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CONCEPTION AND REALIZATION OF A SMART CANE TO ENHANCE THE AUTONOMY OF PEOPLE SUFFERING VISION LOSS

Soutenu le 21 Juin 2018 devant le Jury

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بسم الله الرحمان الرحيم

Abstract :

This project is the conception and realization of a smart cane for the visually impaired people, our device is a replacement of the traditional white cane and it provides a lot of useful features such as detecting obstacles from various directions using ultrasonic sensors, and giving the user an instant feedback using the vibration motors installed in the handle of the device, along with a voice alert with the direction of the obstacle, the device can receive voice commands from the user, and it can communicate with the smartphone of the user using Bluetooth.

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We would like to thank Melle HABIBES Naïma for giving us the honor of being our supervisor.

We would like to thank the respectable members of the jury for giving us their time to comment, discuss and judge our work.

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Introduction

Blindness is the total loss of eyesight; it's a handicap that affects many people in the world. This absence of sight can have multiple causes and consequences. For example, health and sleep are affected by a disruption in the production of melatonin (sleep hormone and diethyl cycle), but those consequences can be dealt with using proper medicine. On the other side, the social life is complicated as a result, the change will be dramatic and it will be hard for those people to do the basic vital tasks such as traveling safely from a place to another, communicating or using technology devices. Therefore, the traditional solution is to have an assistant for those people at home to do all their stuff and meet all their needs for them, which is a hard commitment to maintain, so there comes the need for assistive devices designed specifically for the blind people in order to allow them to do those basic tasks independently and safely. Our project involves the creation of a smart cane that facilitates the movement of a visually impaired person.

Chapter I
Visual impairment (Blindness)

I.1 Introduction

The World Health Organization (WHO) Fact reported that there are 285 million visually-impaired people worldwide. Among these individuals, there are 39 million who are blind in the world. More than 1.3 million are completely blind and approximately 8.7 million are visually-impaired in the USA. Of these, 100,000 are students, according to the American Foundation for the Blind and National Federation for the Blind. Over the past years, blindness that is caused by diseases has decreased due to the success of public health actions. However, the number of blind people that are over 60 years old is increasing by 2 million per decade. Unfortunately, all these numbers are estimated to be doubled by 2020. [1]

The most common navigation tools used by blind people are white canes and trained dogs, the first one is a very affordable option but as of the second one, the dogs are a better option than the cane as they provide a much smother travel overall, they require food and daily care which is not cheap, and overall they both cannot provide the blind with enough information and features for their needs, which are available to other sightful people. [2]

I.2 Visual impairment

also known as vision impairment or vision loss, is a decreased ability to see to a degree that causes problems not fixable by usual means, such as glasses.

The term blindness is used for complete or nearly complete vision loss, and it’s defined as the state of being sightless. A blind individual is unable to see. In a strict sense the word "blindness" denotes the inability of a person to distinguish darkness from bright light in either eye. Visual impairment may cause people difficulties with normal daily activities such as driving, reading, socializing, and walking**.**

I.3 Causes of blindness [3]

❖ Cataracts (51%):

A cataract is a partial or total opacification (clouding) of the lens in the eye. The opacification is responsible for many symptoms such as a gradual decline in vision, faded colors, blurry vision, discomfort to light (photophobia), and trouble seeing at night. Cataracts often develop slowly and can affect one or both eyes.

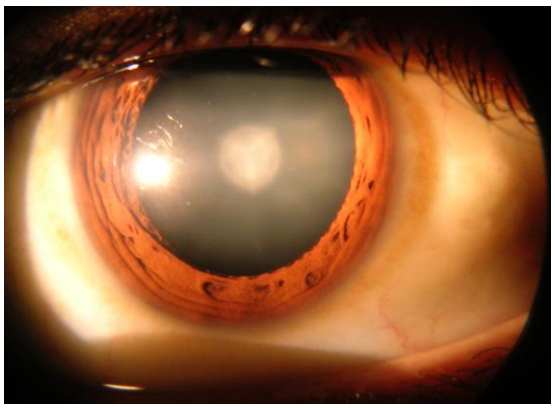

Figure I.1 picture of an eye with cataract condition.

❖ Glaucoma (8%):

it's an eye disease that is often associated with elevated intraocular pressure, in which damage to the eye (optic) nerve can lead to loss of vision and even blindness.

Figure I.2 picture of an eye with glaucoma disease.

❖ Macular degeneration (5%):

also known as age-related macular degeneration (AMD or ARMD), is a disease of the retina caused by progressive degeneration of the macula, the central part of the retina, which can appear from the age of 50, causing a significant weakening of the visual abilities (blurred vision).

Figure I.3 Picture of the back of the eye showing intermediate age-related macular degeneration.

❖ Corneal opacification (4%):

Corneal opacity is a disorder of the cornea, the transparent covering of the eyeball, which can cause serious vision problems. Corneal opacity occurs when the cornea becomes scarred. This stops light from passing through the cornea to the retina and may cause the cornea to appear white or clouded over.

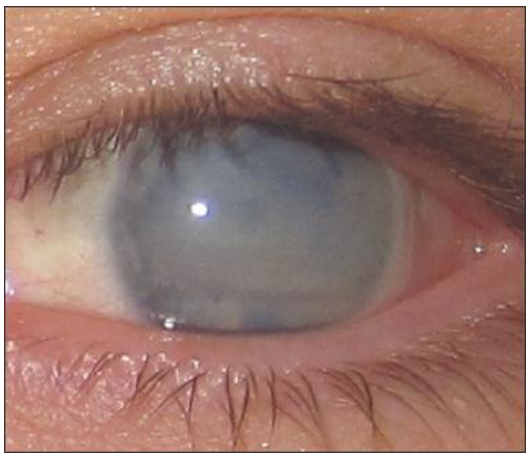

Figure I.4 picture of an eye with corneal opacity.

❖ Childhood blindness (4%):

There are many causes of blindness in children. Blindness may be due to genetic mutations, birth defects, premature birth, nutritional deficiencies, infections, injuries, and other causes.

❖ Refractive errors (3%):

Also known as refraction error, is a problem with focusing light accurately onto the retina due to the shape of the eye.

❖ Trachoma (3%):

Trachoma is an infectious disease caused by bacterium Chlamydia trachomatis. The infection causes a roughening of the inner surface of the eyelids.

❖ Diabetic retinopathy (1%):

It’s a diabetes complication that affects eyes. It's caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina).

❖ Other causes (21%):

- Head injury: A head injury is an injury to your brain, skull, or scalp. This can range from a mild bump or bruise to a traumatic brain injury. Common head injuries include concussions.
- Hypertensive Retinopathy: Over time, high blood pressure can cause damage to the retina's blood vessels, limit the retina's function, and put pressure on the optic nerve, causing vision problems.
- Optic neuritis: The optic nerve carries visual information from your eye to your brain. Optic neuritis (ON) is when your optic nerve becomes inflamed, causing vision loss.
- Retinal Vascular Occlusion: it occurs when one of the vessels carrying blood to or from your retina becomes blocked or contains a blood clot.
- Other rare diseases and eye injuries.

I.4 History

The traditional canes have been used as a mobility tool by the blind people for hundreds of years, until the white cane was introduced after world war I. [4]

In 1921 James Biggs, a former photographer from Bristol who lost his eye sight after an accident, painted his walking stick white to be more visible for others since his home was located in a very busy area. [5]

In 1931 in France, a national white stick movement for blind people was launched by Guilly d'Herbemont, then on February 7,1931, in the presence of several French ministers he gave the first two white canes to blind people. At a later stage 5,000 more white canes were sent to blind French veterans from World War I and other blind civilians. [6]

The long cane was improved upon by World War II veterans rehabilitation specialist, Richard E. Hoover, at Valley Forge Army Hospital. [7] In 1944, he took the Lions Club white cane (originally made of wood) and went around the hospital blindfolded for a week. During this time he developed what is now the standard method of "long cane" training or the Hoover Method. He is now called the "Father ofthe Lightweight Long Cane Technique." The basic technique is to swing the cane from the center of the body back and forth before the feet. The cane should be swept before the rear foot as the person steps. Before he taught other rehabilitators, or "orientors," his new technique he had a special commission to have light weight, long white canes made for the veterans of the European fronts. [8]

Figure I.5 A long cane, the primary mobility tool for the visually impaired

I.5 State of the art

➢ RFIWS:

A Radio Frequency Identification Walking Stick (RFIWS) was designed in [9] in order to help blind people navigating on their sidewalk. This system helps in detecting and calculating the approximate distance between the sidewalk border and the blind person. A Radio Frequency Identification (RFID) is used to transfer and receive information through radio wave medium. RFID tag, reader, and middle are the main components of RFID technology.

A number of RFID tags are placed in the middle of the sidewalk with consideration of an equal and specific distance between each other and RFID reader. The RFID will be connected to the stick in order to detect and process received signals. Sounds and vibrations will be produced to notify the user with the distance between the border of the sidewalk and himself/herself. Louder sounds will be generated as the user gets closer to the border. Figure I.8 shows the distance of frequency detection (Y) and width of sidewalk (X). Each tag needs to be tested separately due to different ranges of detection.

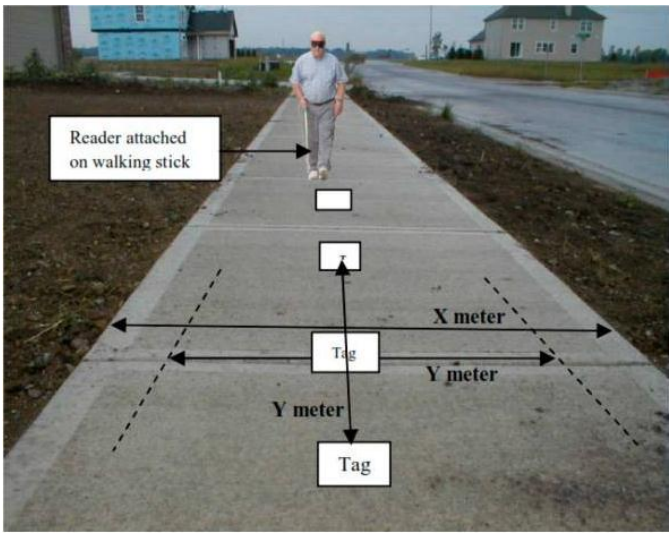

Figure I.6 Distance of the frequency detection on sidewalk.

RFID technology has a perfect reading function between the tags and readers that makes the device reliable in the level of detection. However, each tag needs a specific range which requires a lot of individual testing, that leads to scope limitation. Also, the system can be easily stopped from working in case of wrapping or covering the tags which prevents those tags from receiving the radio waves.

