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Thesis

Design of Smart system for the blind people for more secure movements

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﴿ رَبَّنَا لاَ تُؤَاخِذْنَا إِن نَّسِينَا أَوْ أَخْطَأْنَا رَبَّنَا وَلاَ تَحْمِلْ عَلَيْنَا إِصْرًا كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِن قَبْلِنَا رَبَّنَا وَلاَ تُحَمِّلْنَا مَا لاَ طَاقَةَ لَنَا بِهِ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَا أَنتَ مَوْلاَنَا فَانصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ﴾ سورة البقرة : الآية286 .

" صدق الله العظيم"

Abstract

This "smart system" is designed to help the blind to walk safely and independently. This system consists of: a smart cane and glasses equipped with an artificial intelligence-powered camera. Its main objective is to develop a new way of recognizing objects for blind people and facilitate their communication.

The task of the cane is to detect obstacles and determine the distance. and the task of the glasses is to pick up the obstacle image and convert it into audio, so the person will listen to the audio through a headphone that's connected to the glasses .The glasses used many technologies to perform its tasks like gTTS . Detecting the obstacle in the image was done using the OpenCV, In order to convert the image into speech, it used (gTTS) .

The cane is equipped with Ultrasonic sensor that can detect obstacles and send alert signals to the blind person. Additionally, it include vibration to provide additional information about the surrounding environment .

All the computing and processing operations were done using the Raspberry Pi 3 B+ for the smart glasses, and Arduino Nano for the cane.

Key words: Smart system , smart cane , smart glasses , blind people, Artificial Intelligence, Deep learning.

الملخص

هذا "النظام الذكي" مصمم لمساعدة الأشخاص المكفوفين وضعاف البصر على المشي والتنقل بأمان واستقلالية. يتكون هذا النظام من عصا ونظارات ذكية مجهزة بكاميرا مدعومة بالذكاء الاصطناعي. الهدف الرئيسي لهذا النظام هو تطوير طريقة جديدة للاعتراف بالأشياء للأشخاص المكفوفين وضعاف البصر وتسهيل تنقلهم.

مهمة العصا هي اكتشاف العوائق وتحديد المسافة. ومهمة النظارات هي التقاط صورة العائق وتحويلها إلى صوت، بحيث يستمع الشخص الكفيف إلى الصوت عبر سماعة رأس متصلة بالنظارات. تستخدم النظارات العديد من التقنيات لأداء مهامها مثل gTTS. يتم اكتشاف العوائق في الصورة باستخدام OpenCV ثم تحول الصورة إلى كلام باستخدام (gTTS).

تحتوي العصا الذكية على مستشعر فوق صوتي قادر على اكتشاف العوائق وإرسال إشارات تنبيه إلى الشخص المكفوف من خلال صوت رنين واهتزاز.

تمت جميع عمليات الحساب والمعالجة باستخدام Raspberry Pi 3 B+ للنظارات الذكية و Arduino Nano للعصا.

الكلمات المفتاحية :نظام ذكي ، عصا ذكية ، نظارات ذكية ، الأشخاص المكفوفين ، الذكاء الاصطناعي ، التعلم العميق.

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Abbreviations

AI	Artificial intelligence
ML	Machine Learning
DL	Deep learning

General introduction

In our daily lives, many people suffer from various diseases or disabilities. According to the Ministry of Solidarity (2021), as of December 31, 2021, Algeria counts one million and 118 thousand and 908 people with special needs.220 thousand of them are blind (5%) and others have vision difficulties[RAD22]. These people need some help to make their lives easier and better. The main objective of our smart system of "smart glasses and stick" is to help blind people and people with vision difficulties by introducing a new technology that makes them able to walk and overcome the obstacles in front of them. These glasses are equipped with a camera to see anything in front of them and turn it into a sound so that the blind can know what is in front of him, and a stick that allows him to overcome obstacles by ringing whenever he approaches a certain barrier. The goal of the "smart system" is to help these people in different aspects of life. For example, this system makes the blind person move and move on his own without the need for an escort. Blind people and people with vision difficulties can be able to move safely.

Visually impaired individuals face difficulties in controlling their environment, identifying obstacles, and recognizing potential risks while walking. Additionally, they encounter challenges in communicating with others and understanding their surroundings due to their visual impairment. Obtaining information and interacting with the external world becomes a major challenge for the visually impaired. They heavily rely on traditional canes for mobility and environmental perception, which can be limited and inefficient at times. These obstacles greatly impact the lives of visually impaired individuals and restrict them in various aspects.

Improving technology to assist and provide innovative means of navigation, communication, and access to information can contribute to solving some of these problems and enhancing their quality of life and independence. In this study, a smart system has been designed to assist visually impaired individuals.

The main objective of this study is designed a smart system to help the blind people to walk safely and independently. This system consists of: a smart cane and glasses equipped with an artificial intelligence-powered camera. Its primary goal is to create an innovative approach for object recognition specifically designed to assist individuals with visual impairments, enhancing their ability to communicate effectively.

Our study is organized into two chapters:

Chapter 01: Previous studies on intelligent systems specifically designed to help blind people and, general definitions about of artificial intelligence (AI).

Chapter 02: We will design a system consisting of canes and smart glasses that recognize objects and then convert them into sound that the blind hears through earphones.

Finally, we will end this study with a general conclusion and perspectives.

Chapter I

Literature Review

I.1.Introduction

Individuals suffering from visual impairments and blindness encounter difficulties in moving independently and overcoming various problems in their routine lives. As a solution, artificial intelligence and computer vision approaches facilitate blind and visually impaired people in fulfilling their primary activities without much dependency on other people. In this chapter we will represent: firstly, previous works about different smart systems for blind and visual impairments people, then, definitions of Artificial intelligence AI, Machine Learning ML, Deep learning DL. Finally, a conclusion of what will present in this chapter.

I.2.Previous Works

Developing smart system for the visually impaired is an important and vital endeavor in the world of technology. Several previous studies have been conducted on this topic.

