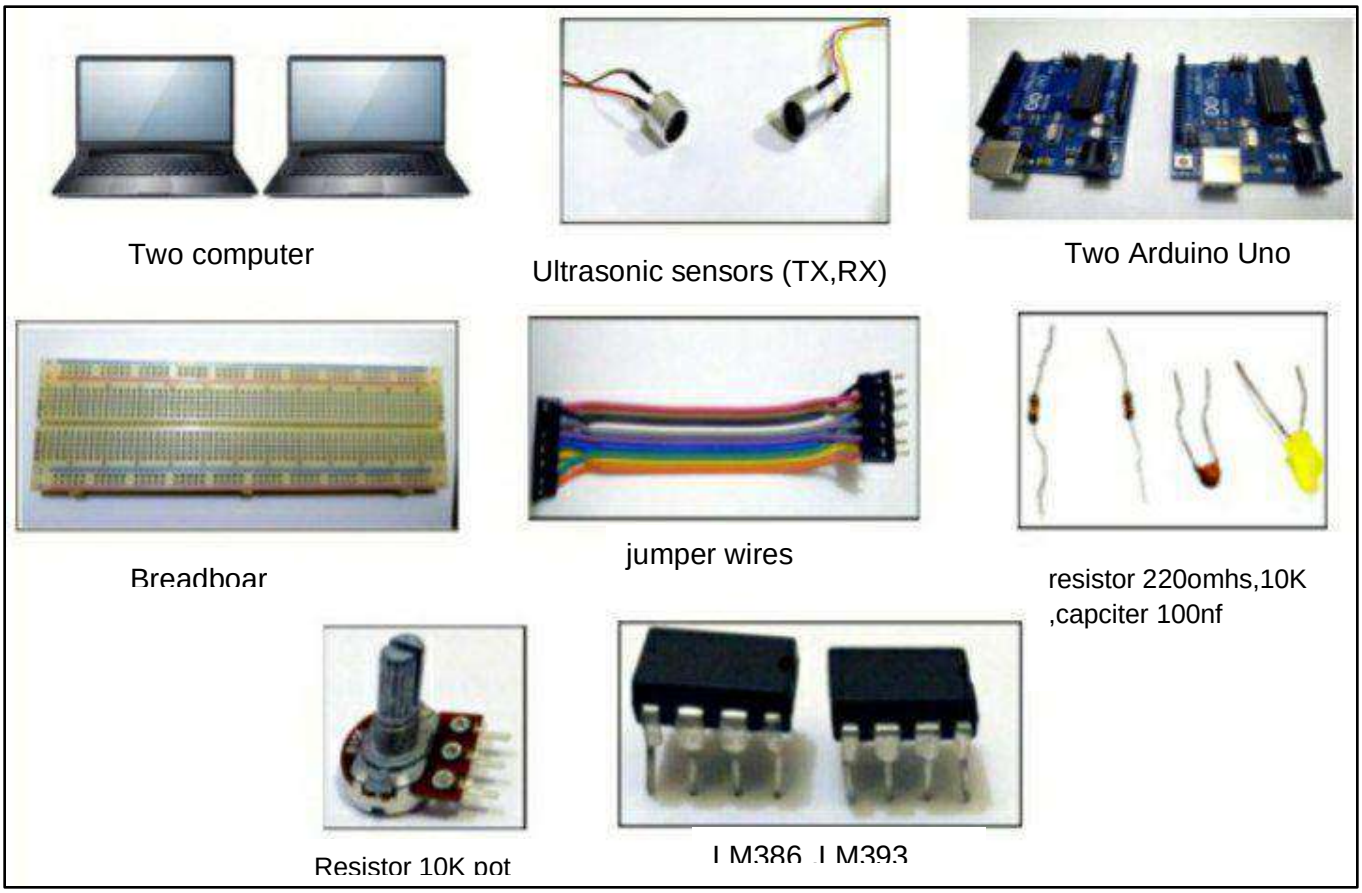
In this chapter, we will study the design of the project, its parts and programming Arduino as well as the project diagrams . in this work, need to two computers, one that sends data and the other receives this data, two Arduino Uno, and one ultrasonic sensors, also need the board (to connect a circuit) in the receiver side.we explain in detail the practical part of the project in below .