➢ Fusion of Artificial Vision and GPS (FAV&GPS)

An assistive device for blind people was introduced in [10] to improve mapping of the user's location and positioning the surrounding objects using two functions that are: based on a map matching approach and artificial vision. The first function helps in locating the required object as well as allowing the user to give instructions by moving her/his head toward the target. The second one helps in automatic detection of visual aims. As shown in Figure I.7, this device is a wearable device that mounted on the user's head, and it consists of two Bumblebee stereo cameras for video input that installed on the helmet, GPS receiver, headphones, microphone, and Xsens Mti tracking device for motion sensing. The system processes the video stream using SpikNet recognition algorithm to locate the visual features that handle the 320 × 240 pixels image.

Figure I.7 An assistive device for the blind people based on map matching approach and artificial vision.

➢ Smart cane:

The Smart Cane was presented originally by Central Michigan University's students. [11] The design of the Smart Cane is shown in Figure I.9. It is a portable device that is equipped with a sensor system. The system consists of ultrasonic sensors, microcontroller, vibrator, buzzer, and water detector in order to guide visually-impaired people. It uses servo motors, ultrasonic sensors, and fuzzy controller to detect the obstacles in front of the user and then provide instructions through hand vibration.

Figure I.8 The smart cane prototype.

➢ Eye Substitution:

Bharambe developed an embedded device to act as an eye substitution for the vision impaired people (VIP) that helps in directions and navigation as shown in Figure I.6 [12]. Mainly, the embedded device is a TI MSP 430G2553 micro-controller.The authors implemented the proposed algorithms using an Android application. The role of this application is to use GPS, improved GSM, and GPRS to get the location of the person and generate better directions. The embedded device consists of two HC-SR04 ultrasonic, and three vibrator motors.

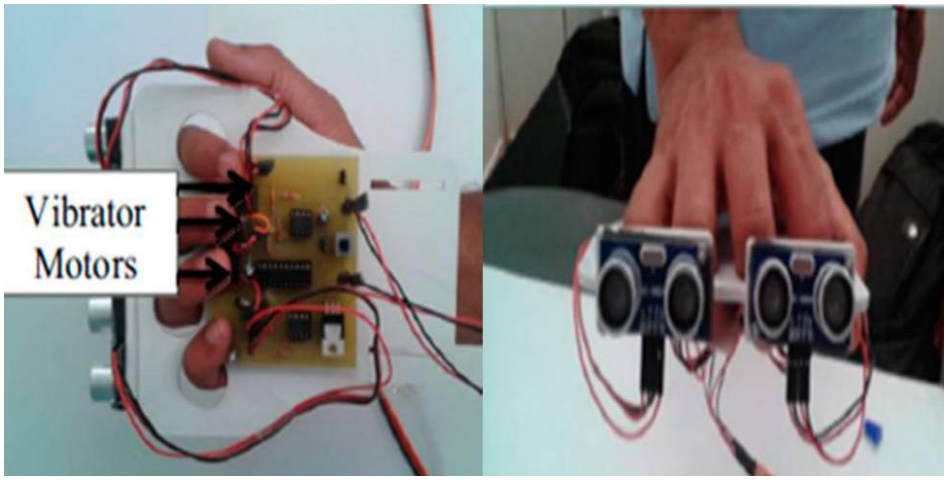

Figure I.9 The prototype of the eye substitution device

The design of the device is light and very convenient. Furthermore, the system uses two sensors to overcome the issue of narrow cone. So, instead of covering two ranges, the ultrasonic devices cover three ranges. This does not only help in detecting obstacles, but also in locating them. However, the design could be better if the authors did not use the wood foundation that will be carried by the user most of the time. In addition, the system is not reliable and is limited to Android devices.

I.6 Conclusion

In this chapter we got to know the numerous causes of visual impairment and how it can limit people's ability to perform everyday tasks and affect their quality of life and ability to interact with the surrounding world. Blindness, the most severe form of visual impairment, can reduce people's ability to perform daily tasks, and move about unaided.

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Chapter II
Conception and realization of the device

II.1 Introduction; assistive technology

Assistive technology represents all the systems, services, devices and appliances that are used by disabled people to help in their daily lives, make their activities easier, and provide a safe mobility. [1]

In the 1960s, assistive technology was introduced to solve the daily problems which are related to information transmission (such as personal care), navigation and orientation aids which are related to mobility assistance. [2]

In Figure II.1, visual assistive technology is divided into three categories: vision enhancement, vision substitution, and vision replacement [3]. This assistive technology became available for the blind people through electronic devices which provide the users with detection and localization of the objects in order to offer those people with sense of the external environment using functions of sensors. The sensors also aid the user with the mobility task based on the determination of dimensions, range and height of the objects [4].

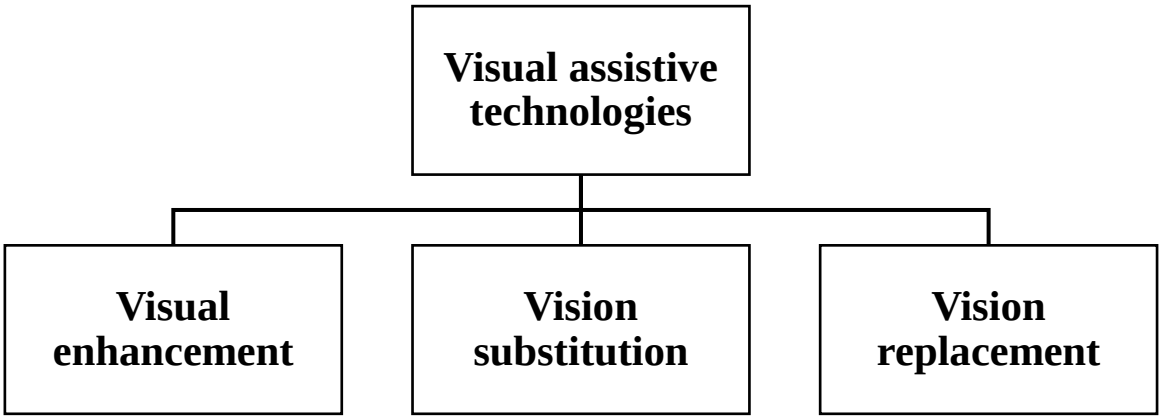

Figure II.1 Classification of electronic devices for visually-impaired people.

The vision replacement category is more complex than the other two categories; it deals with medical and technology issues. Vision replacement includes displaying information directly to the visual cortex of the brain or through an ocular nerve. However, vision enhancement and vision substitution are similar in concept; the difference is that in vision enhancement, the camera input is processed and then the results will be visually displayed. Vision substitution is similar to vision enhancement, yet the result constitutes non-visual display,

which can be vibration, auditory or both based on the hearing and touch senses that can be easily controlled and felt by the blind user.

II.2 Description of the device

Our device belongs to the category of vision substitution, and it consist of a smart cane capable of detecting obstacles using ultrasonic sensors and giving the user live different feedbacks of the surrounding environment via vibration motors or voice alert, which can be proved to be very useful in guiding the user outside without the need of any input from another human. It is capable of communicating with the user directly using voice commands, and it can also exchange information with the smartphone of the user via Bluetooth, the device can measure the heart rate of the user and examine the results, and it has LED's on board that can be switched On and Off automatically using a light sensor, the LED's make the user visible to drivers at night when crossing the road. In the heart of this system we have the Arduino board that controls everything that we stated above as shown in Figure II.2, and it's powered by a standard 5v battery.

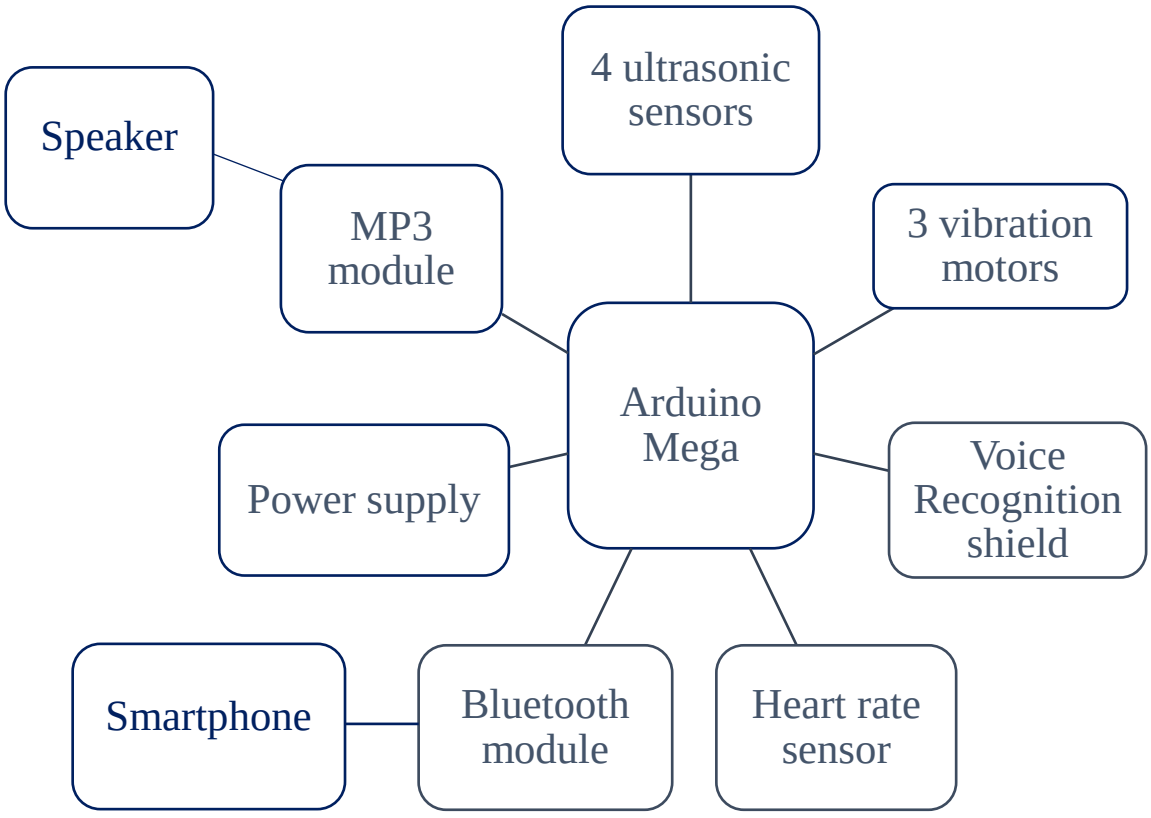

Figure II.2 Bloc diagram of the device.

II.3 Arduino board

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language and the Arduino Software (IDE). [5]

There are several types of Arduino boards, each one has its own specifications depending on the requirements of the project, in our case we chose the RobotDyn Mega board as shown in Figure II.3 mainly because it features more I/O ports than any other board on the market.