In ref [ZHO18] have designed a cane can detect the obstacle barriers and holes, and the other function is to remind blind people of walking in the blind sidewalk. They have produced the cane with different alert sounds on the basis of the distance between the obstacles and the depth of the holes. Others in [GIV16]focused on enhancing the confidence and mobility of individuals with visual impairment by investigating the smart cane. They developed a smart cane with an ultrasonic sensor that effectively alerts people with visual impairments to obstacles or holes ahead through a buzzer beep. Similarly, [SAA16] conducted an experiment to determine the optimal configuration, involving the position and angle, of the ultrasonic ranging module for obstacle detection. The experiment concluded that positioning the sensor at an upper position with a 90° angle yielded the most favorable test results. In addition, [MEG14] introduced a smart cane design that incorporates a Bluetooth-enabled barrier detection module. This module allows for the measurement of the distance between the user and obstacles, which is then transmitted to an Android device via Bluetooth. The user is then provided with distance information through a voice prompt delivered via a Bluetooth headset. This innovative feature enhances the user's awareness of nearby barriers and promotes safer navigation for individuals with visual impairments.

The authors of [BHU17] developed a system specifically designed for visually impaired individuals, which includes a glasses. These glasses are equipped with an in-built sensor that emits ultrasonic waves in the direction the person is heading, scanning a range of approximately 5-6 meters within a 30º field of view. Once an obstacle is detected, the sensor promptly identifies it and transmits the information to a connected device. The device then

generates an automated voice that is delivered to the person's ear through connected earphones.

In ref [MUK21] authors have proposed a smart glass system for blind and visually impaired people, employing computer vision techniques and deep learning models, audio feedback, and tactile graphics to facilitate independent movement in a night-time environment. Which this system is divided into four models: a low-light image enhancement model, an object recognition and audio feedback model, a salient object detection model, and a text-to-speech and tactile graphics generation model. Thus, this system was developed to assist in the following manner:

- enhancing the contrast of images under low-light conditions employing a two-branch exposure-fusion network;
- guiding users with audio feedback using a transformer encoder–decoder object detection model that can recognize 133 categories of sound, such as people, animals, cars, etc., and
- Accessing visual information using salient object extraction, text recognition, and refreshable tactile display.

In another studies [ACM18],[IEE20],[ANK17],[MDP21]an innovative systems were developed using as machine learning and augmented reality techniques to improve the mobility of visually impaired individuals. This system uses cameras and wireless sensors to gather information about the surrounding environment and display it on the smart glasses. Visually impaired users can move their head to navigate the surrounding environment, and the necessary information is displayed on the smart glasses to help them avoid obstacles and recognize surrounding objects and people.

I.3.Artificial intelligence AI

The term "Artificial Intelligence" refers to the art and science of creating computer systems and programs that are capable of performing complex tasks similar to those carried out by humans, and sometimes even surpassing human cognitive abilities in specific areas [BAU19].

These systems and programs are typically designed using a range of modern techniques and methods such as machine learning, artificial neural networks, speech and image recognition, and other technologies [RYA20].

The aim of Artificial Intelligence is to improve and develop automated performance and productivity, and provide intelligent solutions for large and small problems in various scientific, social, industrial, commercial, medical, and other fields. It is also an exciting field of interest for scientists, engineers, researchers, and entrepreneurs, and represents a promising future for improving the quality of life in various societies [RUS10].

❖ How does Artificial intelligence (AI) work

Artificial intelligence (AI) operates through the utilization of specific algorithms that collect data and improve their performance over time. These algorithms form the foundation for managing complex business tasks and online transactions. To understand how artificial intelligence works, it is essential to delve into various AI fields such as Machine Learning, Deep Learning, Neural Networks, Natural Language Processing, Computer Vision, and Cognitive Computing. These domains enable AI systems to process and interpret extensive data, facilitating intelligent decision-making [ATL20].

The diagram shown in **Fig I.1** illustrates how does Artificial intelligence (AI) Work:

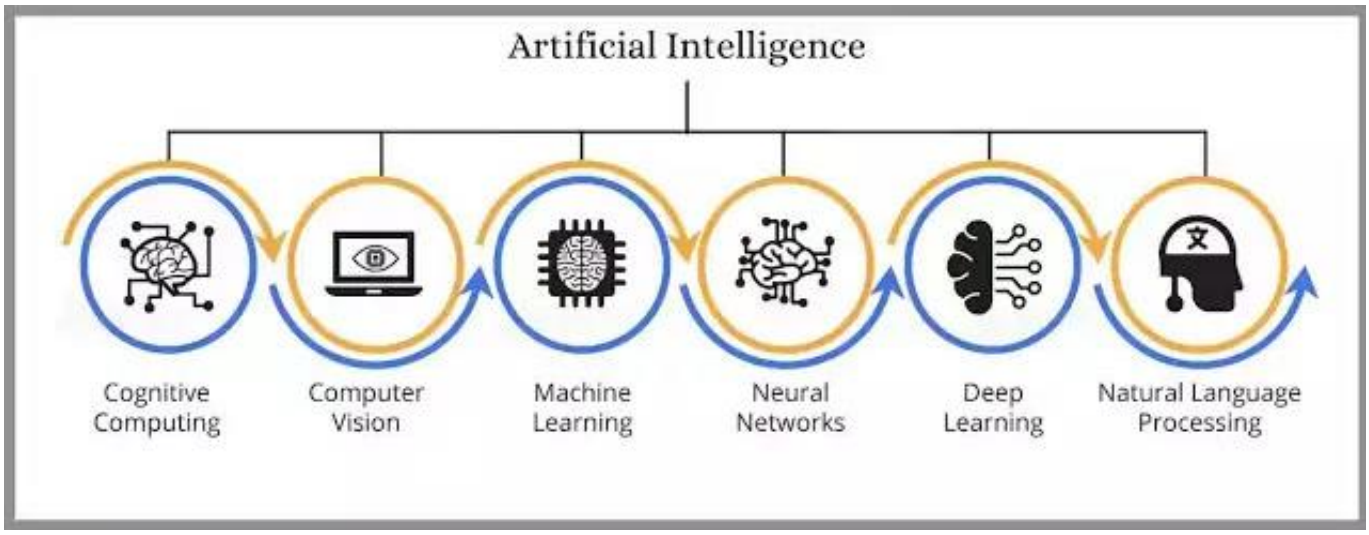


Fig I.1: AI Work

I.3.1 Machine Learning ML

Machine learning is a subset of artificial intelligence that involves developing algorithms and models that enable computers to learn and make predictions or decisions based on data without being explicitly programmed to do so. It is a form of statistical analysis that uses algorithms and models to analyze large datasets, identify patterns and relationships, and make predictions or decisions [ALP20].

