Interactive Surveillance Patrol Robot Vehicle

Taha Elsayed*, Ziad Emad*, Abdallah Salah*, Ahmed Tarek *, Fares Magdy*, Mohamed AMR *, Hamed Sobhi *, Sherif Elsanadily*

* Electronics & Communications Department, Egyptian Academy for Engineering and Advanced Technology (EAEAT), Cairo, Egypt

Email: sherif.elsanadily@eaeat.edu.eg

Abstract- The security missions by using smart tools have become very important in our everyday life. A security patrol robot vehicle is developed and presented in this paper. The paper discusses its main benefits and elaborates how modern technology can be used to address errors that may occur in the security field due to the human factor by designing and implementing an interactive robotic vehicle for periodic monitoring. It can be used in buildings and facilities that require nighttime security. Inspired by Egypt Vision 2030's digital transformation trend, the proposed robotic vehicle will patrol any premises or residential blocks at predetermined intervals, usually at night or during vacations. It is a self-powered system that is integrated with a remote control and monitoring platform and is designed to be placed next to the building or block that needs to be secured in order to carry out its surveillance and patrolling missions, among other magnificent functions. Finally, it provides the control head office with all relevant and necessary data to make the correct decision.

Keywords Image Processing, Sensors, Solar system, GUI, Monitoring, Motion Detection.

I- INTRODUCTION

A robot is a machine that has been designed to replace human labor. At the turn of the century, the need to increase factory output prompted the introduction of new methods of increasing output, such as the introduction of modern machines such as robots programmed to speed up the production process and reduce employment. As a result, the reliance on robots has grown day by day, to the point where they are used in guarding and monitoring to reduce the errors of the human factor in monitoring. Many businesses and factories have used guard patrol robots to secure their premises.

Initially, these robots were only used for photography. However, it is now capable of photographing and identifying strangers using advanced algorithms, and by using modern sensors, it is capable of knowing several things such as fire, gas, and smoke leaks, and other things that have contributed to reducing human factor errors. Traditional surveillance methods, such as surveillance cameras, can provide data in the form of pictures and videos of an accident after it has occurred, but they cannot prevent the accident from occurring in the first place. The project that we want to implement aims to prevent an accident from happening by using a robot that performs monitoring tasks and avoids human errors that a person may make.

We will learn about the importance of patrol security robots in everyday life and how they are developed in this project. We will discuss our patrol security robot and its main benefits, as well as how modern technology can be used to address errors that may occur in the security field due to the human factor by designing an interactive robotic vehicle for periodic monitoring. It can be used in buildings and facilities that require nighttime security. Inspired by Egypt Vision 2030's digital transformation trend, the proposed robotic vehicle will patrol any premises or residential blocks at predetermined intervals, usually at night or during vacations.

II- CAMERA AND IMAGE PROCESSING

The proposed system should have its main features (such as ability to work as a self -powered - equipped with the appropriate devices and sensors enabling it to do its mission effectively and professionally). Therefore, the block diagram of this system should be shown first before logging in the details of the computer vision subsystem (Camera and Image Processing). The block diagram can be depicted in Fig.1 and the final prototype is implemented as shown in Fig.2.
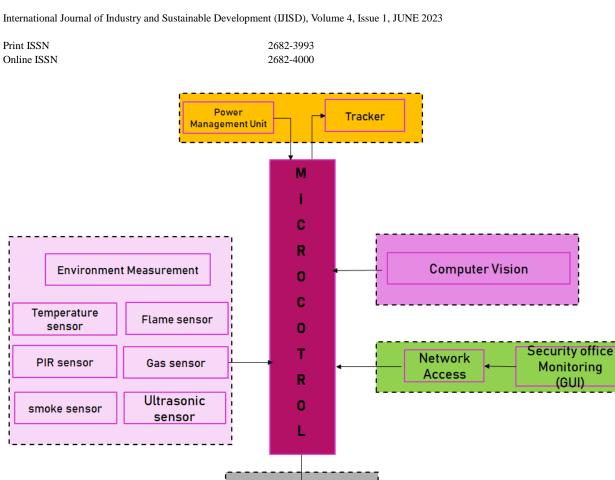
Fig.1 The block diagram of the proposed system

