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DESIGN AND IMPLEMENTATION OF A BIOMEDICAL ASSISTIVE GLOVE FOR THE VISUALLY IMPAIRED

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Abstract:

This project presents the design and implementation of a smart glove to help blind and visually impaired people navigate their environment independently. The glove incorporates ultrasonic sensors, an Arduino Nano microcontroller, and a siren to alert the user of nearby obstacles through audio signals. The system is programmed and assembled to detect objects within a one- meter range and sound an alarm when an obstacle is detected. The system aims to enhance the user's ability to move safely without external assistance. Experimental results demonstrated that the glove is capable of identifying obstacles and providing real-time alerts. Future improvements include adding multiple sensors for broader coverage, using motion sensors to recognize living objects, and integrating artificial intelligence techniques to distinguish the nature of objects. This innovation contributes to enhancing the independence of the blind, improving their quality of life, and providing comprehensive technological solutions.

Keywords: Smart Glove, Blind and Visually Impaired, Ultrasonic Sensors, Arduino Nano, Assistive Technology

1. Introduction

1.1 Background

We are now in the era of technology development and the information revolution, this continuous development has helped humanity He wanted to change his lifestyle for the better, and it would have been difficult to accomplish many tasks without her. There is no doubt that the impact of anything in life is divided into two parts: Positive and negative, the outcome is certain [1].

Using this thing causes the person himself to respond to it, so if he uses it correctly; Reflected the result is positive, and vice veers, One of the most important social issues that has raised a great deal of difference in recent times is cultural technology and modern means of communication, as they have created a cultural boom in various fields of the modern era, and like other modern means that have been used in a wrong way at times, but despite some people distorting the correct image of technology and its importance, it still maintains On some of the advantages it brought to the era Hadith which no one can deny at all [1].

The sense of sight is one of the five most important senses in humans, and in general, humans get 80% of They collect environmental information and analyze it through sight. Eyes and vision play the most important role in human beings' daily activities and play an important role in things such as studying, learning, watching movies, driving, and love of the same kind. The number of people who are completely blind is estimated at about 30 million people around the world, according to the World Health Organization, and they depend completely on others for their movement [2].

1.2 The problem of searching

Blind people lack the ability to know that there is an object opposite them, and they may be exposed to damage that may lead to harm.

1.3 Proposed solution

We will solve these problems by creating smart glove for the blind and visually impaired that help them.

In relying on themselves using ultrasonic sensors and microcontrollers.

Where the shoe depends

On ultrasonic sensors, sensing obstacles and measuring distances, these sensors are fixed on a controller flour [2].

1.4 Aim of the Thesis

We will solve these problems by creating smart glove for the blind and visually impaired that help them.

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2. Optical Ark and Visual Courtyard

2.1 Theoretical Background

Visual perception is the ability to interpret the surrounding environment, by interpreting information within visible light, and the resulting perception is known as "vision".

The various physiological components of vision are collectively known as the visual system, and are the focus of research in psychology, cognitive science, and neuroscience. Molecular biology; All of them are known as the science of vision [4].

The visual system is the part of the central nervous system that enables organisms to process visual detail as well as enabling many visual response functions to shape the image.

This device interprets information from visible light to build a representation of the surrounding world. The visual system accomplishes a number of complex tasks, including receiving light and forming color representations, constructing a perspective perception from a pair of two- dimensional projections, identifying and classifying visual objects, evaluating distances to and between objects, and directing body movements relative to the visual objects.

The psychological process of presenting visual information is known as Visual perception, and its deficiency, leads to what is known as blindness [4].