Some common types of machine learning algorithms include supervised learning, unsupervised learning, and reinforcement learning. In supervised learning, the algorithm is trained on labeled data, where the correct answer is provided. In unsupervised learning, the algorithm is trained on unlabeled data, and it must find patterns and relationships on its own. In reinforcement learning, the algorithm learns through trial and error by receiving feedback in the form of rewards or punishments [GOO16].

Machine learning has many applications in various fields, including healthcare, finance, marketing, and more. It is used for tasks such as image and speech recognition, natural language processing, predictive modeling, and anomaly detection [HAS09].

❖ How does Machine Learning (ML) work

Machine learning algorithms are trained on a dataset to create a model that can make predictions or perform tasks based on new input data. During the training process, the algorithm learns patterns, relationships, and features from the training dataset. Once the model is trained, it can take new, unseen data as input and use the learned patterns to make predictions or perform the desired task. This ability to generalize from the training data to unseen data is one of the key aspects of machine learning [SPI22].

The diagram shown in **Fig I.2** illustrates how does Machine Learning (ML) work :

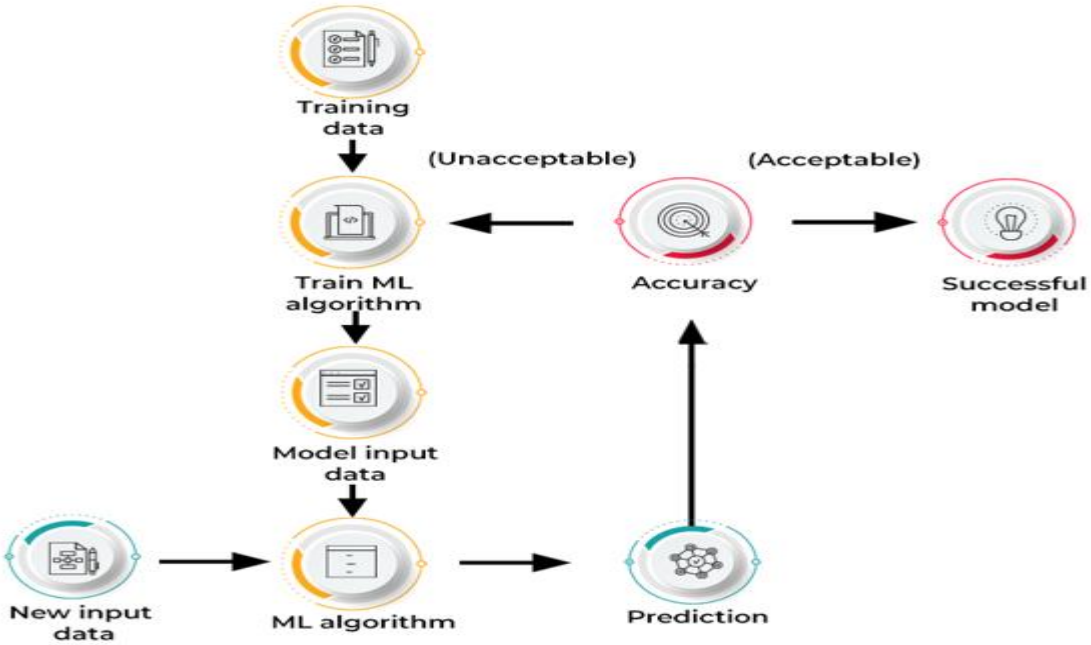


Fig I.2: ML Work

❖ Machine Learning Components

Machine learning typically involves three main components:

1. **Model**: This is the mathematical representation of the relationship between the inputs and the outputs of a machine learning system. The model is designed based on the algorithm chosen for the particular task, and it is trained on a dataset to learn the patterns and relationships within the data [IAN 16].

2. **Algorithm**: This is the set of rules or procedures that the machine learning system follows to learn from the data and make predictions or decisions based on that learning. The algorithm is chosen based on the type of problem being solved and the characteristics of the data [IAN 16].

3. **Data**: This is the raw input that the machine learning system uses to learn and make predictions or decisions. The quality and quantity of the data are critical to the performance of the machine learning system [GRO22].

I.3.2 Deep learning DL

Deep learning is a subset of machine learning that uses artificial neural networks with many layers to model and solve complex problems. It is inspired by the structure and function of the human brain and can learn to recognize patterns in data without being explicitly programmed. Deep learning has shown significant advancements in a variety of applications, including computer vision, natural language processing, speech recognition, and game playing. It has also achieved state-of-the-art performance in many challenging tasks, such as image and speech recognition, language translation, and game playing [GOO16].

I.3.3 The Relationship between Artificial intelligence, machine learning and deep learning

This part provides an overview of developments in artificial intelligence, machine learning, and deep learning. It contains valuable information for individuals interested in these fields. Figure **I.3** shows the main differences between these three scientific disciplines [KAR22].

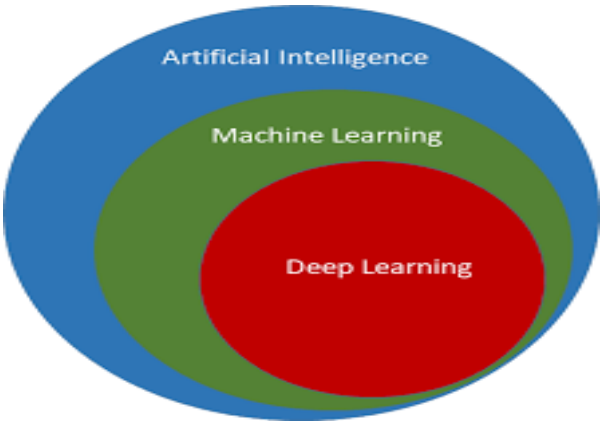


Fig I.3: AI, ML and DL

Artificial Intelligence (AI): Artificial intelligence (AI) is a fundamental component of computer science [MIA17], [RAM04]. It represents a scientific breakthrough in which machines are designed to carry out tasks that are typically associated with human intelligence, such as teaching, logical reasoning, self-correction, and self-programming. The primary objective of AI is to enable computers to perform tasks that were traditionally performed by humans [SIG18]. AI plays a crucial role in various scientific and applied fields, and its influence is evident in everyday activities, spanning industries, agriculture, and medicine. For instance, surgeons employ robots to perform highly accurate surgeries. AI possesses the potential to enhance capabilities in learning, pattern recognition, reasoning, problem-solving, visual perception, and language comprehension [KAR22].