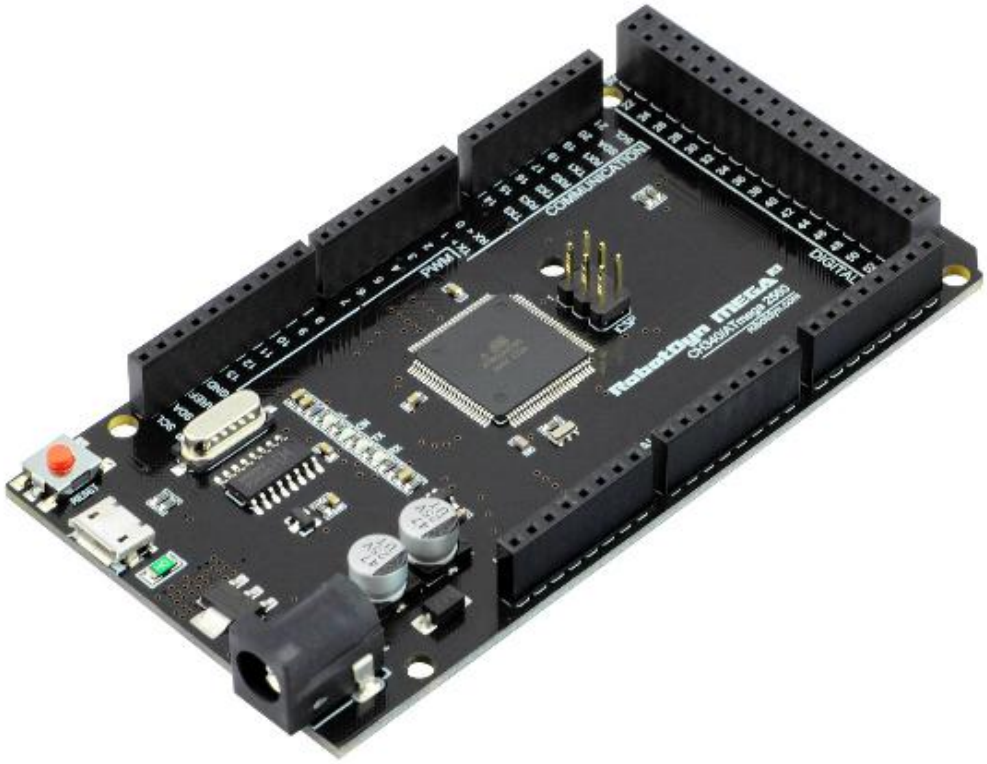

Figure II.3 RobotDyn Mega board.

II.3.1 Characteristics

- Microcontroller ATmega2560.
- Operating Voltage 5V.
- Input Voltage (recommended) 7-9V.

- Input Voltage (limit) 6-18V.
- Digital I/O Pins 70 (of which 14 provide PWM output).
- Analog Input Pins 16.
- DC Current per I/O Pin 20 mA.
- DC Current for 3.3V Pin 50 mA.
- Flash Memory 256 KB of which 8 KB used by bootloader.
- Clock Speed 16 MHz.
- Dimensions: 12 x2.8 x0.4 CM.

II.3.2 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It originated from the IDE for the languages *Processing* and *Wiring*. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple *one-click* mechanisms to compile and upload programs to an Arduino board.

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. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. [6]

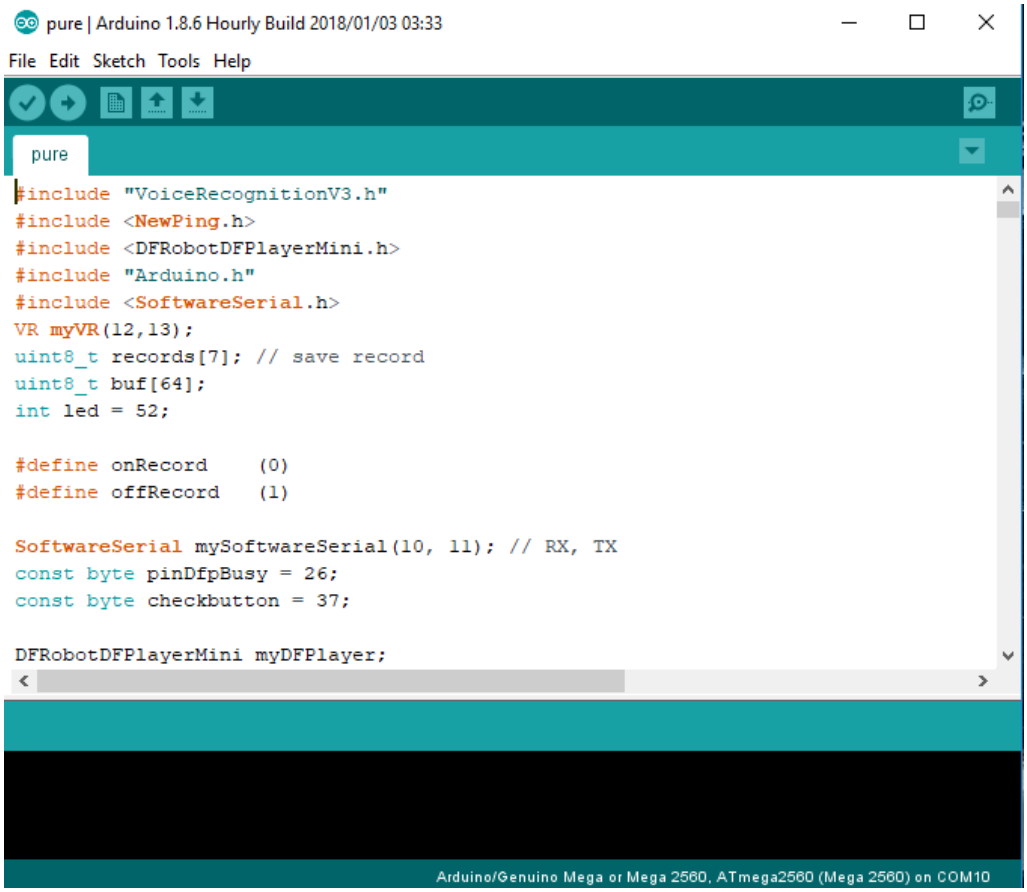

Figure II.4 Arduino IDE.

II.4 Ultrasound

Ultrasound is sound waves with frequencies higher than the upper audible limit of human hearing. Ultrasound is no different from 'normal' (audible) sound in its physical properties, except in that humans cannot hear it. This limit varies from person to person and is approximately 20 kilohertz (20,000 hertz) in healthy young adults. Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz.

Ultrasonic devices are used to detect objects and measure distances. Ultrasound imaging or sonography is often used in medicine. In the nondestructive testing of products and structures, ultrasound is used to detect invisible flaws.[7]

II.4.1 Ultrasonic sensors

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave

being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

$$distance = \frac{speed\ of\ sound\ \times time\ taken}{2}$$

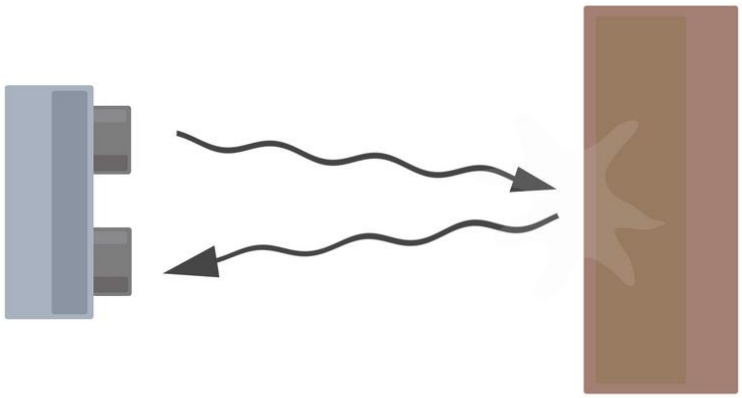

Figure II.5 Diagram of the basic ultrasonic sensor operation.

II.4.2 HC-SR04 module

For our project we chose the HC-SR04 ultrasonic ranging sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a decent ranging accuracy. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. It's easy to operate and cost friendly.

There are only four pins on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).

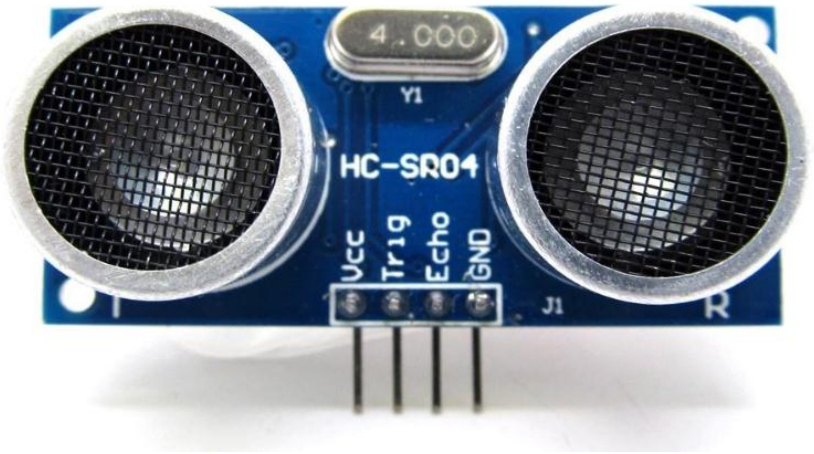

Figure II.6 HC-SR04 ultrasonic sensor module.

We are going to use some specialty mounting bracket for this module as shown in Figure II.7

Figure II.7 plastic mounting bracket for HC-SR04 module.

II.4.2.1 Characteristics

- Working Voltage: DC 5V.
- Working Current: 15mA.
- Working Frequency: 40Hz.
- Max Range: 4m.
- Min Range: 2cm.
- Measuring Angle: 15 degrees.
- Trigger Input Signal: 10µS TTL pulse.
- Echo Output Signal Input TTL lever signal and the range in proportion.
- Dimension 45 * 20 * 15mm.

II.5 Vibration motors

We used some simple good quality motors as shown in Figure II.8

Figure II.8 Vibration Motors.

II.5.1 Characteristics

- Minimum Voltage: 1.5 V Current: 110 MA.
- Recommended Voltage: 2 V Current: 160 MA.
- Maximum Voltage: 3 V Current: 220 MA.
- Weight: about 1.2 grams.