Fig.2 The implemented system

1-THE EYES OF ROBOT

• Basics of a camera device

The vision is the most important thing to consider when building a patrol surveillance car because it will replace the role of a security and the vision is the most important thing when building a security robot. We start working on how to make the patrol car see and analyses, so we start looking into cameras and figuring out how to adjust and program for the required task of the robot we build. To begin this task, we look for a suitable camera and attach it to the Raspberry pi microcontroller to programmer it using the Python language to identify the face of the intruder who enters if he is in the database it will not give an alert if the intruder is not registered in the database of the Patrol robot it will give an alert to the administrator working on the monitoring in his office that there is a person the It recommends programming with machine learning to make the camera recognize the face not only define it as a person but to learn who is the person and learn its detailed info to make sure this person is authorized to enter or not allowed to pass.

Interactive Surveillance patrol robot vehicle is a very good replacement to a real human security it will have several missions and objectives to do we will discuss it by two ways which are how to advertise it and technically. The robot vehicle has some objectives as following:-

a.   Achieving security mission (through its smart vision).
b.   Working as a Self-powered system (depending on solar cells).
c.   Reducing manpower (no need for workers to hire).
d.   Crisis detection and alert system (the safety of the client's surrounding environment).
e.   Being easily controlled and not complicated.
f.   Ability to take actions when a threat detected.

The robot we are going to make must be practical and attractive to the client so we should so we should provide some client needs in it such as the most important three needs of any customer who want to buy any kind of device which are SECURITY & SAFETY & SAVING.

•   Raspberry Pi camera

At first, we look at Raspberry Pi Camera for our project to get the most efficient and practical one for the task. The first type of camera was the basic attached camera to Raspberry Pi as shown in fig. 3. The other models are listed and compared in Table 1 & 2.
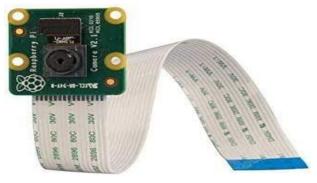

Fig. 3 Raspberry Pi - Camera

Tables 1 Specifications for various camera models to be connected to Raspberry Pi

Points of comparison	C6N	C6CN	C1HC
Quality	1080P	1080P	720P
Vertical Rotation	55°	UP 105° ,Down15°	X
WIFI / CABLE Ethernet	Cable Ethernet(RJ45)	Cable Ethernet(RJ45)	WIFI 2.4GHz
Night Vision Range	10m	10m	10m
View Angle Horizontal	75°	92°	92°
View Angle Vertical	45°	62°	60°
View Angle Diagonal	85°	115°	110°
Look			

Table 2: The Chosen Camera Specifications

Aspects of Camera Module	Specs
Picture Sensor	IMX 219 PQ CMOS
Resolution	5-megapixel
Max image transfer rate	720p: 30fps
How to connect to Raspberry pi	15-pin ribbon cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI-2).
Dimensions	23.86 x 25 x 9mm

This first thing we planned was the Raspberry pi Camera but it isn't good idea due to the following:

1- Don't Cover an Area.
2- We need three Cameras to Cover area.
3- Bad Image processing.
4- 4- Low fps.

For our project we focus on the night vision cameras because they work at night (we can use a flash for clearer photo) so we search for new idea to be able to make the photo clearer.
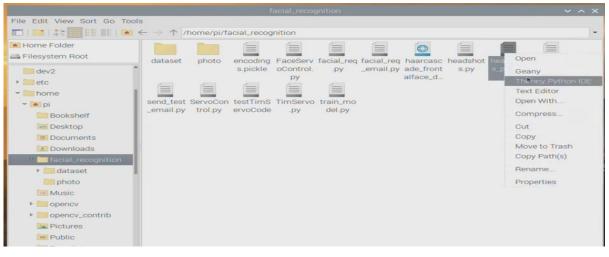
· **IP Camera**

Digital video cameras that accept control data and transmit picture data via an IP network are known as IP cameras. They occur frequently and are employed for surveillance however, unlike analogue closed-circuit (CCTV), just an area local network is needed. This same name "IP camera" or "netcam" typically exclusively refers to those that are directly applicable accessible through an access point, despite the fact that the majority of Camcorders are webcams. We choose to look through various types of cameras to find the most efficient and practical one to the task. While we were searching, we found lots of kinds that we can attach it using its ribbon to the microcontroller the types of cameras we searched was the Raspberry pi cameras and employing Ethernet ports, which have various features and functions resolutions (C6cn) it can be adjusted and attached to the needed Raspberry Pi.