Machine Learning (ML): Machine learning, a subset of artificial intelligence [KUH19], [MIJ20], involves the development of information technology systems that can learn patterns and relationships from data without explicit programming. Over the years, machine learning has proven to be highly beneficial in various domains such as business, research, and enhancement [MIJ20], [ABD20]. It has the capability to automatically generate knowledge, train algorithms, discover relationships, and identify unfamiliar patterns. The patterns and relationships uncovered through machine learning can then be applied to new and unseen datasets to make predictions and optimize processes [KAR22].

Deep Learning (DL): Deep learning is a specialized field within machine learning that strives to create models capable of solving complex real-world problems at a level comparable to the human brain. It achieves this by leveraging artificial neural networks and simulation-based learning techniques [FON18], [LAK16]. Deep learning models are designed to mimic the structure and functioning of the human brain, enabling them to process and interpret vast amounts of data in order to make accurate predictions and decisions. By

utilizing deep neural networks with multiple layers, these models can extract intricate patterns and representations from the data, enabling them to solve intricate and challenging problems in various domains [KAR22].

I.3.4 The difference between deep learning and machine learning

Machine learning involves the use of algorithms to analyze data, learn from it, and make informed decisions or predictions based on that learning. On the other hand, deep learning is a subset of machine learning that structures algorithms in layers to form an "artificial neural network." This network can autonomously learn and make intelligent decisions without explicit programming. Deep learning algorithms, with their multiple layers of interconnected nodes, excel at capturing complex patterns and representations in data. Thus, deep learning can be seen as a more advanced and intricate form of machine learning, leveraging neural networks to tackle complex task [ZEN23].

Figure **I.4** shows the difference between deep learning and machine learning

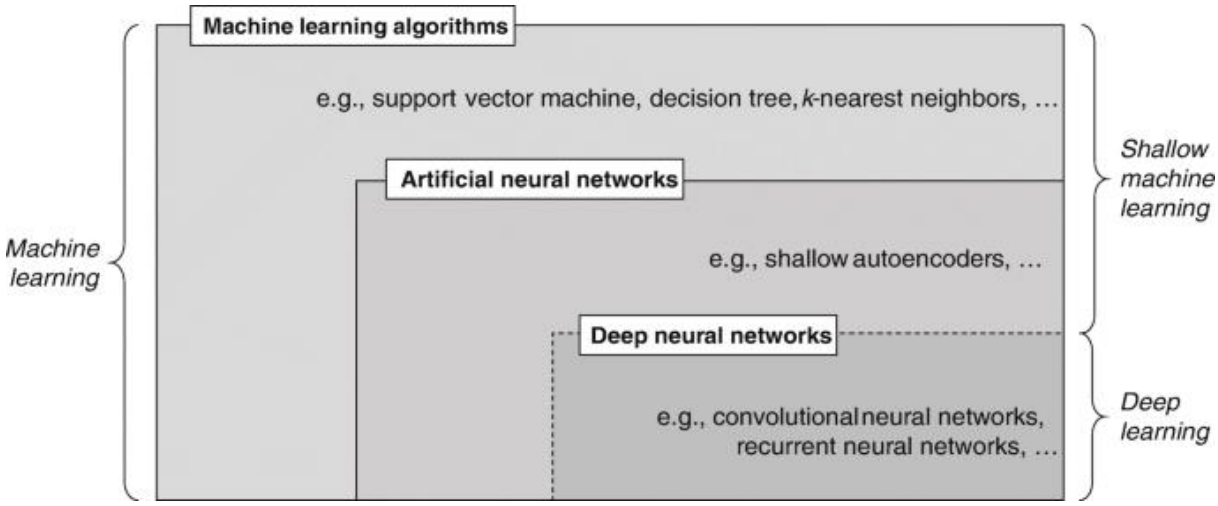


Fig I.4: machine-learning algorithm [JAN21]

I.4 Conclusion

In this chapter, we discussed prior researches on cane and smart glasses for the blind people, and then provided a brief overview of artificial intelligence (AI), machine learning (ML), and deep learning (DL). We explored how AI works and the fundamental concepts behind machine learning and deep learning, highlighting the relationship between these three fields. Additionally, we distinguished the differences between machine learning and deep learning.

In the next chapter, we will delve into the experimental aspect of the project, where we will explain the process of creating and assembling both cane and smart glasses.

Chapter II

Design of Smart system for the blind people

II.1.Introduction

In this chapter, we will design an intelligent system to assist blind individuals in walking safely. This system consists of two main parts. The first part is a smart cane designed to detect and determine the distance of obstacles. The second part is smart glasses that include a head-mounted camera and an earpiece that utilizes artificial intelligence to recognize obstacles.

II.2. Smart system architecture

This smart system is designed to help the blind to walk safely and independently. This system consists of: a smart cane and glasses equipped with an artificial intelligence-powered camera. Its main objective is to develop a new way of recognizing objects for blind people and facilitate their communication.

The task of the cane is to detect obstacles and determine the distance, and the task of the glasses is to pick up the obstacle image and convert it into audio, so the person will listen to the audio through a headphone that's connected to the glasses.

The smart system diagram in **Fig II.1** consists of two main elements (smart cane and smart glasses)

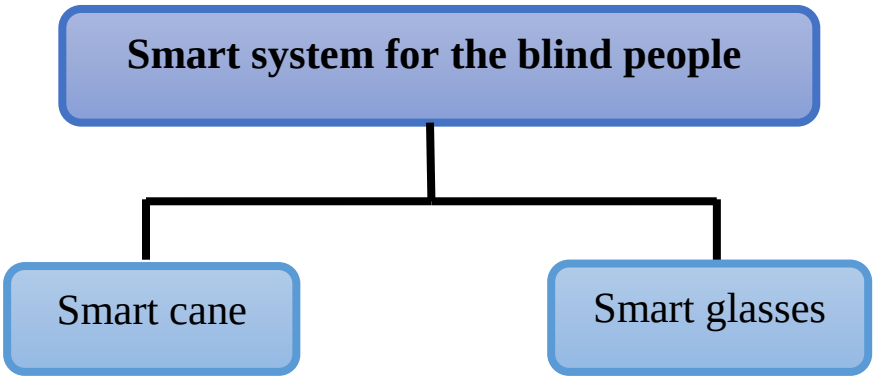


Fig II.1. Smart system for the blind people (smart cane and smart glasses)

II.2. 1. Smart cane

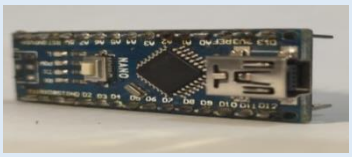
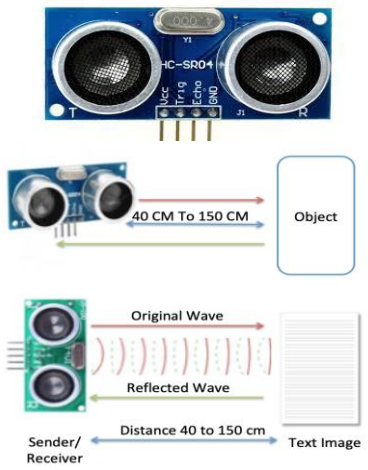
The cane is a tool that can serve of the old people and the handicapped. It also can used to sense the environment for the blind people, serving as the third eye.