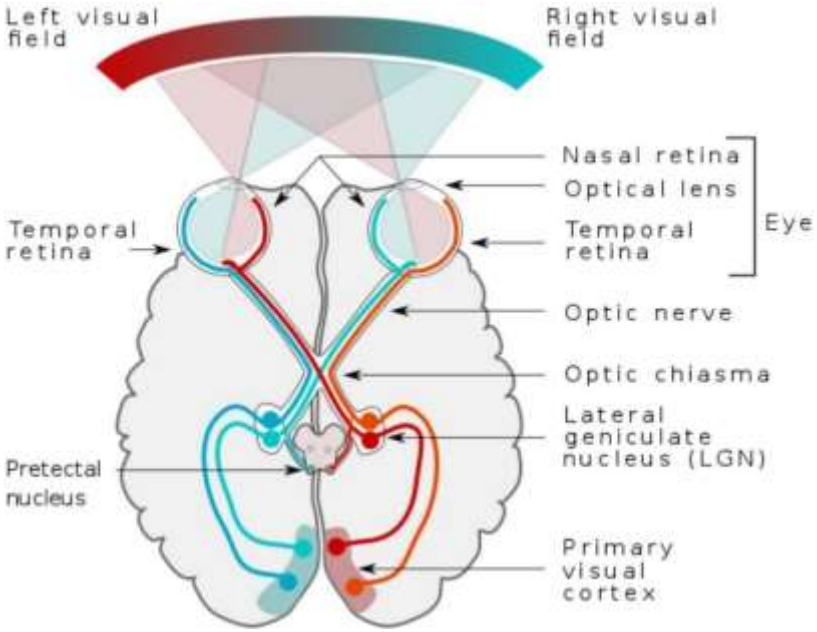

Figure 1. The human vision system.

2.2The eye and the sense of sight

The eye is considered one of the most complex and wonderful parts of the human body. The human eye consists of three layers: [5]

1. Solid.
2. Choroid
3. The retina.

The retina is the deepest and most important layer of the eye's structure, the area most sensitive to light and plays a role in it plays a very important role in the sense of sight due to its cone and cylindrical cells.

The retina and its various parts are located behind the eye and play a very important role in clarifying images.

The retina consists of three main and very important parts:

1. The macula: It is a part of the retina in the visual axis of the eyeball. This section contains many cone receptors and plays a very important role in accuracy and sharpness. Many basic eye diseases cause damage to this area and can cause irreparable damage. Fix it for the eyes And them Vision

2. Retinal pigment layer: Rich in pigments and necessary for accuracy and vision correction through absorption Additional light, the cylindrical and cone cell layer are the main and important layers Very much in the retina and differ from each other in terms of structure and physiological function These cells are responsible for producing and producing visual sensory signals after light enters and passes through the basic layers of the eye.

3. Blind spot: It is the end of the retina where the optic nerve leaves the retina and transmits signals Optical transmission to the brain, after passing through the cornea, the light reaches the lens and after passing through A gel-like substance called the vitreous reaches the retinal layer, after passing through the eye Light reaches the retina through the eye's lens system and after passing through its outer layers The retina reaches the cylindrical and cone cells in the retina, possessing substances. Light-sensitive chemicals in these cells have the ability to decompose into chemical compounds and through Producing molecules and chemical compounds, they are capable of triggering nerve impulses and depolarization Cone and cylindrical cells [5].

2.3Transmission of the sense of sight to the optic nerve

Visual sensory messages produced in the cone and cylindrical cells slowly reach the horizontal cells, bipolar cells, and amercing cells in the retinal layers and finally enter the optic nerve.

Optic nerve the second optic nerve: A sensory nerve extends from the end of the retina to deliver primary visual messages to the brain. Signals or messages from the visual sense leave the retina through the optic nerve and are transmitted to the other side of the brain after reaching the optic chiasm.

2.4The visual cortex in the brain

The visual cortex in the brain is the area of the cerebral cortex that processes visual information. It is located in the occipital lobe. Sensory inputs arising from the eyes are transmitted through the lateral geniculate nucleus in the thalamus and then reach the visual cortex [6].