3.2 System Description

Wireless communications are an essential part of our lives, and some of the wireless communication systems commonly used in our daily lives are: mobile phones, GPS receivers, remote controls, Bluetooth audio, and Wi-Fi. this system presents another method for the wireless communication system, which is through used of ultrasound. Ultrasound plays an important role in enhancing the reliability of the communication system due to its ability to transmit data over certain distances with the lowest error rate and the lowest cost Price, which makes it popular. The main objective of this work is to transmit data from the transmitter to the receiver without wires by using ultrasonic sensors and to find the most suitable distance for data transmission with the least error rate for the transmitted data.

3.3 Components Of The Project;

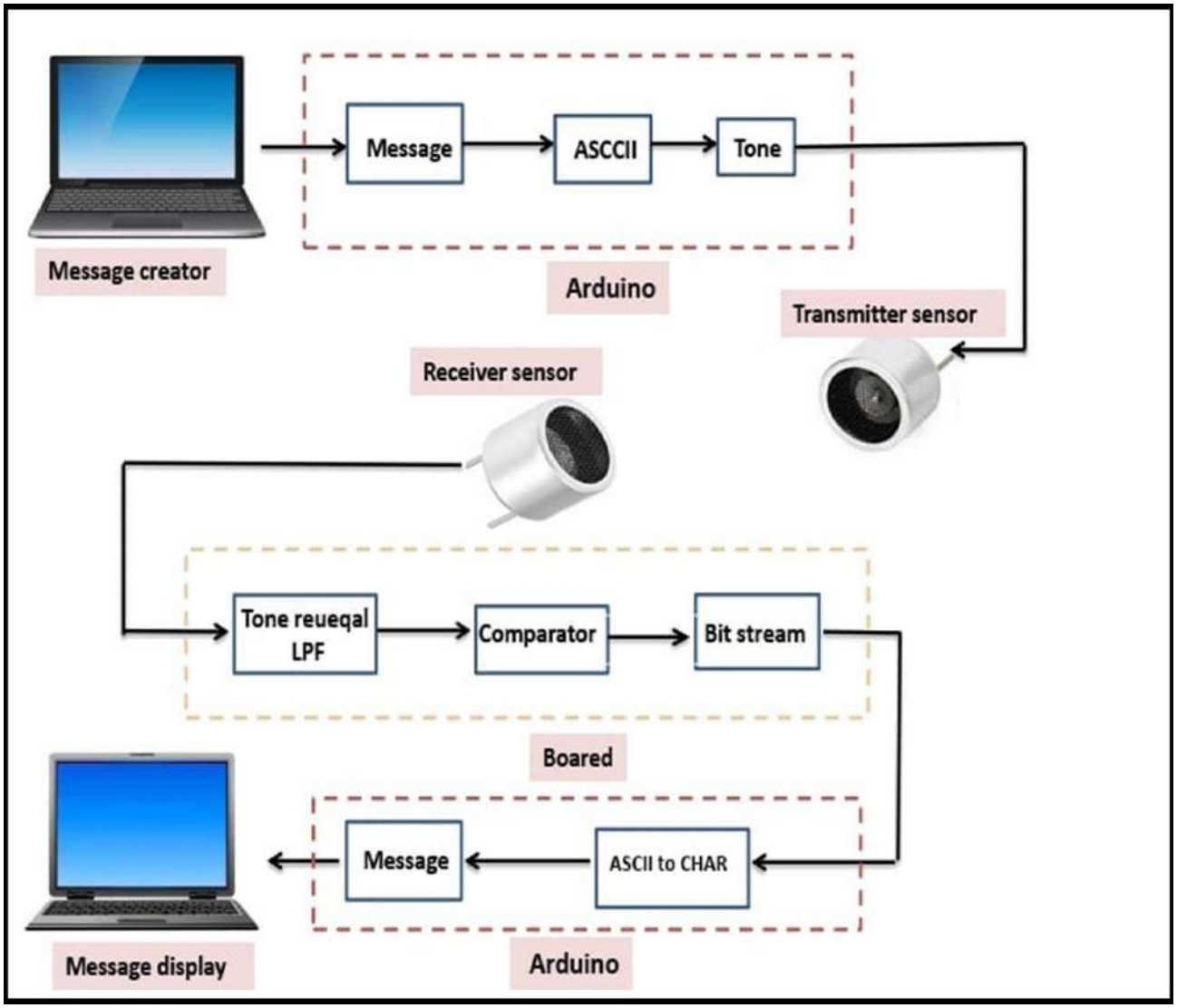
- Ultrasonics sensors (HC -SR04 module transducer TX and RX)
- two computer
- Two Arduino Uno
- LM 386 to amplify the received signal and LM 393 for comparing the signal once amplifier
- Resistor 10K pot for the tuning
- LED
- resistor 220 omhs ,capciter 100 nf ,resistor 10k
- Breadboard
- jumper wires



Figure(3-1) components of the project

3.4 System Design

The Flow chart with project it described the project in detail from point the transmit data to receiver this data .