❖ Architecture and Component

The cane is equipped with Ultrasonic sensor that can detect obstacles and send alert signals to the blind person. Additionally, it include vibration to provide additional information about the surrounding environment.

The components are used for making the cane presented in the **Table II.1**

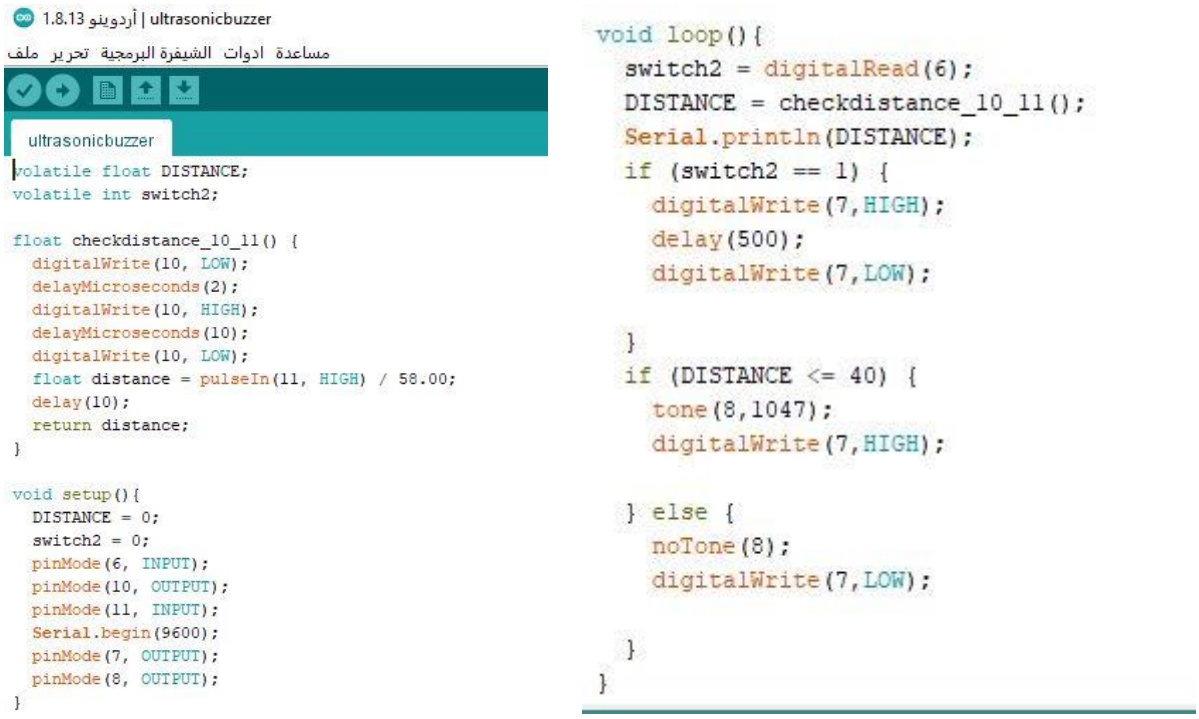
Table II.1: The components of the smart cane

Components	Function
Arduino nano 	The Arduino Nano is a small-sized, breadboard-friendly board based on the ATmega328P– 8-bit AVR microcontroller family. ✓ Power: Vin, 3.3V, 5V, GND ✓ Analog Input Pins: 6 ✓ Digital I/O Pins:14 (6 provide PWM output) ✓ IIC: A4 (SDA), A5 (SCA) ✓ Frequency (Clock Speed): 16MHZ ✓ EEPROM, SRAM:1KB, 2KB ✓ DC Current on I/O Pins: 30Ma
Ultrasonic Sensors 	Ultrasonic sensors are designed to gauge distances by utilizing ultrasonic waves. These sensors transmit ultrasonic waves and then detect the reflected waves to determine the distance between the sensor and an object. Typically, ultrasonic sensors have a range of 2-400 cm. Distance L = 1/2 × T × C ▪ L: The distance ▪ T: Time between the emission and reception ▪ C: Sonic speed The value is multiplied by 1/2 because T is the time for the go-and-return distance.
Buzzer 	A buzzer is an electronic component used with an Arduino board to create sounds. It has two pins that connect to the Arduino. By passing current through the buzzer, it vibrates at a frequency, producing sound. The tone () function sets the frequency and duration, while no Tone () stops the sound. Buzzer + Arduino = sound.
Vibrator 	A vibrator is a motor that generates vibrations and is commonly found in electronic devices like cell phones, pagers, and game controllers. It serves various purposes, such as providing haptic feedback, alert notifications, or communication in situations where sound cannot be used.

The cane 	A cane is a handheld device that is used to provide support and improve mobility for people with mobility impairments, such as those who are blind, visually impaired, or have difficulty walking. Canes typically consist of a long, slender shaft made of lightweight materials such as aluminum, carbon fiber, or wood, and a handle at the top. Overall, canes are essential tools for people with mobility impairments, providing support, stability, and independence.
Battery 	Batteries are widely used in portable electronic devices, electric vehicles, backup power systems, and renewable energy systems. Batteries can be categorized by voltage, capacity, chemistry, and size. The life and performance of batteries depend on various factors such as the battery type, application, and usage and storage conditions.
Button 	A button is a small, typically circular, component that is used in electronics to perform a simple on/off or momentary action. It typically consists of a small, spring-loaded metal dome or contact that is pressed down to complete an electrical circuit.
Jumper 	Electrical wires are conductive threads used to transmit electrical current between devices and electrical components.