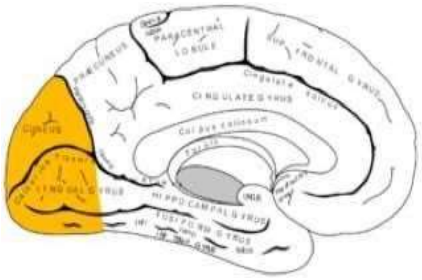

Figure 2. Lateral section of the occipital lobe.

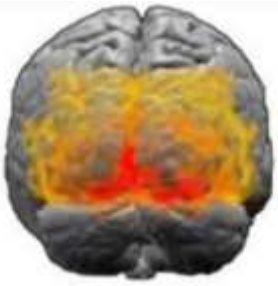

Figure 3. Occipital lobe.

2.4.1 Primary visual cortex:

The primary visual cortex is anatomically located in the calcimine groove and is the site of direct visual signals from the eye. This part of the visual cortex receives raw and direct visual signals from the macular area in Retina [7].

2.4.2 Secondary visual cortex

The secondary visual cortex is located on four sides of the primary visual cortex and is able to analyze visual sensory messages for visual concepts. This area of the brain receives and analyzes visual signals from the primary visual cortex. The visual cortex in the brain contains many different and specialized cells. Each of them has the ability to analyze and parse specific information from visual messages and work in two general ways [7].

Reach the visual cortex in the brain. The visual cortex is located in the middle of the occipital lobes and is divided into primary and secondary visual cortex [6].

2.5Vision loss

Blindness is the condition of complete loss of sight in both eyes. A completely blind person is unable to see at all. However, the word blindness is commonly used as a relative term to denote poor eyesight or poor vision, meaning that even with glasses, contact lenses, medicine or surgery no the person sees well, Visual impairment can range from mild to severe [8].

2.6 Causes of vision loss

Problems at any point on the visual path can cause vision loss, including:

1. Cataract

In this case, the lens develops a type of cloudiness as a result of cataracts, and other symptoms accompanying the disease include blurry vision, double vision, and intolerance to sunlight.

The causes of this condition are as follows:

- Growing old.
- The birth of a child with this condition.
- A bruise or injury to the eye.

The condition is usually treated by replacing the damaged lens of the eye, and the success rates of this operation are high. Whether surgery is resorted to or not, continuous eye care under the supervision of a specialist doctor is sufficient to maintain look [8].

2. Diabetic retinopathy

One of the possible complications of diabetes is the development of what is called diabetic retinopathy, where vision loss may occur as a result of weakness in the blood vessels in the retina, causing tears and bleeding. Inside the eye. As the eye attempts to heal from the tear, the resulting scars on the retina may cause vision loss

Absolutely, so this condition is one of the common causes of blindness among diabetics. Laser surgery is usually used to treat diabetic retinopathy eyes with continuous follow-up Under the supervision of a doctor, available treatments may cause loss of peripheral vision, but they save what remains [8].

3. Glaucoma

Glaucoma, also known as glaucoma, is one of the causes of blindness. Glaucoma affects the eye gradually as follows:

- Excessive production of eye fluids or a defect in the eye fluid production and drainage system.
- Increased pressure on the eye.
- Causing damage to the optic nerve, which carries visual signals to the brain.
- Blindness due to continued pressure on the nerve.
- A person may suffer from glaucoma for a period of time without realizing it, because the pressure taken
- Growing in the eye does not cause any significant pain, so eye examinations should always be performed periodically [9].

But it must be noted here that this condition has no cure, and the available medical options prevent the condition from occurring It's only getting worse, nothing more.

4. Macular degeneration

Optic degeneration is one of the main causes of blindness in people over the age of 55 years. A healthy eye contains within the retina an area crowded with millions of light-sensitive cells that have. A major role in producing the detailed images that we see. As we age, the aforementioned cells begin to gradually deteriorate, causing blurry vision or the appearance of a spot Black in the middle of the field of vision. There are two types of macular degeneration, one is dry and the other is wet, and dry is the most common. The specialist here may resort to treating the condition by injecting the eye with special injections, which are often monthly, or with other treatments, such as laser [9].