Figure(3-2) Flow chart with project

3.5 Circuit Implementation

In project we connected two circuit .as shown in figure (3-4)in transmitter circuit we connect ultrasound sensor (TX) with arduino uno and computer to create and transmit the data .
In receiver circuit we connect the arduino uno with ultrasound sensor (RX)via the Breadboard (the circuit the breadboard in figure (3-3)) and we connect computer with receiver circuit to display the receiver data.

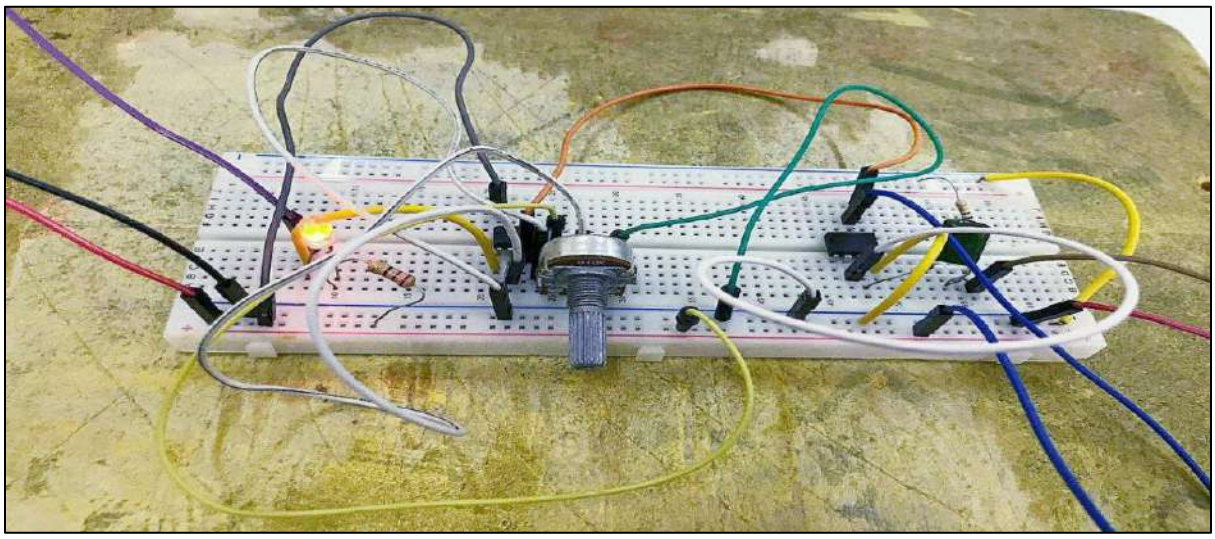
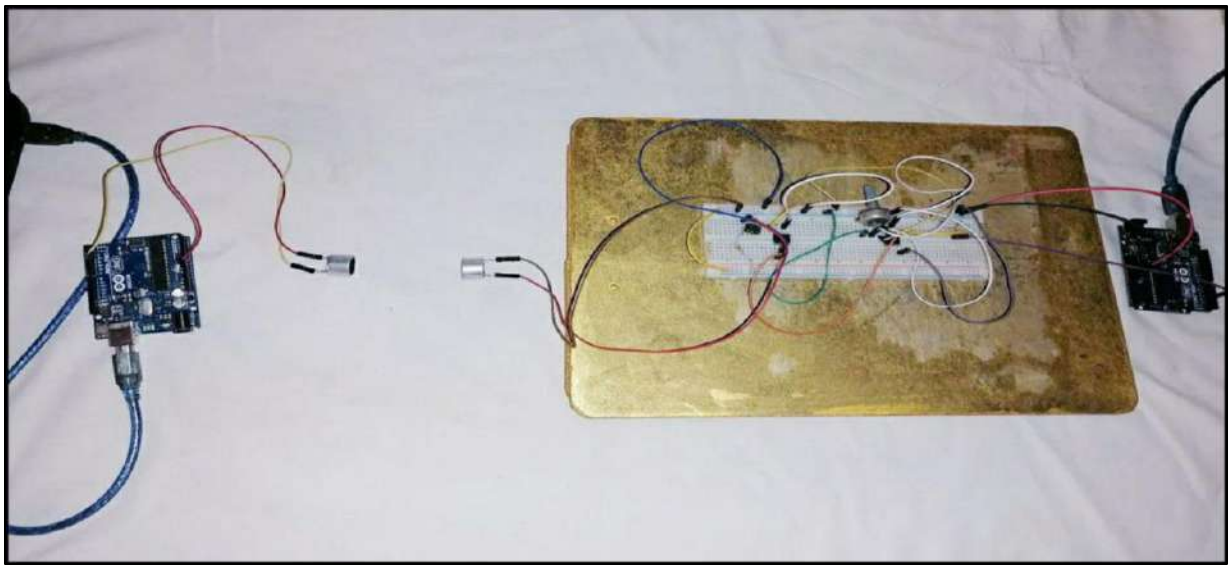