- **Code for the smart cane**

The smart cane has been programmed using Arduino Nano card in arduino IDE environment, as illustrated in the **Fig II.2**.



```
1.8.13 أردوينو | ultrasonicbuzzer
ملف تحرير البرمجية الشيفرة ادوات مساعدة
ultrasonicbuzzer
volatile float DISTANCE;
volatile int switch2;

float checkdistance_10_11() {
  digitalWrite(10, LOW);
  delayMicroseconds(2);
  digitalWrite(10, HIGH);
  delayMicroseconds(10);
  digitalWrite(10, LOW);
  float distance = pulseIn(11, HIGH) / 58.00;
  delay(10);
  return distance;
}

void setup(){
  DISTANCE = 0;
  switch2 = 0;
  pinMode(6, INPUT);
  pinMode(10, OUTPUT);
  pinMode(11, INPUT);
  Serial.begin(9600);
  pinMode(7, OUTPUT);
  pinMode(8, OUTPUT);
}
```

```
void loop(){
  switch2 = digitalRead(6);
  DISTANCE = checkdistance_10_11();
  Serial.println(DISTANCE);
  if (switch2 == 1) {
    digitalWrite(7,HIGH);
    delay(500);
    digitalWrite(7,LOW);

  }
  if (DISTANCE <= 40) {
    tone(8,1047);
    digitalWrite(7,HIGH);

  } else {
    noTone(8);
    digitalWrite(7,LOW);

  }
}
```

Fig II.2. the cane control code in Arduino IDE

❖ The prototype

The cane worked efficiently as it detected obstacles within a range of 30 cm. It emitted a sound and vibration at the hand level, allowing the blind person to recognize the presence of an obstacle in front of them and become aware of it.

The **Fig II.3** represent the prototype of the smart cane designed in the our smart system.

Fig II.3. The prototype of smart cane

II.2. 2. Smart glasses

Glasses detect obstacles using a camera that captures an image. The image is then processed using an artificial intelligence algorithm from a pre-trained model . After that, it recognizes the obstacle and converts its name into a voice that can be heard by the blind person through an earpiece.

❖ **Architecture and Component**

The components are used for making the smart glasses presented in the **Table II.2**

Table II.2: Component of the smart glasses

Components	Function
Raspberry pi 3B+ 	The Raspberry Pi 3 B+ is a single-board computer with a Broadcom BCM2835 system-on-chip, 512MB of RAM, 4 USB 2.0 ports, Ethernet, HDMI, composite video output, audio jack, micro-USB power connector, and 40-pin GPIO header. It has a smaller form factor and improved power consumption compared to its predecessor, and is popular for hobbyist, educational, and developer projects.
Camera 	It is an external camera. The Version: It's the newest endoscope. Built-in 6/8pcs[8mm] led lights Camera head diameter:5.5mm/7.0mm/8.0mm Focal distance: about 70^{o} Support: Android, XP ,Win7/8/9/10, MAC
Earphone 	Earphones, or ear buds, are small devices worn inside the ear canal that convert electrical signals into sound waves. They typically have a cable that connects to an audio source and may include features like in-line controls, noise isolation, and built-in microphones

Glasses	Battery
	

❖ **AI module(coco)**

The "Coco" model is a model used for object recognition. This model relies on deep learning and artificial intelligence techniques. "Coco" is trained using a large dataset of categorized images of different objects. After training, "Coco" is capable of recognizing similar objects in new images and accurately classifying them. The "Coco" model is used in a variety of applications such as photography, identity verification, and robotics.

Some examples of objects that the "Coco" model can recognize include:

✓ Person	✓ Chair
✓ Car	✓ Book
✓ Refrigerator	✓ Keyboard
✓ Spoon	✓ Smartphone
✓ Apple	✓ Tree
✓ Bed	✓ Airplane

These are just a few examples, and the range of objects that the "Coco" model can recognize can be expanded based on appropriate training.

❖ **Code for the smart glasses**

Smart glasses are programmed using artificial intelligence via the Python programming language.

Fig II.3. Logo of Python

The following libraries were used in the programming process:

OpenCV: A computer vision library used for image processing and object detection.

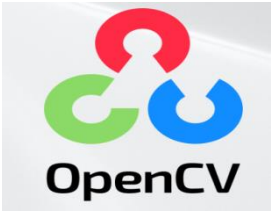


Fig II.4. Logo of Open CV Library

NumPy: A library for numerical computing and array operations, often used in image manipulation.

Fig II.5. Logo of NumPy Library

gTTs: is a Python library that converts text to speech using the Google Text-to-Speech service. It's widely used in various applications for generating speech from text, including machine learning, robotics, and web development.

Soundfile: is a Python library for handling audio files. It supports various formats like WAV, FLAC, and OGG. It allows you to read and write audio data, perform signal analysis, and save modified audio files. It is commonly used in audio-related projects for tasks such as playback, recording, and analysis.

Sounddevice: is a Python library for audio recording and playback. It offers a simple interface to capture audio from input devices and play it back through speakers or headphones. With low latency and real-time streaming capabilities, Sounddevice provides control over sample rate, buffer size, and channels. It is commonly used in audio applications for recording, streaming, and signal processing.

These libraries, among others, were utilized in the programming process to enable specific functionalities and enhance the performance of the smart glasses.

❖ **System Settings of Raspberry Pi**

To set up the Raspberry PI system we follow the following steps:

1- We reformat a card micro SD.

2- We download the operating system of Raspberry pi. It is Raspbian by Raspberry pi Imager from the official website of Raspberry pi.

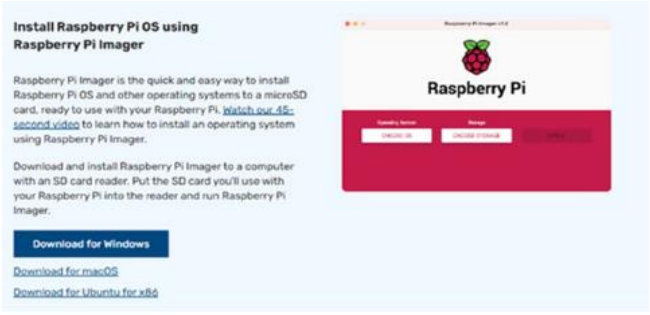


Fig II.6. Install Raspberry pi operating system

3- We connect card a micro SD to the Raspberry pi.

Fig II.7. Connect a card a micro SD

First, we connect the keyboard and mouse to the USB ports. Then, we connect an HDMI cable to display the system interface on the screen. Finally, we provide power to the Raspberry Pi using a 5V power supply.