2- Image Processing

- **Face recognition system process**

In order to begin the process of the image analysis so the system will begin to detect and know the face we will begin to feed the camera with the needed photos and apply python code to the camera to start processing begin the detection process by using OpenCV functions as shown in Fig, 4,5. We begin to feed the camera some photos of the user that his face needed to be recognized:
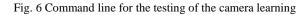

Fig,4 Choosing Headshot Python Script Code

Fig.5: Editing the name inside the code

After the process of feeding the camera with the needed photos by using the headshot Python Script Code we begin to see the output and the reaction of the camera after seeing the photo of the user . Opening command window and summon the line python train_model.py which will begin to process the image already taken. Command Line Will Process the Photos in The Folder Dataset as shown in Figures (6-8).

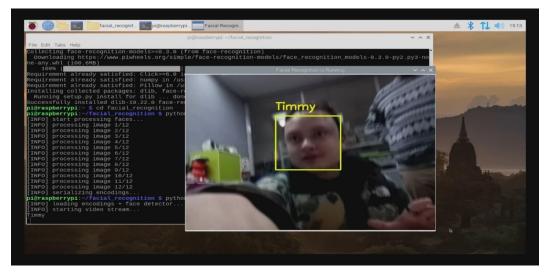Fig. 6 Command line for the testing of the camera learning
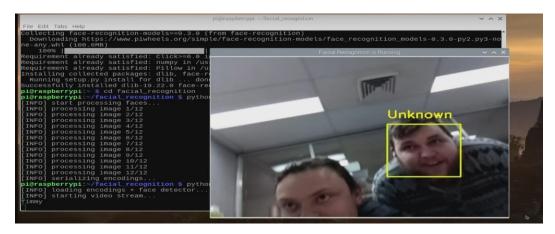

Fig.7. Face recognition success

Fig.8 Unknown face detection process

If It Is a Success, It Will Give You a Yellow Square with The Folder Name in The Dataset Which Means It Recognize the Person Now; If The Face is Unrecognized, It Will Give an Unknown Indication.

- **Camera targeting technique**

If a threat is detected, we must teach the machine how to deal with it, so we must implement a tracking system to target the moving threat in the area, which will be accomplished by using the Pimoroni Pi K Pan-Tilt Hat, which is a servo that uses specific codes to move in the ordered directions, providing you with an efficient tracking process. First download the files needed which are the python codes to adjust the Pan-Tilt on the Raspberry . Tracking applied when we run the python code Facetracker.py .Also, there is a problem if the face's position is changed the servo will stop tracking so by using another python code (Face track-Pan -Tilt-Hat.

III- SOLAR POWER SUPPLY SYSTEM

- **Solar panel system**

A photovoltaic (PV) panel, also known as a solar panel, is a device that converts solar energy into electricity. It is composed of a number of solar cells that are linked together to form a panel. Each solar cell is made of a semiconductor material, typically silicon, that absorbs photons from the sun and releases electrons, resulting in an electrical current flow. Multiple solar cells are typically connected in series to create a higher voltage and in parallel to increase current. The electricity produced by the solar cells is direct current (DC), which is then converted to alternating current (AC) by an inverter. The alternating current electricity can then be used to power homes and businesses, or it can be fed back into the grid. Residential and commercial solar power systems, as well as largescale utility solar power plants, can all benefit from the use of solar panels. They are gaining popularity as a source of clean, renewable energy that can help reduce reliance on fossil fuels and reduce energy costs. Solar panels are important for a variety of reasons, including: Solar energy is a clean and renewable energy source that does not emit greenhouse gases or other pollutants. This means that it has the potential to reduce reliance on fossil fuels while also mitigating the effects of climate change. Solar energy has become increasingly cost-effective in recent years, making it cost-competitive with traditional forms of energy. This means that solar energy can aid in the reduction of energy costs for both homes and businesses. Solar energy systems can be installed on homes and businesses to allow them to generate their own electricity and become less reliant on traditional utility companies. Energy security: Solar energy is not dependent on fuel imports, which can be disrupted. This improves energy security by lowering the likelihood of blackouts due to fuel shortages. Job Creation: The solar energy industry is rapidly expanding, creating jobs in a variety of fields such as installation, engineering, research, and manufacturing. Remote Area Energy Access: Solar energy can be used to provide electricity to remote areas where extending the power grid would be difficult or expensive. Overall, solar energy is a valuable source of clean, renewable energy that can help to reduce climate change, lower energy costs, improve energy security, create jobs, and expand access to electricity in remote areas. The solar panel that we require is the source of electrical power for our robot, and we must measure all current features of the security robot required for car motion, sensors, and cameras. so, if we see the sensors need 0.3 Amp, cameras need 0.5 Amp and motion of the car needs 1.5 Amp. We need solar panel that its capacity can support all of that .so we choose the 50w solar panel which can charge the batteries and not just that. We need to charge the batteries for 15 hours of working and patrolling but before we have to know about many factors.