II.6 DFPlayer Mini MP3 module

The DFPlayer Mini MP3 module is a compact size and cheap Arduino MP3 module with a micro SD card slot on board, the module is capable of playing sound directly to the speaker via a simplified output, it can be used alone or with any device with RX/TX capabilities. [8]

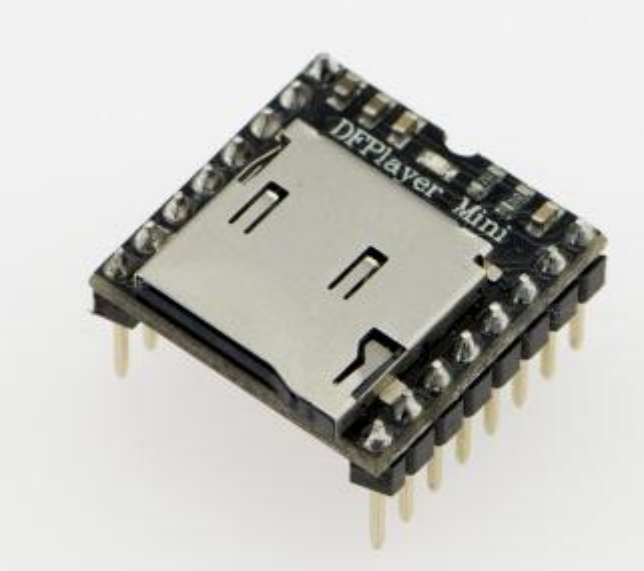

Figure II.9 DFPlayer - A Mini MP3 Player For Arduino.

II.6.1 Characteristics

- supported sampling rates (kHz): 8/11.025/12/16/22.05/24/32/44.1/48
- 24 -bit DAC output, support for dynamic range 90dB , SNR support 85dB.
- fully supports FAT16 , FAT32 file system, maximum support 32G of the TF card, support 32G of U disk, 64M bytes NORFLASH.
- a variety of control modes, I/O control mode, serial mode, AD button control mode.
- advertising sound waiting function, the music can be suspended. when advertising is over in the music continue to play.
- audio data sorted by folder, supports up to 100 folders, every folder can hold up to 255 songs.
- 30 level adjustable volume, 6 -level EQ adjustable.

II.6.2 Pin map:

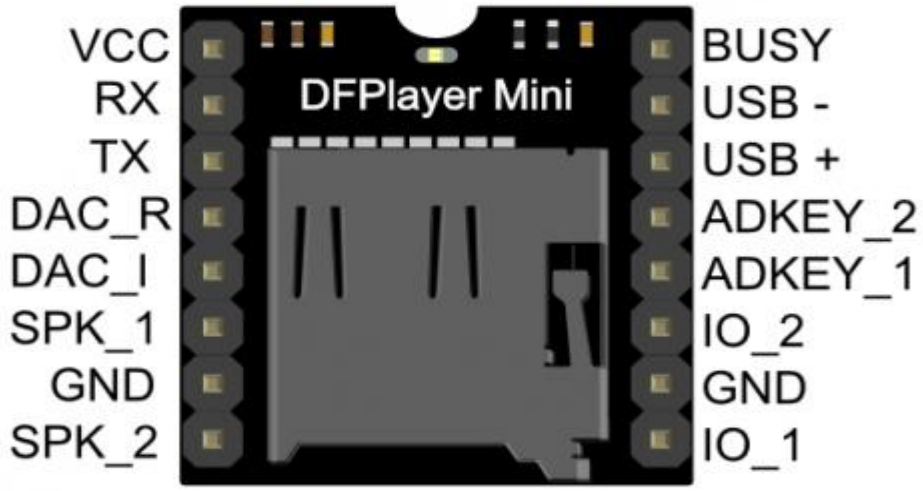

Figure II.10 Pin map of the DFPlayer module.

Pin	Description	Note
VCC	Input Voltage	DC3.2~5.0V;Type: DC4.2V
RX	UART serial input	
TX	UART serial output	
DAC_R	Audio output right channel	Drive earphone and amplifier
DAC_L	Audio output left channel	Drive earphone and amplifier
SPK2	Speaker-	Drive speaker less than 3W
GND	Ground	Power GND
SPK1	Speaker+	Drive speaker less than 3W
IO1	Trigger port 1	Short press to play previous（long press to decrease volume）
GND	Ground	Power GND
IO2	Trigger port 2	Short press to play next（long press to increase volume）
ADKEY1	AD Port 1	Trigger play first segment
ADKEY2	AD Port 2	Trigger play fifth segment
USB+	USB+ DP	USB Port
USB-	USB- DM	USB Port
BUSY	Playing Status	Low means playing \High means no

Figure II.11 Pin-description-note of the DFPlayer module.

II.7 Speech recognition

speech recognition is a computer-based technique that can be used to analyze the human voice captured by a microphone and transcribe it into machine-readable text.

Speech recognition, as well as speech synthesis, speaker identification or speaker verification, are part of speech processing techniques. These techniques make it possible to produce human-machine interfaces (HMIs) where part of the interaction is done by voice: "voice interfaces".

There are two types of speech recognition systems, the first type called “speaker dependent system”, those systems require “training” where the user has to speak the text or the commands into the system, the system analyzes the user’s voice and use it as a reference point to compare with resulting in increased accuracy.

The second type is called “speaker independent system” which no training is required before the system can be used.

Speech recognition applications include voice user interfaces such as voice dialing (e.g. "Call home"), call routing (e.g. "I would like to make a collect call"), domotic appliance control, search (e.g. find a podcast where particular words were spoken), simple data entry (e.g., entering a credit card number), preparation of structured documents (e.g. a radiology report), speech-to-text processing (e.g., word processors or emails), and aircraft (usually termed direct voice input). [9]

II.7.1 Elechouse speech recognition module V3

ELECHOUSE speech Recognition Module is a compact and easy to control speech recognition board. This product is a speaker-dependent voice recognition module. It supports up to 80 voice commands in all. Maximum of 7 voice commands could work at the same time. Any sound could be trained as command. The user need to train the module first before it can recognize any voice command. [10]

Figure II.12 Elechouse V3 module

II.7.2 Characteristics

- Voltage: 4.5-5.5V.
- Current: <40mA.
- Digital Interface: 5V TTL level for UART interface and GPIO.
- Analog Interface: 3.5mm mono-channel microphone connector + microphone pin interface.
- Size: 31mm x 50mm.
- Recognition accuracy: 99% (under ideal environment).
- Support maximum 80 voice commands, with each voice 1500ms (one or two words)
-

II.8 Heart rate

Heart rate is the speed of the heartbeat measured by the number of contractions of the heart per minute (bpm). The heart rate can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide. It is usually equal or close to the pulse measured at any peripheral point. Activities that can provoke change include physical exercise, sleep, anxiety, stress, illness, and ingestion of drugs. Several studies, as well as expert consensus, indicate that the normal resting adult human heart rate is probably a range between 50 and 90 bpm, though the American Heart Association states the normal resting adult human heart rate is 60–100 bpm. Tachycardia is a fast heart rate, defined as above 100 bpm at rest. Bradycardia is a slow heart rate, defined as below 60 bpm at rest. During sleep a slow heartbeat with rates around 40–50 bpm is common and is considered normal. When the heart is not beating in a regular pattern, this is referred to as an arrhythmia. Abnormalities of heart rate sometimes indicate disease. [11]

II.8.1 SEN-11574 Pulse sensor

The Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects.It essentially combines a simple optical heart rate sensor with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings. Also, it sips power with just 4mA current draw at 5V so it's great for mobile applications. [12]

Figure II.13 Pulse sensor module.

II.9 Bluetooth

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by Dutch electrical engineer Jaap Haartsen, working for telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. [13]

II.9.1 BLE 4.0: Bluetooth low energy

BLE is intended for light duty cycle devices that support small data throughput and operate a long time on a coin-sized battery. BLE is not only standardized, but will also inhabit over 2 billion cell phones, which will have regular Bluetooth and it smaller brother, Bluetooth LE.

A BLE device may operate in different modes depending on required functionality. The main modes of operation are called the advertising mode, scanning mode, master device, and slave device. In advertising mode, the BLE device periodically transmits advertising information and may respond with more information upon request from other devices. The scanner device, on the other hand, listens advertising information transmitted by other devices and may request additional information if active scan mode is enabled.

II.9.2 HM-10 Bluetooth module

The HM-10 is a readily available Bluetooth 4.0 module based on the Texas Instruments CC2540 or CC2541 Bluetooth low energy (BLE) System on Chip (SoC).

Figure II.14 Bluetooth HM-10 module

II.9.2.1 Characteristics

- Version: Bluetooth Specification V4.0 BLE
- Working frequency: 2.4GHz ISM band.
- Modulation method: GFSK(Gaussian Frequency Shift Keying).
- Power: +3.3VDC 50mA.
- Power: In sleep mode 400uA~1.5mA, Active mode 8.5mA.

- Working temperature: –5 ~ +65 C.
- Size: 26.9mm x 13mm x 2.2 mm.

II.10 LM393 light level sensor

The LM393 is a simple photo-resistor light sensor that has analog output. We use it to detect the brightness level and set the Arduino to turn the lights on when the analog input value is less than a predefined reference point for when the environment is described as dark.

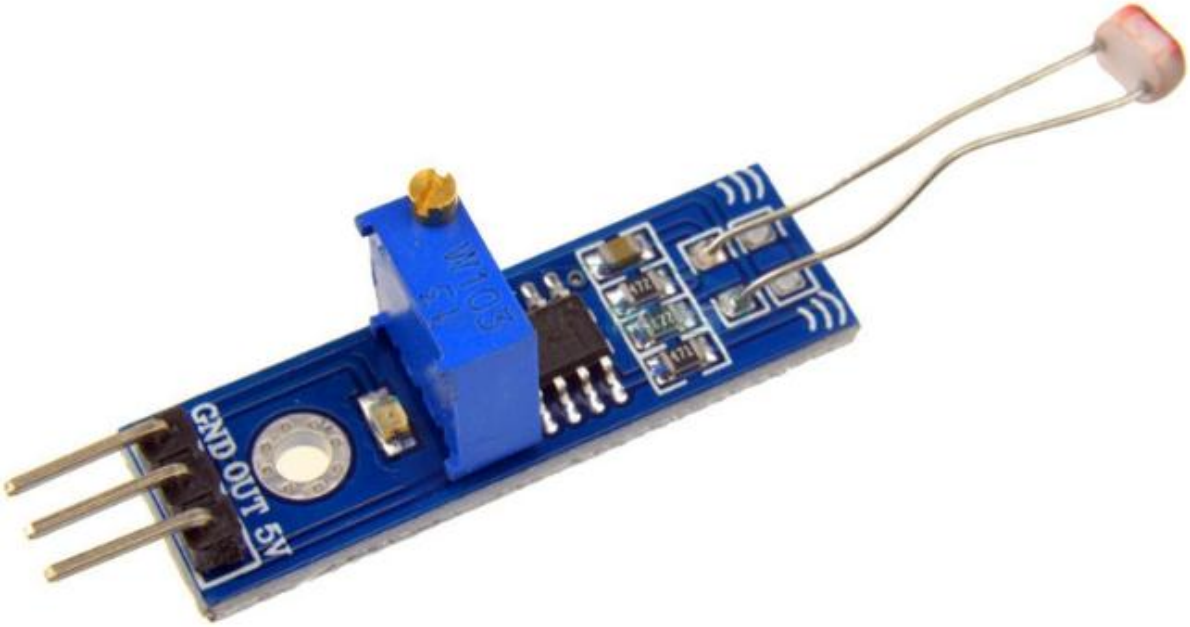

Figure II.15 LM393 light level sensor.