Fig II.8. Connect Raspberry Pi to the screen

4- We install the Raspbian operating system on the Raspberry pi and then adjust the system settings.

❖ **Preparing the working environment of the model**

In order to set up the working environment of the form, we perform the following steps[PYS]:

1- Update Raspberry pi by typing these commands in terminal

```
sudo apt-get update
sudo apt-get upgrade
```

2.Install dependencies

```
sudo apt-get install build-essential cmake pkg-config
sudo apt-get install libjpeg-dev libtiff5-dev libjasper-dev libpng12-dev
sudo apt-get install libavcodec-dev libavformat-dev libswscale-dev libv4l-dev
sudo apt-get install libxvidcore-dev libx264-dev
sudo apt-get install libgtk2.0-dev libgtk-3-dev
sudo apt-get install libatlas-base-dev gfortran
```

3.Install Python 3 and Pip3:

```
sudo apt-get install python3-dev
sudo apt-get install python3-pip
```

4.Install Opencv:

```
pip3 install opencv-python
```

5.Extra depencies for Opencv and the Camera:

```
sudo apt-get install libqtgui4
sudo modprobe bcm2835-v4l2
sudo apt-get install libqt4-test
```

❖ Connecting the rest of the system to Raspberry pi

We connect the camera, earphone and battery to the raspberry

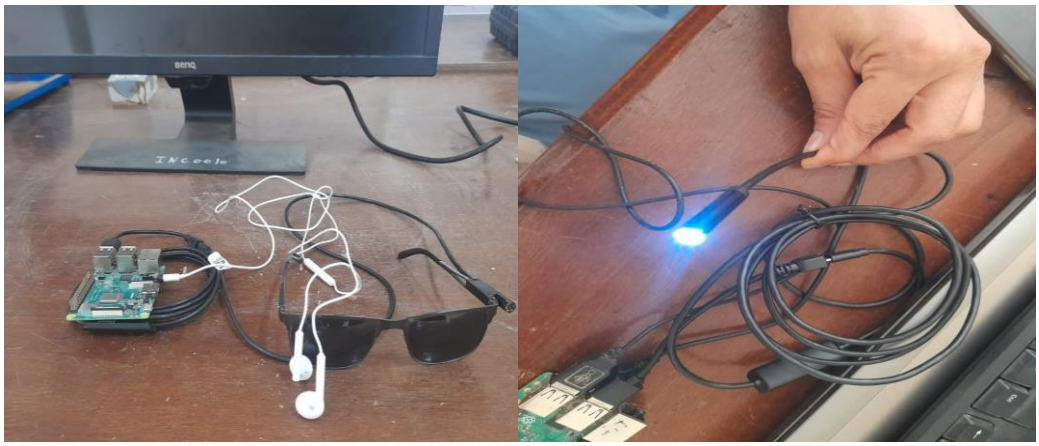


Fig II.9. Connecting system elements

❖ System Testing

The system has been tested using the computer camera after the following steps:

1- Installing the libraries previously in Python.
2- Writing the code for the smart glasses in a Python program.or Visual Studio Code
3- Issuing the command to execute the code.

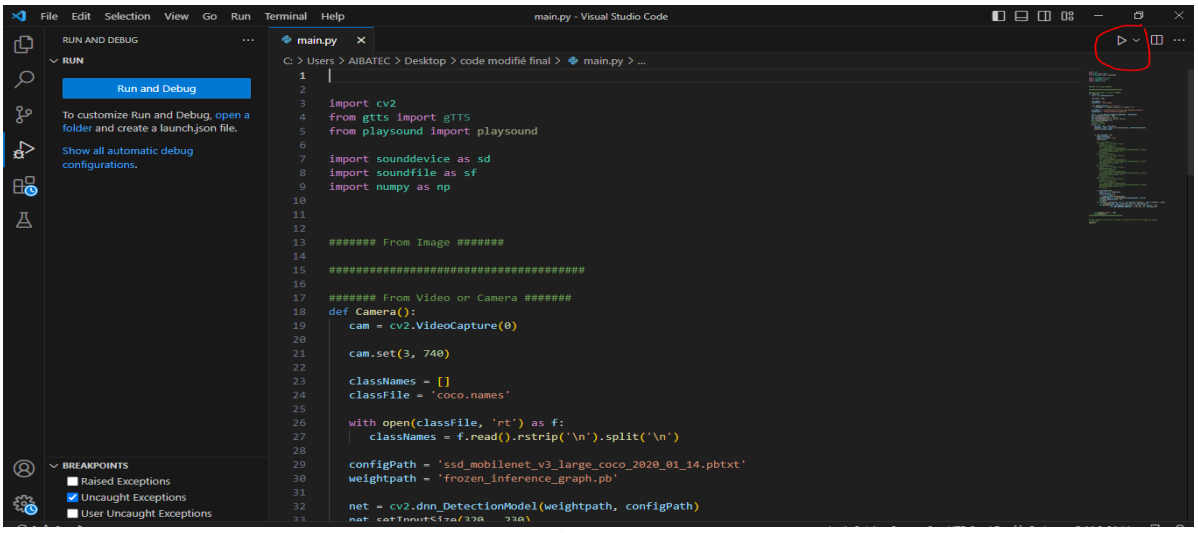


Fig II.10. Code execution process

Then, we obtain the results as illustrated in the Fig II.11, where the camera detects the objects in front of it. It proceeds to outline the detected objects and write their names, in addition to pronouncing the name aloud so that the visually impaired person can know what is in front of them.

Fig II.11. Code execution process System Testing

❖ **The prototype**

Fig II.12 represents the prototype of smart glasses designed in our intelligent system. The glasses worked efficiently as they discovered the obstacles in front of them. The glasses make a sound where the blind person shows what is in front of him by pronouncing the name of the object in front of him, allowing the blind person to recognize the presence of an obstacle in front of him and stay away from him.