Figure (3-3)the circuit I breadboard



Figure(3-4) the connect the project (two circuit)

3.6 The Signals of the transmitter circuit in oscilloscope

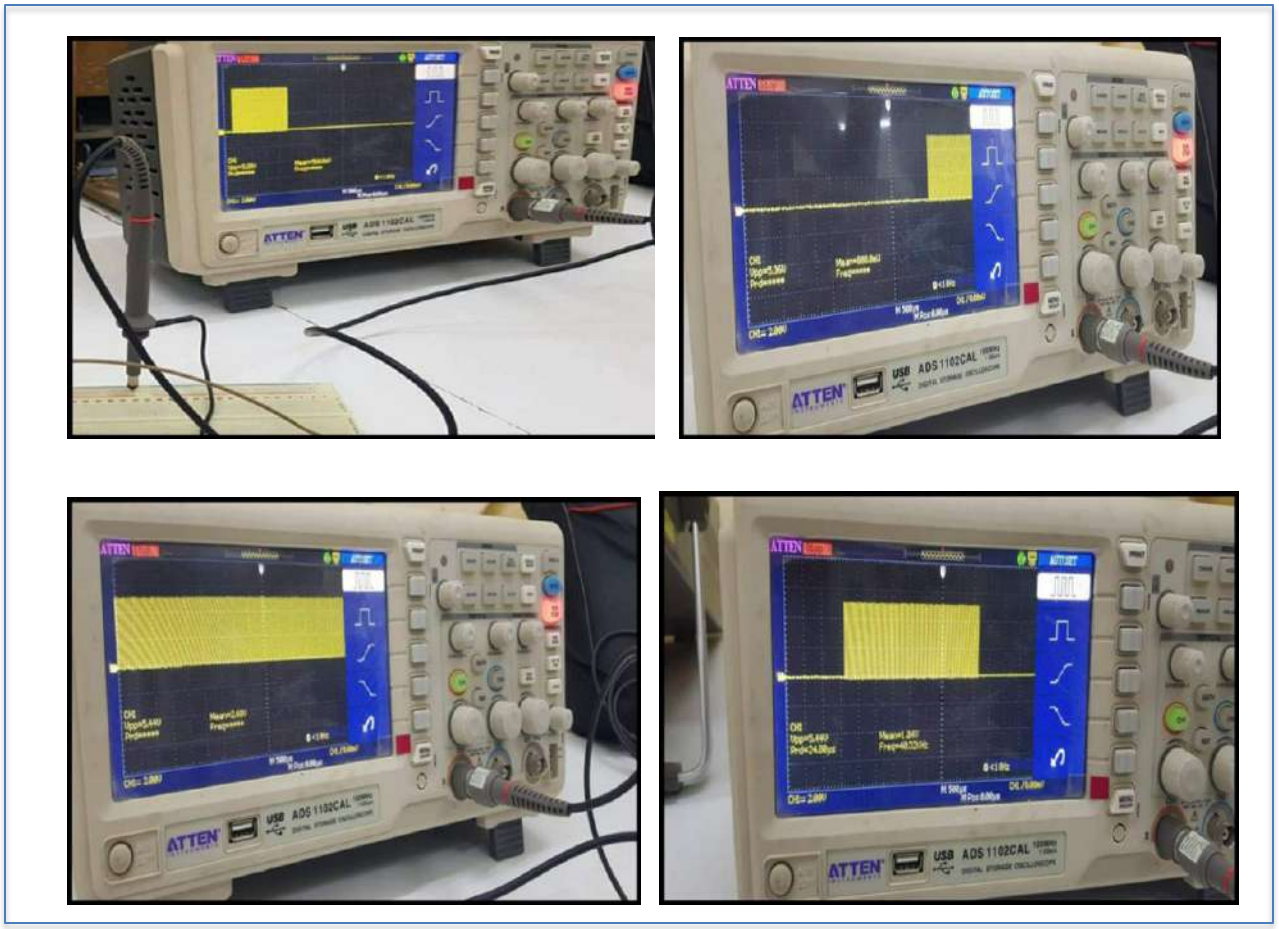


Figure (3-5)Some pictures of the output

signals from oscilloscope in frequency <10HZ

We can measure the signal of the transmitter circuit in oscilloscope it is a pulses means once at zero and one more time at a certain value.