II.11 Final Product

❖ How it works

When the device is turned on the 4 ultrasonic sensors start working simultaneously to detect and measure the distance between the smart cane (the user) and the obstacles, if an obstacle is detected within 70cm-200cm the vibration motor of the corresponding sensor start vibrating slowly, if the distance between the obstacle and the sensor is lower than 70 cm the vibration gets more powerful and a voice alert is played through the speaker with the direction of the obstacle (right, left, front, and low), those voice alerts are already recorded in mp3 format and played by the DFPlayer mp3 module,

there are 8 possible alerts in total to provide a more precise feedback to the user so he can act accordingly. At the top of the cane there is an integrated button that the user can press to activate voice commands, when pressed the system start listening to the user's voice and take commands such as "heart rate" command and the system will give instruction to the user and start measuring his heart rate, or he can request the cane to communicate and send commands to the smartphone such as "request a Rekba" which is a local taxi service in Algeria, or "call emergency contact".

❖ Isis diagram

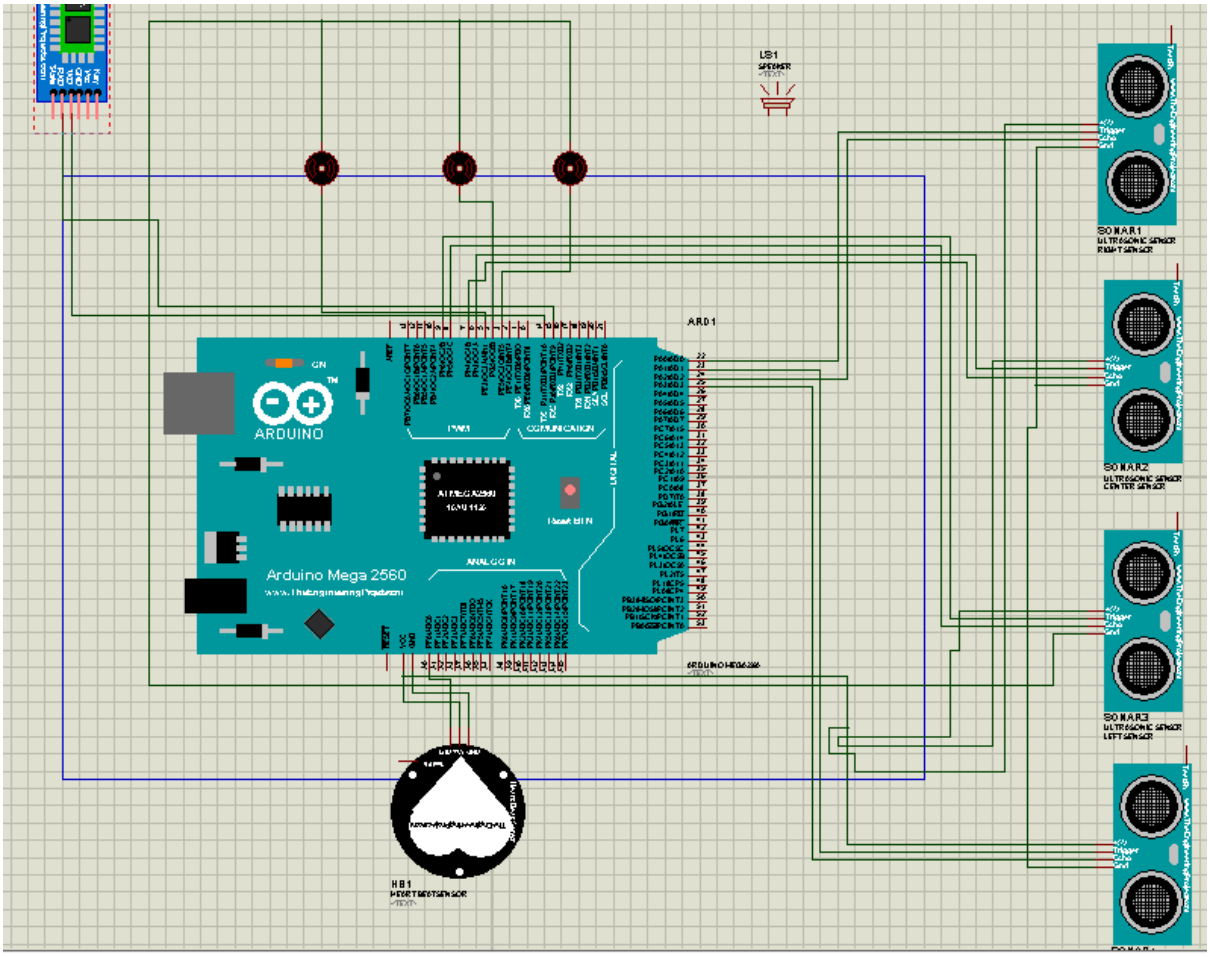

Figure II.16 Diagram of the circuit in ISIS.

Figure II.17 Image of our realized device.

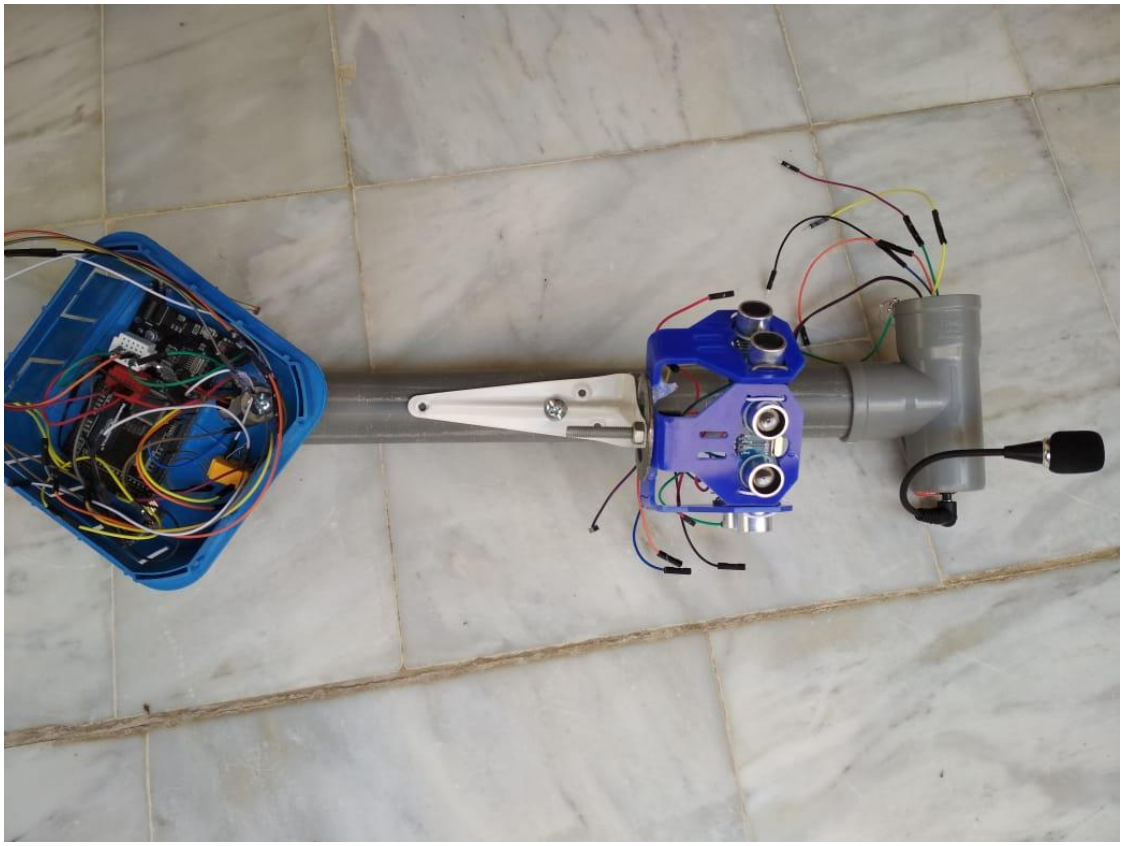

Figure II.18 close picture of the realization of the device.

II.12 Conclusion

In this chapter we went through all the details regarding the conception of the device, from choosing the parts, the characteristics and benefits of each one, to how they work and communicate together, and how they can be useful to the user.

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[8] https://www.dfrobot.com/ retrieved 2 June 2018.

[9] Speaker Independent Connected Speech Recognition- Fifth Generation Computer Corporation". Fifthgen.com. Archived from the original on 11 November 2013. Retrieved 2 June 2018.

[10] http://www.elechouse.com/elechouse/index.php?main_page=product_info&products_id=2254 retrieved 2 June 2018.

[11] https://en.wikipedia.org/wiki/Heart_rate retrieved 3 June 2018.

[12] https://www.sparkfun.com/products/11574 retrieved 3 June 2018.

[13] https://en.wikipedia.org/wiki/Bluetooth retrieved 3 June 2018.

Chapter III
Creation of the android application

III.1 Introduction

Android is a mobile operating system developed by Google, based on a modified version of the Linux kernel and other open source software and designed primarily for touchscreen mobile devices such as smartphones and tablets. In addition, Google has further developed Android TV for televisions, Android Auto for cars, and Wear OS for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics.

Android software development is the process by which new applications are created for devices running the Android operating system. Officially[3], apps can be written[1] using Java, C++ or Kotlin using the Android software development kit (SDK). Third party tools, development environments and language support have also continued to evolve and expand since the initial SDK was released in 2008.

III.2 Android studio:

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as primary IDE for native Android application development.

III.2.1 Advantages:

- Gradle-based build support.
- Android-specific refactoring and quick fixes.
- Lint tools to catch performance, usability, version compatibility and other problems.
- ProGuard and app-signing capabilities.
- Template-based wizards to create common Android designs and components.
- A rich layout editor that allows you to drag-and-drop UI components, preview layouts on multiple screen configurations, and much more.