5. Retinitis pigments

Retinitis pigments is a hereditary disease in which the condition of the retina worsens day after day. It is usually diagnosed at an early age, and begins with night blindness, followed by a gradual loss of vision, ending with blurred vision. It is like seeing in a tunnel. There is no cure available to date for this particular disease, and it often ends up being an infection Retinoblastoma pigments is one of the causes of complete blindness [10].

6. Stroke

The eye may suffer from loss of vision in a certain direction because of a stroke or a brain tumor. If the affected side of the vision is the right, this means that the affected half of the brain is left and so on [10].

There is no treatment available for this condition, but the patient must adapt to it as much as he can, and a stroke may occur One of the causes of blindness in one eye [11].

7. Reaching menopause early in women, as the chances of developing glaucoma increase.
8. Smoking, which increases the chances of developing macular degeneration.
9. Staring at the sun, this is similar to shining a laser directly at the eye.
10. Taking certain medications, as they may cause deposits on the retina over time and loss of Sight at last.
11. Sleeping with contact lenses.
12. Vitamin A deficiency.
13. Retinitis pigments.
14. Primary or secondary malignant tumors of the eye.
15. Congenital malformations
16. Genetic eye diseases
17. Chemical poisoning from toxic agents such as methanol.
18. Corneal or retinal infections, glaucoma, and inability to get any glasses [11].

2.7 Types of blindness

2.7.1 Color blindness

See differences in shades of different colors, especially green and red, which 20 of 37 are inherited (genetic) and affect about 8% of males and less than 1% of women. People with color blindness usually have otherwise normal vision and can function well visually. This is actually not true blindness.

2.7.2 Night blindness

It is difficulty seeing under low-light conditions. It can be hereditary or acquired. The majority of people with night vision difficulties work well under low-light conditions regular; This is not a case of poor eyesight.

2.7.3 Snow blindness

It is the loss of vision after the eye is exposed to large amounts of ultraviolet radiation. Snow blindness is usually temporary and results from swelling of the cells on the surface of the cornea. Even in the most severe cases of snow blindness, the individual is still able to see shapes and movement. [12]

2.8Symptoms of blindness

If the patient is completely blind, he will not see anything. If the patient is partially blind, he may experience the following symptoms:

1. Cloudy vision.
2. Inability to see shapes.
3. Seeing shadows only.
4. Poor night vision.

2.9 Risk factors for blindness

Risk factors include:

1. Poor prenatal care.
2. Premature birth.
3. Advanced age and malnutrition.
4. Not wearing safety glasses when needed.

5. Poor hygiene and smoking.
6. Family history of blindness, and the presence of various visual diseases [12].

2.10 Diagnosis of blindness

Blindness is diagnosed by examining each eye individually and measuring visual acuity, visual field, or peripheral vision.

People may be blind in one eye (unilateral blindness) or both eyes. (Binary blindness) Historical information regarding blindness can be helpful in diagnosing the cause of blindness. Sudden vision loss differs in possible causes from progressive or chronic blindness. Temporary blindness differs in cause. About permanent blindness, the cause of blindness is determined by a comprehensive examination by an ophthalmologist [13].

3. Application Framework

3.1Components

1) Arduino Nano

An electronic development board consists of an open source electronic circuit with a microcontroller on one board and is programmed by computer and is designed to make the process of using electronics Interactivity in multidisciplinary projects is easier.

The Arduino is mainly used in designing interactive electronic projects or projects that aim to build various environmental sensors such as temperature, wind, pressure and the Arduino can be connected to various programs on the personal computer.

In its programming, the Arduino relies on the open source programming language, and the programming codes for the Arduino language are similar to the Programming Language C) and it is considered one of the easiest programming languages to use.