3.7 The codes

- **The transmitter code**

```
void setup()
{
  Serial.begin(115200);
  pinMode(3,OUTPUT);
}

void loop()
{
  send("Ultrasonic communication shamam, amna, khairallah, mohammed \n");
  send("Hello World\n\n");
}

void send(String msg)
{
  byte ch;
  unsigned int pos = 0;
  unsigned int sz = msg.length();
  while(pos<sz)
  {
    ch = msg.charAt(pos);
    Serial.print((char)ch);
    tone(3,40000);
    delay(10);
    noTone(3);
    for(int i=0;i<8;i++)
    {
      boolean b;
      b = bitRead(ch,7-i);
      if(b)
      {
        tone(3,40000);
        delay(2);
      }
      else
      {
        tone(3,40000);
        delay(4);
      }
      noTone(3);
      delay(11);
    }
    pos++;
  }
}
```

- **The Receiver code**

```
int pos = 0;
unsigned char CH = 0;
unsigned int bits1 = 0;
boolean capture = false;

void setup()
{
  Serial.begin(115200);
  pinMode(5,INPUT_PULLUP);
}

void loop()
{
  if(digitalRead(5))
  {
    bits1 = 0;
    unsigned long deltaT = millis();
    while(millis()-deltaT <= 10) if(digitalRead(5)) bits1 ++;
    //Serial.println(bits1);
    if(capture)
    {
      boolean b = 0;
      if(bits1 > 290 && bits1 < 600) b = 0;
      if(bits1 > 20 && bits1 < 290) b = 1;
      if(b) bitSet(CH,7-pos); else bitClear(CH,7-pos);
      //Serial.print(b);
      pos++;
      if(pos == 8)
      {
        Serial.print((char)CH);
        pos = 0;
        capture = false;
      }
    }
    if(bits1 > 600)
    {
      capture = true;
      pos = 0;
    }
  }
}
```

CHAPTER 4

Results and discussion

Results And Discussion

In wireless communcation by using ultersound sensor we can transmit data from transmitter to receiver and there are some error we will discussion the result to this system.We measure different of distanse between two sensors and we take note about the quantity of the error rate