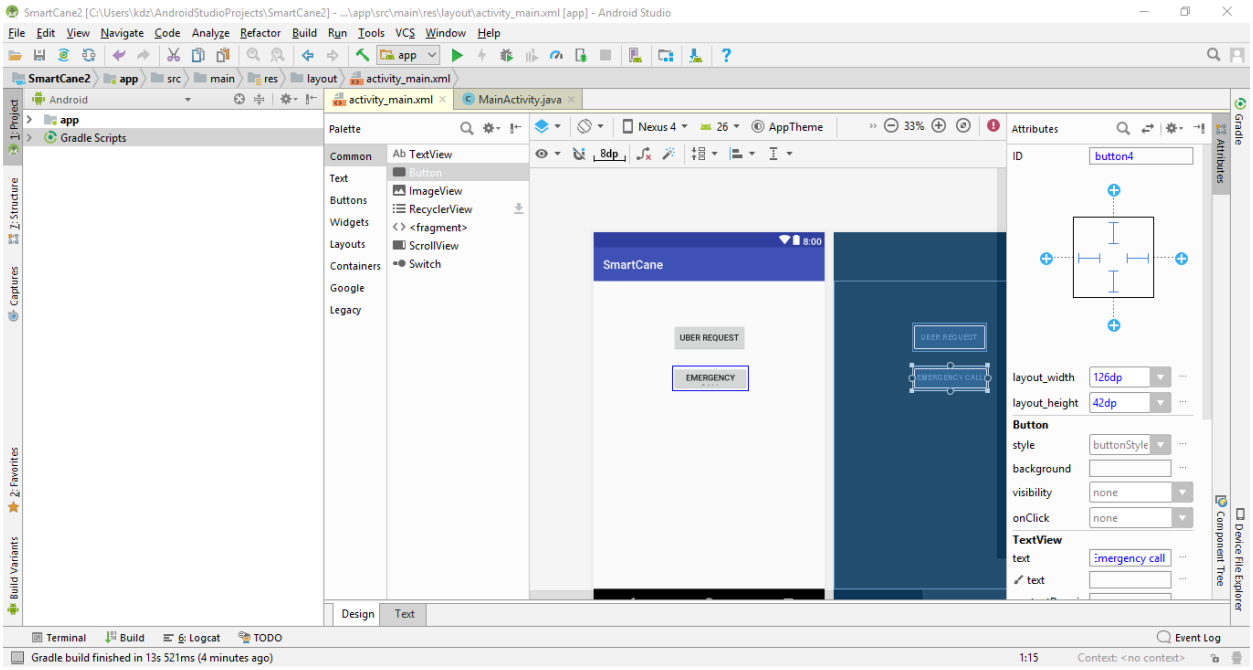


Figure III.1 Android Studio IDE.

III.3 Our application

Our android application is a way to allow the user to communicate with his smartphone via voice commands given to the cane and sent to the phone via Bluetooth, allowing him to use his phone hands free, to do some daily life necessary tasks such as request an Uber ride, call someone, etc …

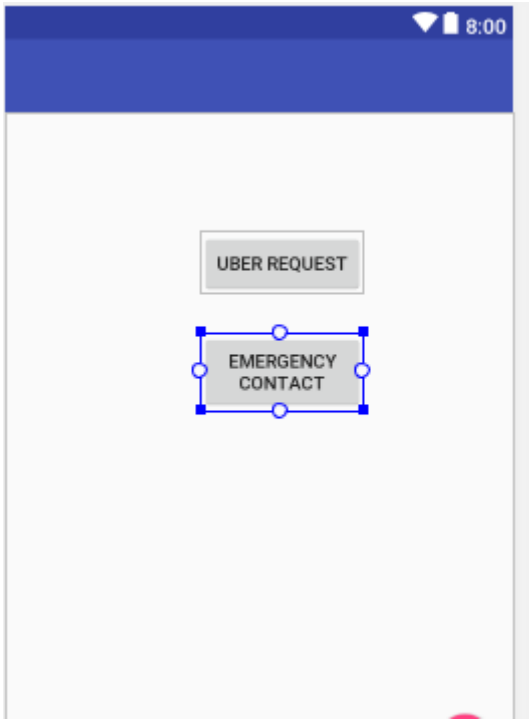


Figure III.2 Android Application in android studio.

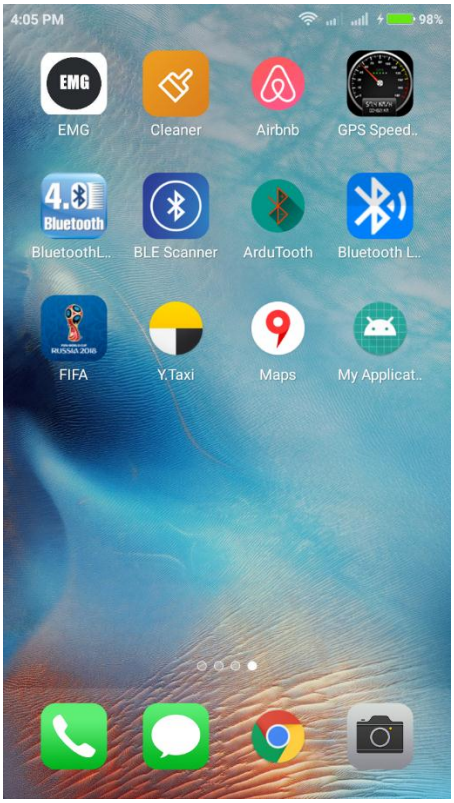


Figure III.3 screenshot of the app.

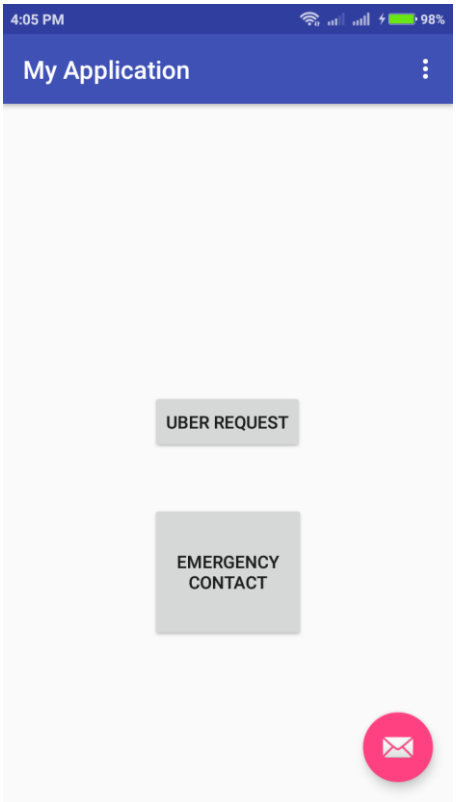


Figure III.4 screenshot of the main activity of the app.

Conclusion

This project is meant to help the blind people pursue their daily life activities independently without the need to rely on other people to guide them in the most basic tasks, such as traveling from a location to another, for that we provided a reliable system to guide them and help them avoid obstacles and walk safely, we provided some other handy features such as voice commands and heart rate measurement, and our device have a lot of room to improve regarding the communication with the smartphone as it will be able to determine location and use the navigation system of the phone, request a taxi ride via Rekba or other providers, voice command phone calls, etc…

Perspectives

➢ Ultrasonic sensors

There is actually a better ultrasonic sensor to use for this project and it is the same as the one used in car parking assistant, it's very sophisticated and can be synchronized together, very accurate and responsive, and they are made for outdoor use so they are waterproof, they are not cheap as the HC-SR04 module but the real challenge is to make it work with Arduino as it is made to only work with the provided circuit board.

Figure IV.1 Ultrasonic sensors used in car parking assistant.

➢ Using cylindrical battery cells

We can take advantage of the cylindrical body of the device to use integrated battery inside the tube which fits very well and can be swapped out or recharged easily.

Figure IV.2 cylindrical battery cell.

- **Enhance the communication with the smartphone**

  Getting several useful information from the smartphone in the form of a text such as location, weather, call history and converting it to the user via text to speech software which require a more powerful processor than the one on the Arduino, and also the challenging part is getting the authorization on android to do such things.

- As we have showed in our app the user will be capable of requesting an uber via voice commands the only part that remain is developing the app and get the authorization to use that button from Uber.

- Materiel wise we can use aluminum or hard plastic or carbon fiber to make the device, the most convenient to use is aluminum as it is available for a reasonable price and durable.

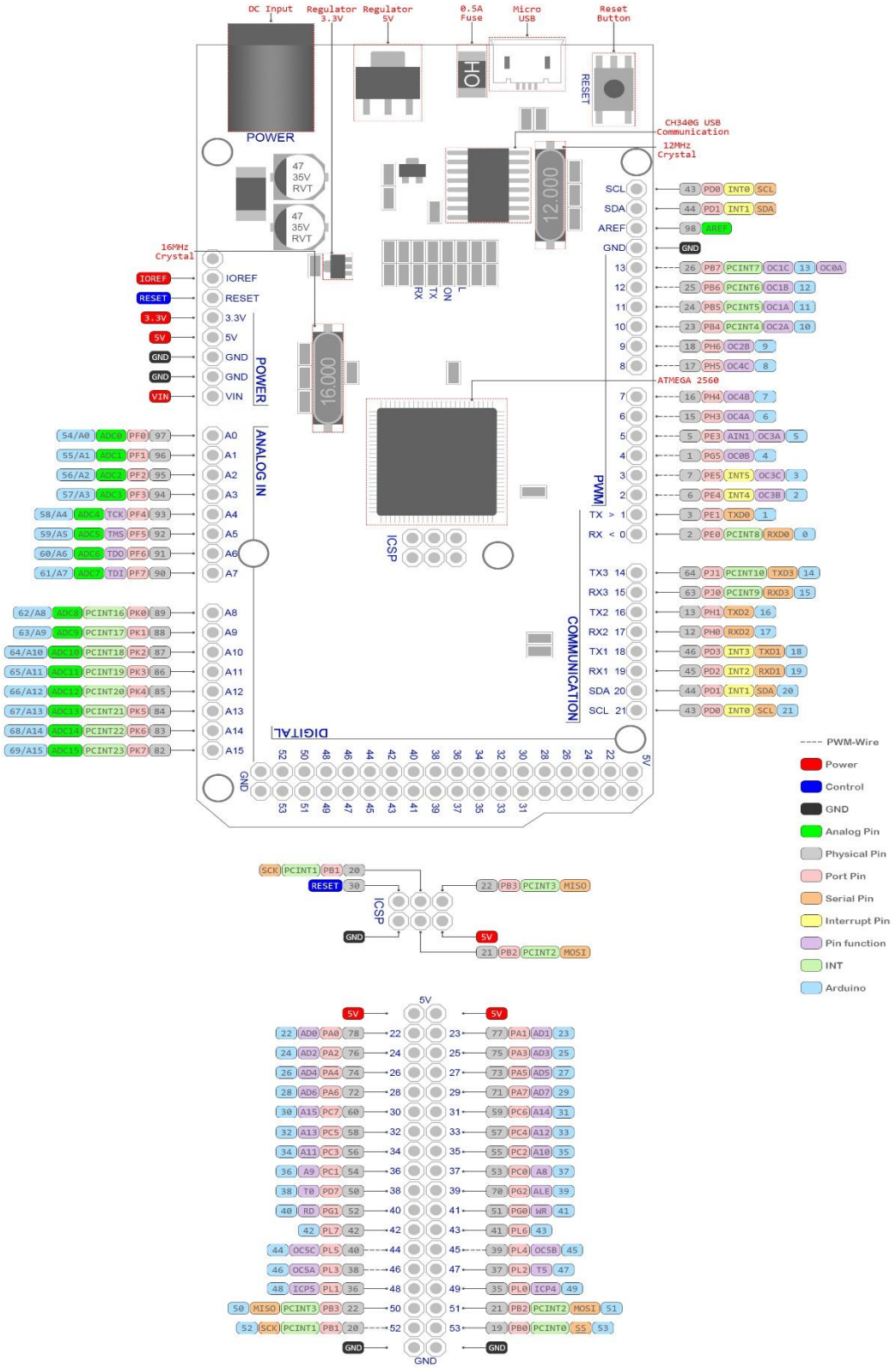
- We need to do experiments on blind people to determine if it is better to use a wheel at the bottom of the device that can be locked or not, this will probably make the travel experience more smooth and fast and effortless for the user than carrying it around from point to point.