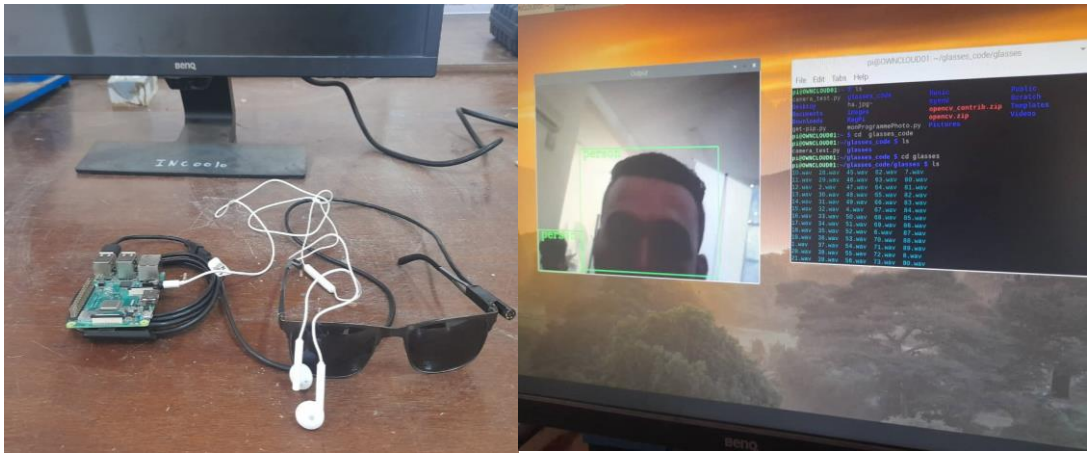


Fig II.12. The prototype of smart glasses

II.3. conclusion

In this chapter, our aim was to create an intelligent system that enhances the safety of visually impaired individuals during their movements. The system we developed consists of a smart cane and smart glasses.

The smart cane is equipped with an Ultrasonic sensor, enabling it to detect obstacles and promptly send alert signals to the blind person. Moreover, the cane incorporates vibration feedback to provide additional information about the surrounding environment.

As for the smart glasses, they utilize a camera to capture images and employ an artificial intelligence algorithm based on a pre-trained model for image processing. This algorithm allows the system to recognize obstacles within the captured image. The system then converts the recognized obstacle into a voice output, which can be heard by the blind person through an earpiece.

Overall, this intelligent system, comprising the smart cane and smart glasses, offers valuable assistance to visually impaired individuals, enabling them to navigate safely and with increased awareness of their surroundings.

General Conclusion

Artificial intelligence has greatly facilitated many tasks in life and has made a significant impact on rapid advancements in various fields. One of its most prominent achievements is the facilitation of movement and mobility for the visually impaired, as mentioned in this study.

In the first chapter, we discussed previous works related to different intelligent systems for blind individuals and those with visual impairments. We then provided general definitions for Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL). We also explored the relationship between artificial intelligence, machine learning, and deep learning, followed by the differences between deep learning and machine learning.

In the second chapter, we focused on our intelligent system, which consists of a smart cane and smart glasses. Firstly, we talked about the smart cane, which contains an ultrasonic sensor capable of detecting obstacles and sending alert signals to the visually impaired person through a buzzer sound and vibration. Secondly, we discussed the smart glasses, which utilize various technologies to perform their tasks. Obstacles are detected through a camera that uses OpenCV to capture and process the image using artificial intelligence algorithms with a trained model (COCO) to identify the obstacle's name. This information is then translated into sound using gTTS, which the visually impaired person hears through earphones connected to the glasses.

The objective of this study is to develop an intelligent system that enhances the daily lives of the visually impaired by facilitating their movements and navigation through the utilization of the aforementioned smart cane and glasses. However, it is important to acknowledge that our current intelligent system has certain limitations, which we hope will serve as focal points for future advancements. For instance, our aim is to enable blind individuals to recognize their family members by name or distinguish their own home's entrance from others, among other potential improvements.

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[Fig I.1] https://www.atlearner.com/2020/07/what-is-ai.html

[FigI.2] https://www.spiceworks.com/tech/artificial intelligence/articles/what-is-ml/

[FigI.3] https://encrypted tbn0.gstatic.com/images?q=tbn:ANd9GcSoJrgOFAYXBXH7RanDX7_V1u0dLfjJJB1TOFzjwxNaLqi96Tl_jNcuagjmiUj0yAsrolI&usqp=CAU

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الجمهورية الجزائرية الديمقراطية الشعبية
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R2-FO-03
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Nature de la demande de protection *

Brevet d'invention ☑ Extension de la demande internationale selon le PCT ☐ Certificat d'addition ☐

[71] - **DEPOSANT[S]** : *Nom, Prénom, [dénomination], et Adresse complète*

Université Echahid Hamma Lakhdar - El Oued
BP 789 le nouveau groupement * El Oued * Algérie * 39000

Nationalité du ou des déposants Algérienne

[72] - **INVENTEUR[S] :** *Nom, Prénom, Adresse*

KHIARI, Ahmed khiari, Cité 420 logements ouest teksebt, El Oued, 39006, Algérie.
AIBA, Mahmoud, Cité Elhoria, El Oued, 39000, Algérie.
CHERIF ,Hakima, Cité Elkaouter Nezla,El Oued, 39001, Algérie

[54] - **TITRE DE L'INVENTION** :

Conception d'un système intelligent pour les personnes aveugles afin de sécuriser leurs déplacements

[30] – **REVENDICATION DE PRIORITE (S)**

[31] - N°[s] de dépôt	[32] - date[s] :	[33] - pays d'origine	Nature de la demande

Numéro de dépôt	Date de dépôt	Heure
230109	09 FEV. 2023	11:26

N° de la demande internationale et date internationale de dépôt

Visa

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BOUALLEG El Hafsi
Service Dépôt
DTP
Chef de Service

Demande de certificat d'addition rattaché au brevet principale n° **du**

[74] - **MANDATAIRE** : *Nom, Prénom, Adresse*

Date du pouvoir

Le préposé à la réception

Fait à : le :

Signature et cachet
Qualité du signataire
pour les personnes morales

Autres informations

BORDEREAU DES PIECES DEPOSEES *

- ☐ Copie de la demande internationale
- ☐ Mémoire descriptif en langue nationale
- ☐ Mémoire descriptif original en langue française
- ☐ Mémoire descriptif duplicata en langue française
- ☐ Dessin(s) original (aux) Planche(s)
- ☐ Dessin(s) duplicata (aux) Planche(s)
- ☐ Abrégé descriptif
- ☐ Pouvoir
- ☐ Document de priorité
- ☐ Cession de priorité
- ☐ Titre ou justification du paiement de taxes

Les demandes doivent être remises ou adressées par pli postal recommandé avec demande d'avis de réception, à l'Institut National Algérien de la Propriété Industrielle (INAPI) dont les coordonnées sont indiquées ci-dessous.

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