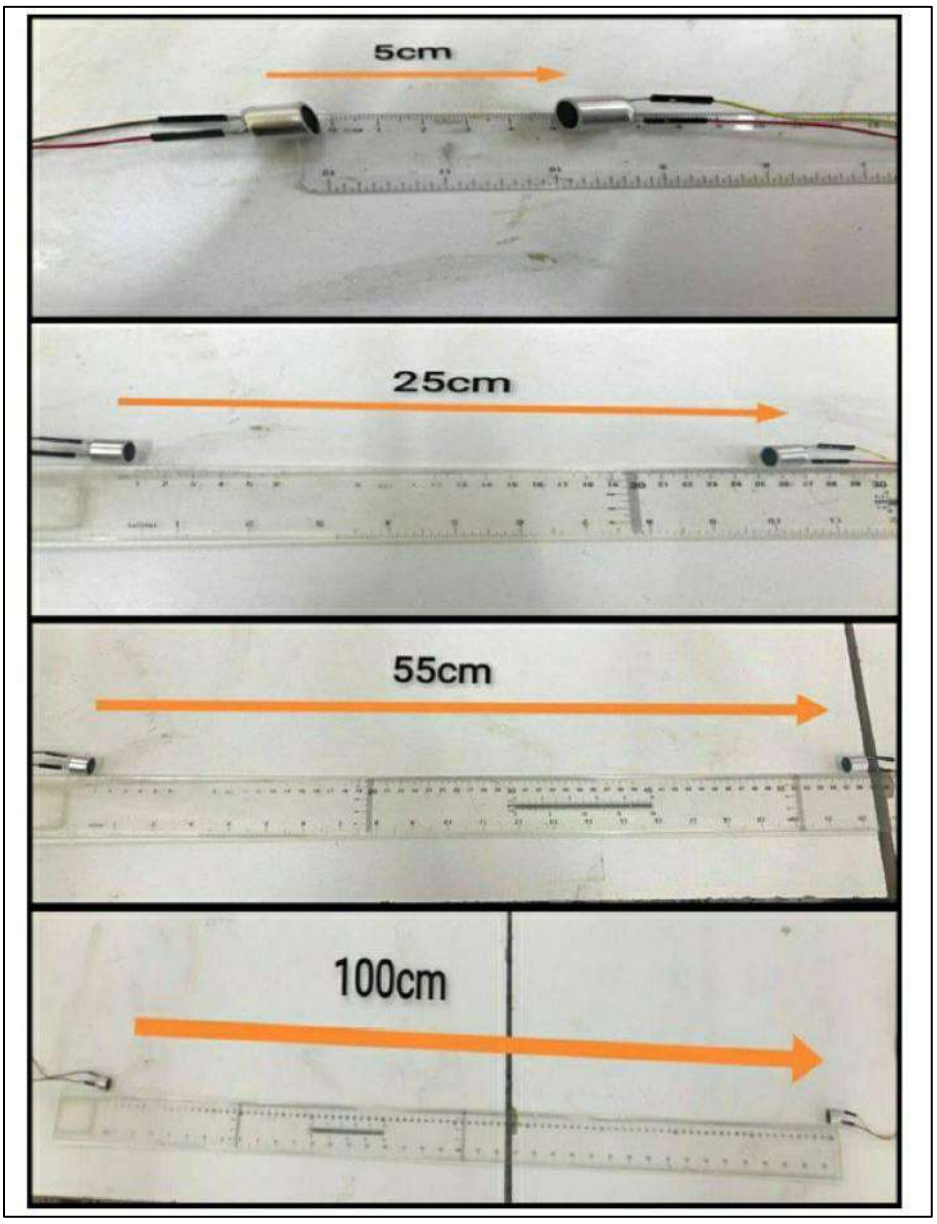


Figure (4-1) measure the different distance

The error rate is the number of bit errors per unit time. Or it is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unit less performance measure, often expressed as a percentage.

$$\text{Error ratio} = \frac{\text{number of characters errors}}{\text{total number of transferred characters}} \times 100\%$$

The table (4-1) is the measurements for different distance between two sensorsm. and that has effect on the data that transmitted and we see in the 25 cm , 35cm the best distance to transmit the data and this values the error ratio is varied by the number of character which transmit here we transmit 34 characters and we make list the result it shown down.

Table (4-1)

distance (cm)	Error ratio%
10 cm	No read
25cm	0%
35cm	0%
40 cm	0.029%
45cm	0.059%
55cm	0.26%
65cm	0.38%
75cm	0.62%
85cm	0.74%
100cm	0.91%
110cm	1

This curve shows that the direct (linear) relationship between the distance and the error ratio. The increase in distance leads to increase in error rate and vice versa without barrier

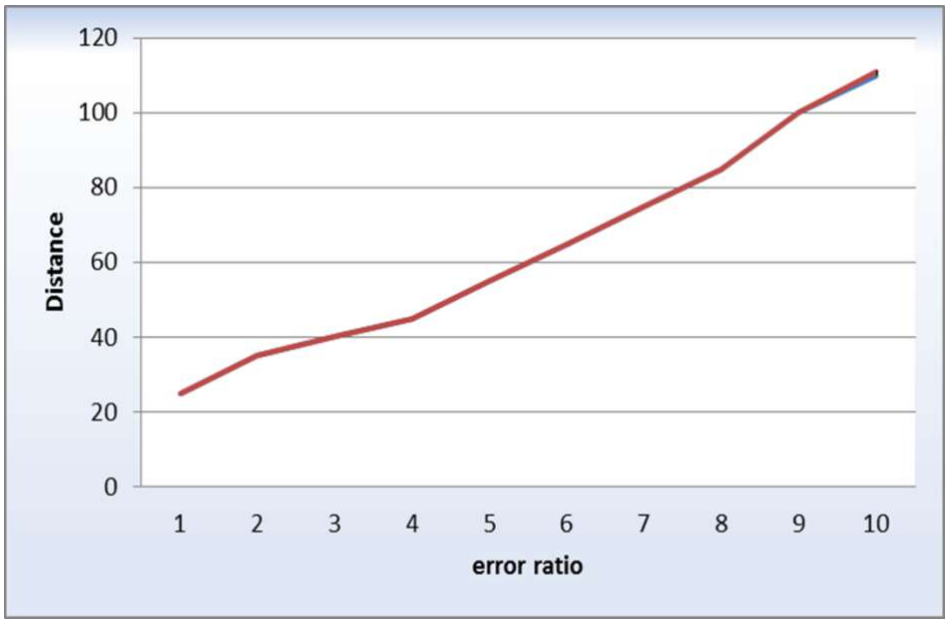


Figure (4-2) Relation between distance (cm)and the error ratio

Experiment Different Obstacles (Barriers)