- We can add more portable healthcare devices to our project, like a non evasive glucometer, for monitoring glucose levels and making it available to the person in charge of the patient to visualize at any given moment.

APPENDIX

RobotDyn®
www.robotdyn.com
PINOUT DIAGRAM

Mega 2560 CH340G /ATmega2560 - 16AU



RobotDyn®
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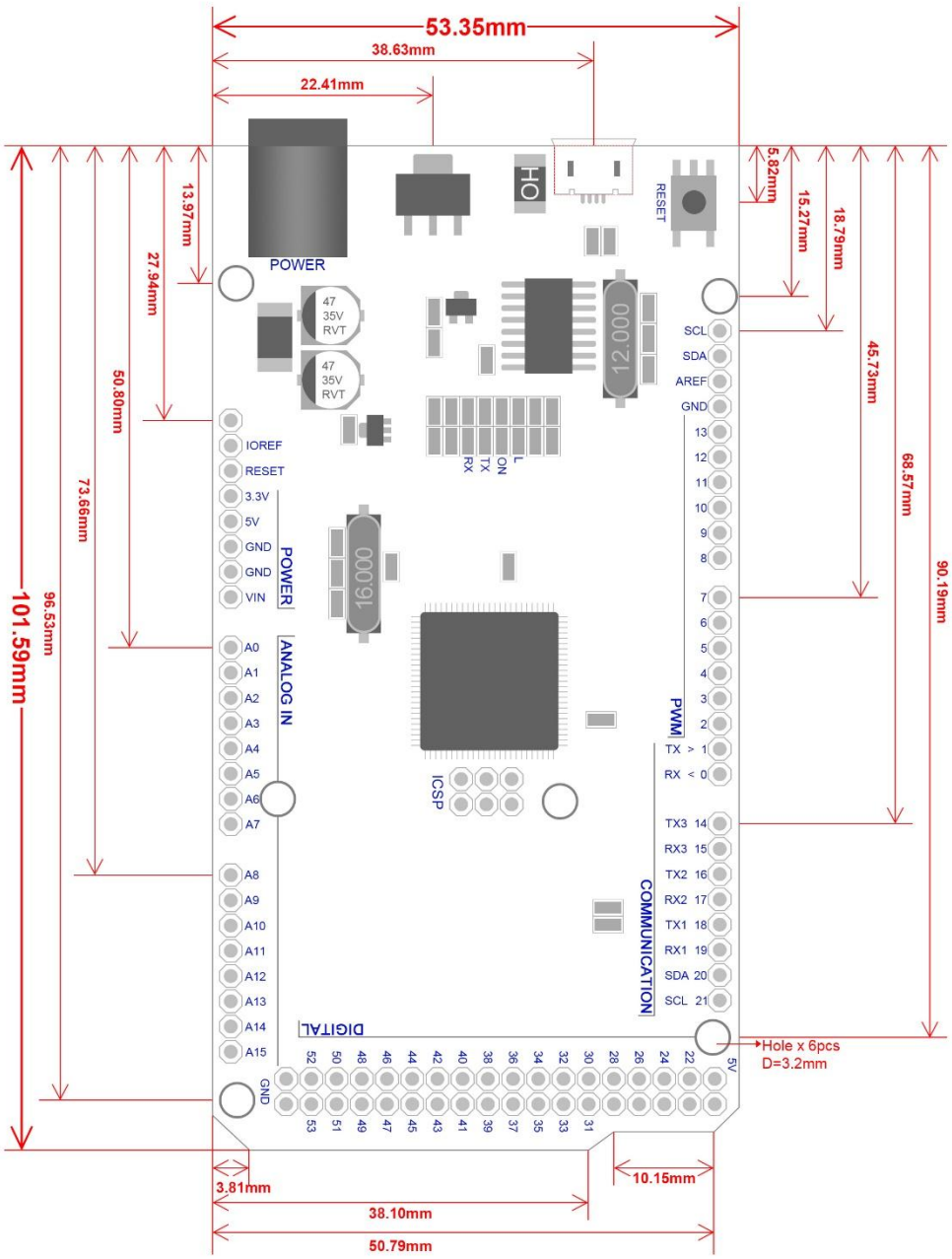
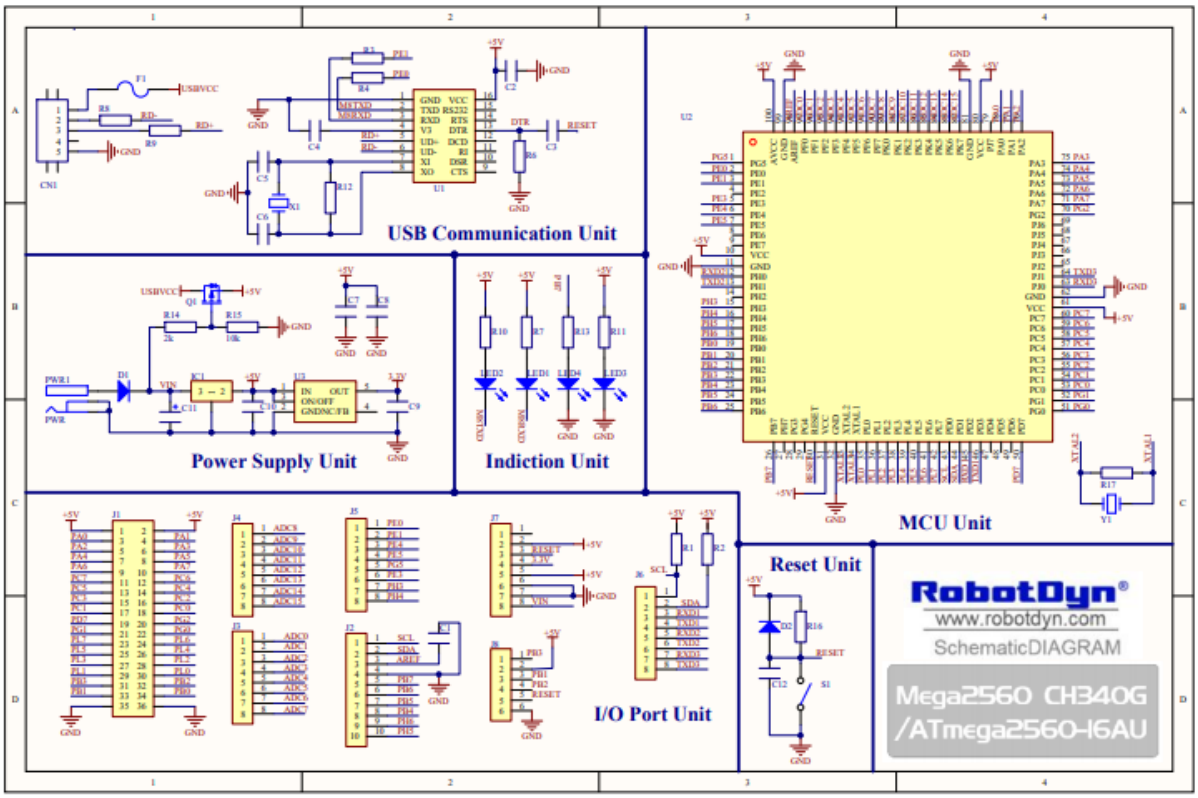
DIMENSION DIAGRAM

Mega 2560 CH340G /ATmega2560 - 16AU





DFPlayer mini

Module's serial port is 3.3V TTL level, so the default interface level is 3.3V. If the MCU system is 5V. It is recommended connect a 1K resistor in series.