In writing microcontroller programs Arduino also simplifies the process of working with microcontrollers, but it offers advantages to specialists, students, and interested hobbyists over other systems in:

- Inexpensive, Arduino boards are relatively cheap compared to other microcontroller platforms.
- Multiple systems: The Arduino program runs on Windows and Macintosh, Linux operating systems and most microcontroller systems are limited to Windows only.
- Simplicity and clear development environment The Arduino development environment is easy to use for beginners, but flexible enough for advanced users to benefit from it as well
- It is conveniently based on a processing programming environment so that students learning programming in that environment will be familiar with the look and feel of the Arduino.
- Open source and extensible software. Arduino has been published as an open source tool, and is available for extension and development by experienced programmers. The language can be extended through C++ language libraries.

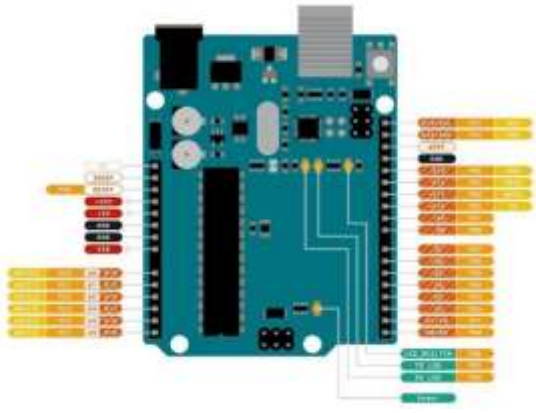

Figure 4. Arduino Nano data distribution.

Figure 5. Arduino Nano board.

2) Ultra Sonic sensor

This sensor works on the principle of ultrasound, the idea is based on emitting high-frequency waves When they collide with an object, these waves bounce back in the form of an echo. What is meant by an object here is any obstacle present in front of the sensor, as it does not differentiate between living bodies and objects The other is in contrast to the motion sensor, which is capable of recognizing living objects (such as humans) and determining their movement About the various things surrounding him.

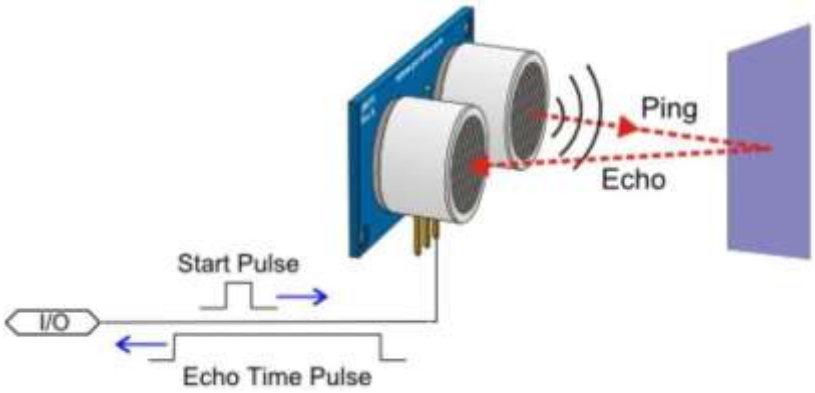

Figure 6. Ultrasound waves bouncing off a barrier.

This sensor works to determine the distance of objects from a distance of 2-400 cm, meaning that it can calculate distances up to 4 meters. The circuit of this sensor contains a wave-transmitting circuit that works through (trigger pin), a wave-receiving circuit that works through (echo pin) and a control circuit. An internal system that controls the organization between the two circuits Transmission and reception.

3) Voltage raiser

It is a direct current converter, and one of the types resulting from switching the power of the supply.

The voltage raiser converts the direct current into another direct current with an output voltage greater than the value of the supplied voltage. It raises the voltage and thus the strength of the current decreases.

This requires the presence of two semiconductors, namely the diode and the transistor, and of course the presence of an energy supply whose voltage is to be changed. It also requires the presence of an energy store such as a coil (sometimes called an inductor), a capacitor, or both source the key energy Pregnancy.

Figure 7. Lithium polymer battery.

4) Connecting wires

Wires are used to collect and connect electronic parts to build the electrical circuit required to implement the project.

Figure 8. Connecting wires.