Test materials :we put different barriers between the transmitter and the receiver , and watch the results, finally we add the noise sound and test if it effect on the system in figure (4-3)

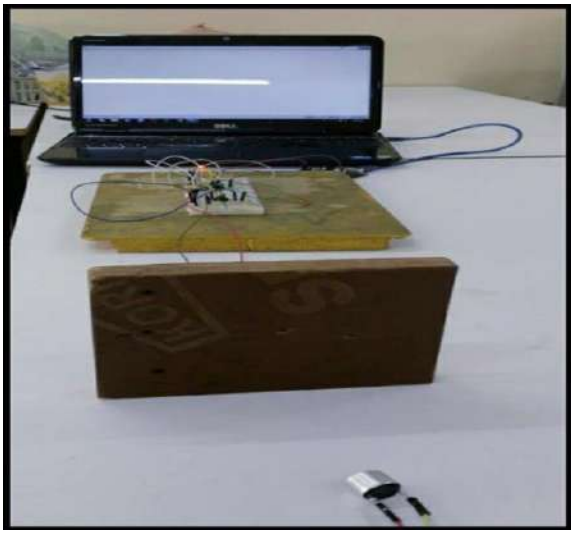
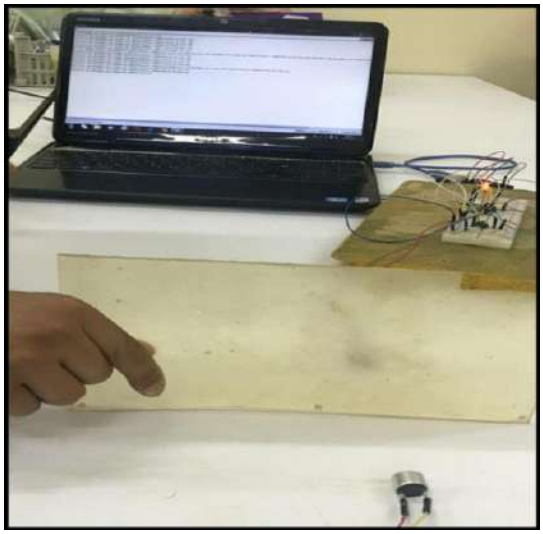
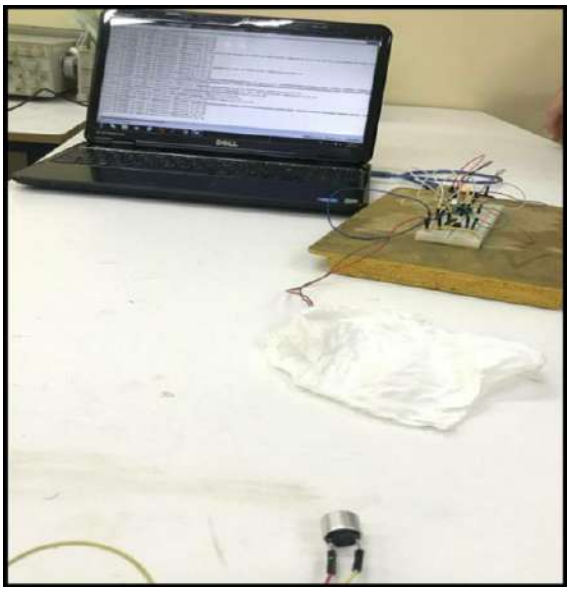