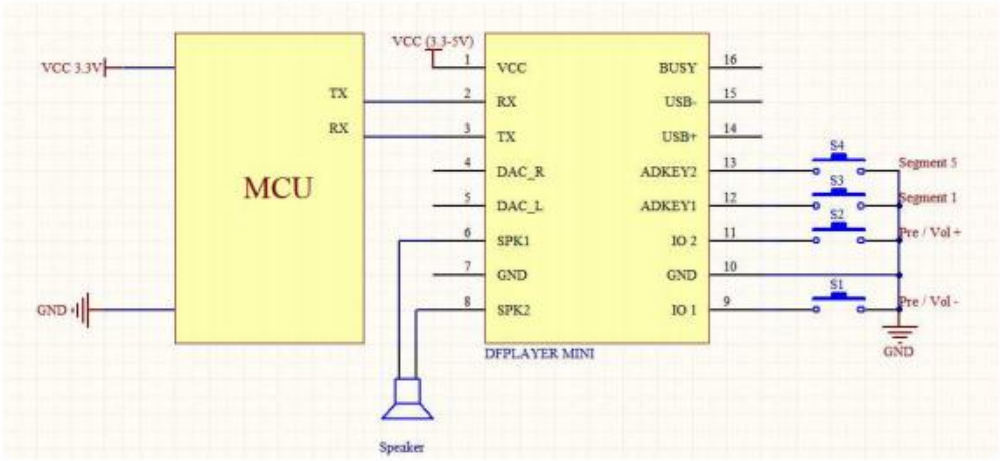
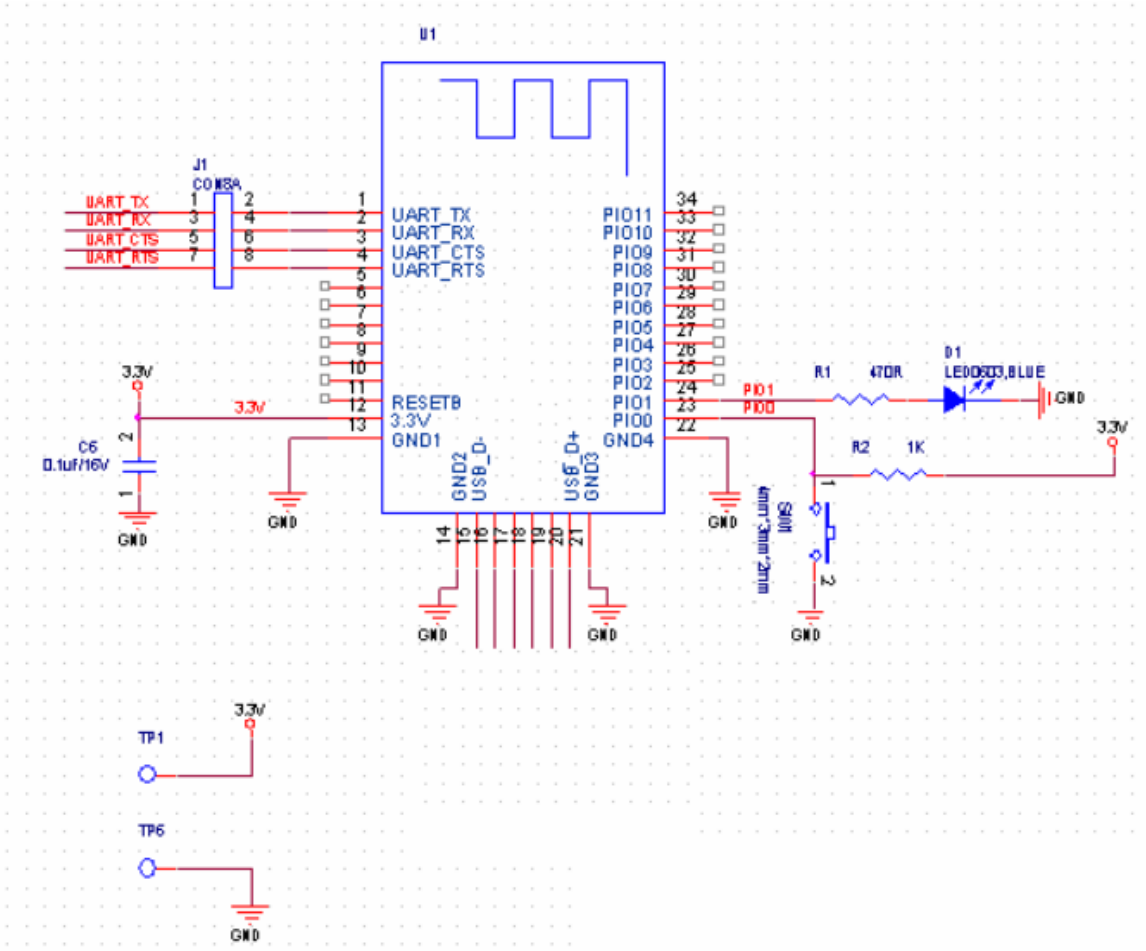


Figure 4.1 Serial Connect (3.3V)

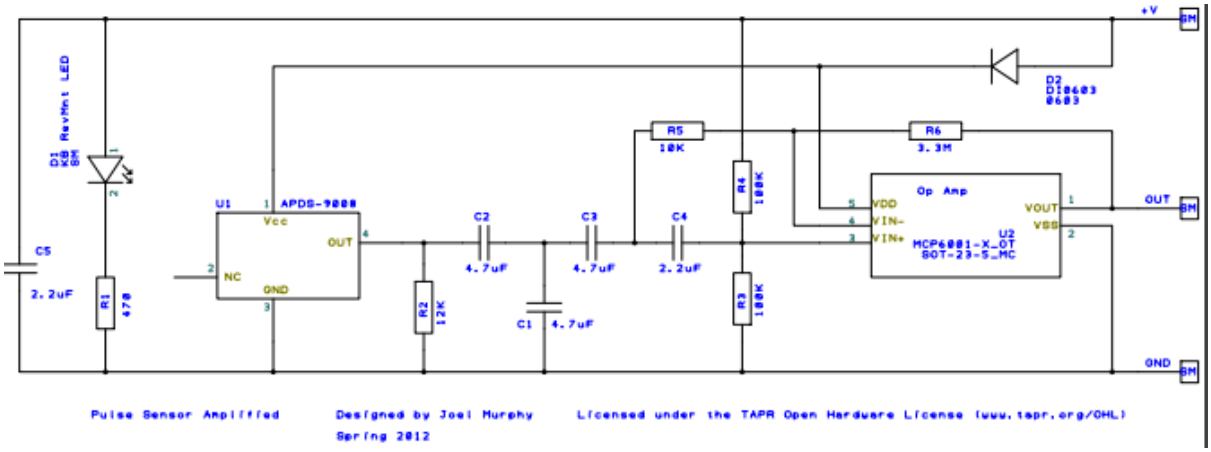
I/O Input Specification						
Item	Description	Min	Type	Max	Unit	Test Condition
VIL	Low-Level Input Voltage	-0.3	-	0.3*VDD	V	VDD=3.3V
VIH	High-Level Input Voltage	0.7VDD	-	VDD+0.3	V	VDD=3.3V
I/O Output Specification						
Item	Description	Min	Type	Max	Unit	Test Condition
VOL	Low-Level Output Voltage	-	-	0.33	V	VDD=3.3V
VOH	High-Level Output Voltage	2.7	-	-	V	VDD=3.3V

Commands	Function Description	Parameters(16 bit)
0x3C	STAY	
0x3D	STAY	
0x3E	STAY	
0x3F	Send initialization parameters	0 - 0x0F(each bit represent one device of the low-four bits)
0x40	Returns an error, request retransmission	
0x41	Reply	
0x42	Query the current status	
0x43	Query the current volume	
0x44	Query the current EQ	
0x45	Query the current playback mode	
0x46	Query the current software version	
0x47	Query the total number of TF card files	
0x48	Query the total number of U-disk files	
0x49	Query the total number of flash files	
0x4A	Keep on	
0x4B	Queries the current track of TF card	
0x4C	Queries the current track of U-Disk	
0x4D	Queries the current track of Flash	

HM-10 Bluetooth



Pulse sensor



LM393 light sensor:

Electrical characteristics

T_A = 25°C. 2854°K tungsten light source

Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	1000 lux 10 lux	- -	400 9	- -	Ω kΩ
Dark resistance	-	1.0	-	-	MΩ
Dark capacitance	-	-	3.5	-	pF
Rise time 1	1000 lux 10 lux	- -	2.8 18	- -	ms ms
Fall time 2	1000 lux 10 lux	- -	48 120	- -	ms ms

Simplified Schematic

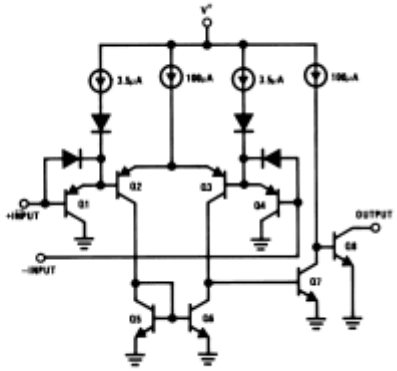


Figure 1 **Power dissipation derating**

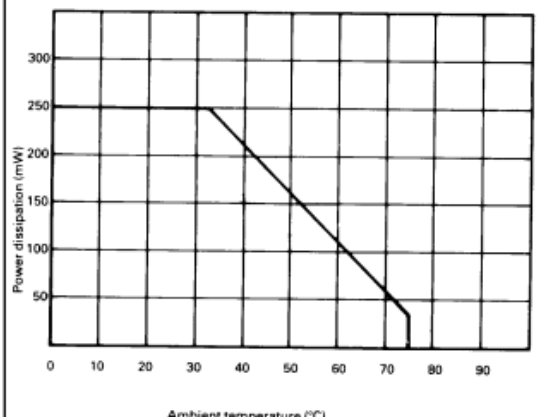
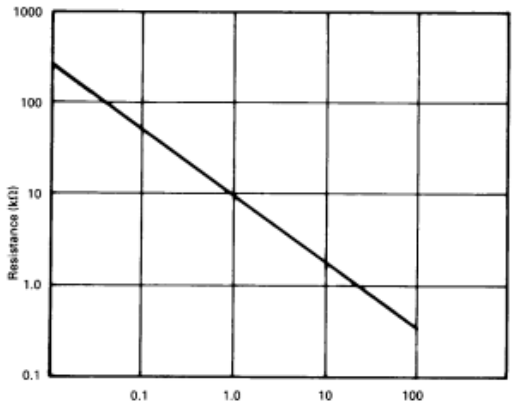


Figure 3 **Resistance as a function of illumination**



*1Ftc=10.764 lumens

ملخص:

هذا المشروع يتمثل في تصميم وإنجاز عصا ذكية للأشخاص الذين يعانون من فقدان البصر لتكون بديل للعصا التقليدية المستعملة لغرض التوجيه. العصا تتكون من الهيكل الذي يحمل كافة المكونات الأخرى المتمثلة في بطاقة الأردوينو لمعالجة المعلومات، حساسات للأمواج الفوق صوتية للكشف عن العقبات وتحديد المسافة بينها وبين المستخدم، وإعطاء رد فعل للمستعمل على شكل اهتزازات متفاوتة على مستوى المقبض، إضافة إلى تنبيه صوتي، كما يمكن للمستخدم إعطاء أوامر صوتية للعصا التي يمكنها الإتصال مع الهاتف الذكي بإستخدام البلوتوث، يمكن للعصا قياس دقات القلب وتحليلها، كما أنها مزودة بأضواء تنبيه ليلية تشتغل اوتوماتيكيا حين الإنتقال للظلام.

Abstract :

This project is the conception and realization of a smart cane for the visually impaired people, our device is a replacement of the traditional white cane and it provides a lot of useful features such as detecting obstacles from various directions using ultrasonic sensors, and giving the user an instant feedback using the vibration motors installed in the handle of the device, along with a voice alert with the direction of the obstacle, the device can receive voice commands from the user, and it can communicate with the smartphone of the user using Bluetooth.

Résumé:

Ce projet est la conception et la réalisation d'une canne intelligente pour les non-voyants, notre appareil est un

remplacement de la canne blanche traditionnelle et il fournit beaucoup de fonctionnalités pratiques telles que la détection des obstacles de diverses directions en utilisant des capteurs à ultrasons, et donner à l'utilisateur une rétroaction instantanée utilisant les moteurs de vibration installés dans la poignée de l'appareil, avec une alerte vocale avec la direction de l'obstacle, l'appareil peut recevoir des commandes vocales de l'utilisateur, et il peut communiquer avec le smartphone de l'utilisateur via Bluetooth.