5) Buzzer Or Electric Buzzer

A device that converts electrical energy into audible sound. It is used for sound notification in cars, ovens, microwaves, etc.

There are different types of electric buzzers. The typical buzzer operates on voltage 12-6 volts and carries a constant current of approximately 25 mA.

Figure 9. Buzzer or Electric Buzzer.

3.2 Charging circuit

It is the primary power source for AC Power in some modern devices.

3.2.1 Components of the charging circuit

1. Shipping socket.
2. Charging fuse or fuse resistance.
3. Shipping file.
4. Normal resistance.
5. Thermal resistance (if any).
6. Charging diode.
7. Charging capacitors.
8. Easy shipping.
9. Battery blades.
10. Battery.

3.2.2 Explain the components of the charging circuit

1. The charger: It converts the electrical voltage (home electricity) from 220 volts AC to 57 DC. The use of non-original chargers is one of the most important causes of charging malfunctions due to their unstable voltage and lack of continuous current output from them.

2. Charging socket: It is the electrical voltage input from the charger to the device, and it is the first piece in the charging circuit In old devices, it consists of two leads: The positive leg (V-Bar): which takes the voltage from the charger. The ground leg (GND): which is the negative leg that completes the circuit. In modern devices, there are legs called data, and their function is to identify the device to the computer and transfer information from the device to the computer and vice versa. The number of legs of the charging station varies from one device to another. Installing an incorrect charging housing

may cause a short to the charger or the device.

3. The fuse: Its function is to protect the charging circuit from high currents, as it turns out and prevents current from passing It is called the “combat” fuse because it protects the components that follow it. If the fuse is damaged, it interrupts the charging circuit, and if it is damaged, we can Replace it with a thin wire (soldering) or seal its place with tin (soldering), but we will lose its function, which is to protect the circuit from High currents, it is advisable to replace it when damaged.

4. The function of the coil is to raise the current to the appropriate value in the event that the charger’s current decreases and the coil is damaged, interrupting the charging circuit. We can replace it in the same way as the fuse, but it will lose its function and must be replaced.

5. the resistor is to resist and reduce the current to the appropriate value to charge the device. Therefore, its damage interrupts the charging circuit, and we can compensate for it if its value is small. However, if its value is large, it must be replaced, and its value is often large.

6. The charging diode's function is to pass current in one direction and prevent it from returning in the same direction If the diode is damaged, it will cause a short or a power surge again, which will cause the battery to swell.

3.3Smart glove with artificial intelligence technology

The latest generation of smart sticks uses artificial intelligence technology to enhance their capabilities. AI-powered wands can learn and adapt themselves to the user's environment, providing personalized assistance, object detection, obstacle avoidance, and path planning.

3.4 Linkage circuit

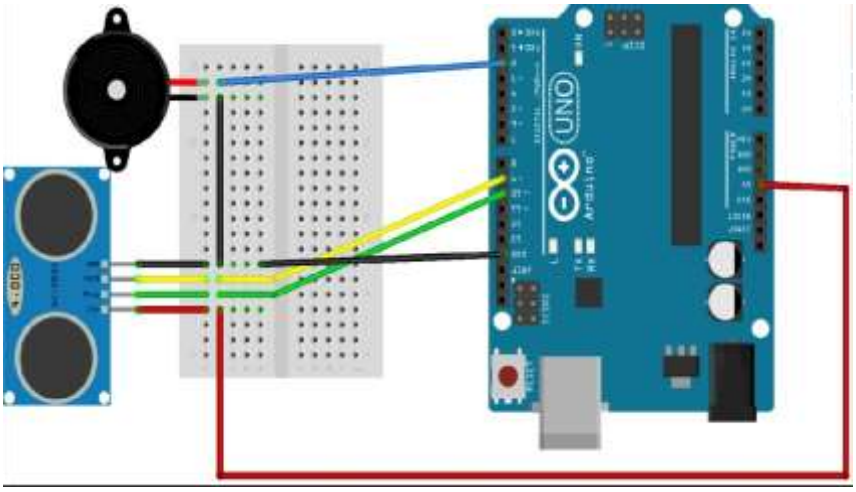

Figure 10. Linkage circuit.