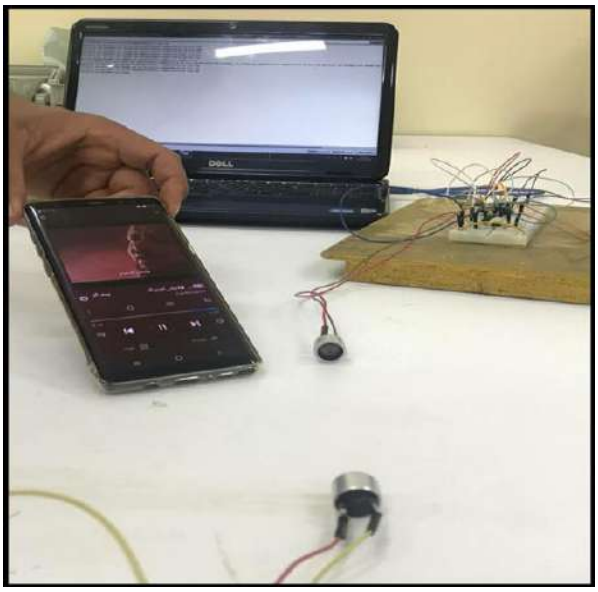
Figure (4-3)A- The barrier is billet



B-The barrier is plastic



C-The barrier is tissue



D-noise sound near by the sensors

We experiment different obstacles (barriers) and we observe that When we put billet between the two sensors the data will not reach to Receive as shown in figure (4-3)A .
But when we put plastic between the two sensors the data will reach to Receiver with some of error like in figure B-
And when we put tissue between the two sensors the data will reach to Receiver without error such as figure C-.
Finally we put noise sound near by the two sensors ,the data will reach to Receiver without error (it not effected) such as in figure D-.

Chapter 5

CONCLUSION

In this study, a new method to wireless communication system by using ultrasonic sensor , the circuit was successfully connected and the program was sent to the arduino microcontroller chip to run the circuit. The ultrasonic sensor (TX)can transmit the data and the ultrasonic sensor can receiver this data . there were value recorded for the different distance between two sensors ,also the error rate varies with difference the distance , and have been measured the signal in transmitter side it 10 KHZ and it was be pulses one time zero and another time have value.

Then the circuit was tested by placing barriers between the sensors to verify the quality and correctness of the design. The results showed that the error rate in the small distance is small, and vice versa, since at the distance of 25 cm the error ratio is o % while in distance 100 cm, the error rate is 100%.

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الملخص

نظام الاتصالات اللاسلكي بالموجات فوق الصوتية في هذا المشروع يمكننا نقل البيانات بين نقطتين بواسطه استخدام متحسسات الموجات فوق الصوتية (إرسال البيانات من جهاز الإرسال وتمريرها عبر المتحسسات (المرسل والمستقبل) بالموجات فوق الصوتية واستقبالها من جهاز الاستقبال ، عندما تظهر النتائج سوف تكون المسافة اقل من 10 سنتمتر لا توجد قراءه للمتحسس المستقبل اما عندما تكون المسافة اكبر من 10 سنتميتر سيكون الزيادة خطية أي كلما ازدادت المسافة بين المتحسسين ازدادت نسبه حدوث الخطأ ,وان المسافة من 35 سم إلى 45 سم هي المسافة الأنسب لنقل البيانات لانها تكون بدون اخطاء (هنا عند إرسال 34 حرفًا) ، تختلف هذه النسب وفقًا لعدد الأحرف المرسلة ، ونقوم بإجراء اختبار حول العوائق المختلفة ونلاحظ ان المناديل والضوضاء لا تؤثر علي البيانات المرسلة واما الخشب فهو يمنع وصول البيانات المرسلة إلى جهاز الاستقبال

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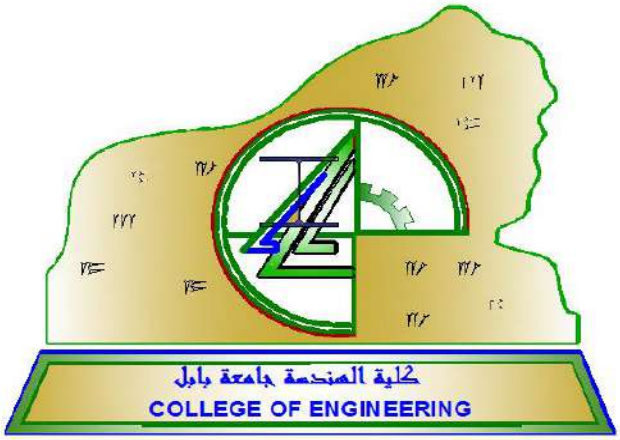

نظام الاتصالات اللاسلكي باستخدام الموجات فوق الصوتية

قدم هذا المشروع لإستكمال جزء من متطلبات الحصول على درجة البكالوريوس في الهندسة الكهربائية

قدم من قبل:

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