3.5 Steps to implement the system

1. The first stage

The program written in the Arduino environment to operate the circuit is uploaded to the microcontroller who controls it.

2. The second stage

Connect all components of the independent circuit by using wires to connect all components with Arduino as follows:

- The positive power source or voltage source was connected to the microcontroller via port No. 12.
- Ultrasonic sensors with a microcontroller to which the Trig transmitter terminal is connected Sensitive with microcontroller pin No. 2.
- Echo receiving pin with microcontroller pin No. 3, and GND sensitive pin with source Negative power and VCC sensitive pin with positive power supply.
- Buzzer, connected to the independent microcontroller via pins 10.
- The negative of the battery is connected to the negative of the voltage booster, and the positive of

the battery is connected to the positive of the voltage booster as well The negative of the charging circuit is with the negative of the battery, and the positive of the charging circuit is with the positive of the battery. The latest generation of smart sticks uses artificial intelligence technology to enhance their capabilities. AI-powered wands can learn and adapt themselves to the user's environment, providing personalized assistance, object detection, obstacle avoidance, and path planning.

3.6 System status

If there are no obstacles, whether this obstacle is in front of me, that is, if the distance is greater than 1 meter in Independent controller If there is an obstacle in front of you, this means that the distance between the user and the obstacle is less than 1 meter In this case, the system alerts the user by emitting a beep sound. [13]

Figure 11. Final form of the device.

4. Model Evaluation

4.1 Results

After implementing the system, we reached the following results:

1. The system detects the obstacles facing the user by alerting him using Beep.

2. The electrical circuit was built, which consists of a microcontroller, ultrasonic sensors, and a buzzer. 3- This circuit performed its function in that it detects obstacles that lie in front of the user at a distance 1 meter and alerted by buzzer.

4.2 Recommendations and proposals

To make the system more effective, we will later add the following characteristics to the proposed system:

1. The system is equipped with several ultrasonic sensors to identify all obstacles and in any direction.
2. Using a motion sensor allows us to identify living objects such as stones and others.
3. Including a type of artificial intelligence through which it determines the nature of the thing in front of it.

4.3 Difficulties

1. High prices for used parts
2. Inability to coordinate work within the project.
3. Lack of knowledge about how to deal with pieces

4.4 Procedures

A smart glove is a glove made of cloth or other materials, and performs many functions for humans, as they use it as a weapon to defend themselves, and may use it to walk easily when they grow older

or suffer from a motor disability, and for the blind, it represents one of the most important tools they need for movement and enables them to be independent and self-reliant in many matters, so it is no wonder that this tool has become a symbol for the blind.

a. Working procedures

The glove carries special sensor points that measure the distances between any obstacle and the blind person, and these sensor points issue an audible or vibrating alarm to the blind person, to inform him of the presence of an obstacle that he must overcome.

b. Uses

The smart blind glove can be used in a variety of settings and situations to assist individuals with visual impairments. Some of its key uses include:

1. Personal Mobility: The primary use of the smart blind glove is to provide individuals with visual impairments greater independence and safety while navigating both indoor and outdoor environments.
2. Public Spaces: The stick can be beneficial in public spaces, such as airports, train stations, and shopping centers, where visually impaired individuals may need assistance in maneuvering through complex and crowded areas.
3. Remote Assistance: The smartphone app connectivity opens up the possibility for remote assistance, where friends, family, or support networks can provide real-time guidance or help locate the user if needed.
4. Creating Inclusive Environments: By promoting greater accessibility and in dependence for individuals with visual impairments, the smart blind glove.

5. Conclusion

This research has been completed, which helps blind and visually impaired people move by using ultrasonic sensors to remotely sense and detect obstacles facing the user Alert him if there is an obstacle in front of him.

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