Our goal is to have the security robot patrol from 3 p.m. to 6 a.m., which means the security robot will be working for 15 hours and charging for 12 hours from 6 a.m. to 6 p.m., so we chose a 50W solar panel that will provide everything we require. And now it's time to learn more about our solar panel, its features, and some of the confiscations. There are some things we need to know about our solar panel in order to understand it. as in the relationship between current and voltage in a solar panel when the voltage and current increase until they reach a point. That point, known as "Mpp," represents the maximum voltage and current that a solar panel can produce.

We can use this method to deduce the graph of the power which the Max point in this graph will be Max power that solar panel can produce that is called "P_{max}" as shown in Fig.9 [5].

Table 3 Solar panel Characteristics

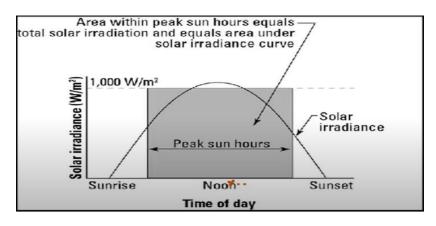| Electrical Characteristics	
Product code	MESM-50W
Maximum po wer(Pmax)	50W
Voltage at Pmax(Vmp)	17.8
Cur rent at Pmax(Imp)	2.81
Open-ci rcuit voltage(Voc)	22.3
Shor t -circuit current(Isc)	3.03
Power temperature coefficient	-0.41%/☐
Voltage temperature coefficient	-0.31%/☐
Cirrent temperature coefficient	+0.05%/☐
Cells Efficiency(%)	18.43%
The maximum system voltage	600VDC(IEC)
Output power tolerance	±3%

Fig.9 Area within peak

Returning to the peak sun hours, we assume this project will be in Egypt, and the peak sun hours will be from 7 a.m. to 5 p.m. There is a relationship between current and temperature, and this is dependent on the irradiation variation effect that comes from the sun. Obviously, the more radiation from the sun, the more current that solar panel can produce. There are two types of measures for any solar panel in the world, and they measure different types of solar panels in different situations, and anyone can use either of them depending on the conditions that the robot will be in. They are STC and NOCT. STC stands for Standard Test Conditions, and it has an irradiation of 1000 w/m2, a cell temperature of 25°C and a pressure of 1.5 air mass. In the case of the NOCT, which is Normal Operating Cell Temperature and Irradiation, the temperature of the cell is 45°C, the pressure is 1.5 air mass; and the wind speed is 1 m/s. There is an important point in this solar panel system that without it can cause more problems and possibly burn the load, and there are many reasons to use it, which is the solar charger controller.

- **Importance of solar controller:**
  - Regulate voltage to value suitable for charging batteries.
  - Protect batteries from excessive charging.
  - Protect batteries from fast discharging.
  - Monitoring and measuring the off - grid system.
  - Protect panels during night from reverse current.

32

There are two types of solar controllers, and they are the most commonly used in Egypt: PWM (pulse width modulation), which is low efficiency, low cost, and less commonly used. The other is MPPT, which stands for maximum power point tracker. It is more expensive than PWM and is more commonly used.

• Battery

Now we can get into the batteries we'll be using, but first we need to go over some important points in the batteries, such as how to measure the battery. The discharge rate and the time it takes for batteries to discharge are used to calculate their capacity. Assume we have a 100A.H battery and I want to charge a load that requires 1 Amp. That means the battery will be fully charged in 100 hours. If we use the same batteries to power a load that requires 100Amps, the battery will discharge in 1 hour. However, these are idealistic words that are unsuitable for everyday use. There is some point effect on these calculations in the practical works. We discovered that the discharge rate is related to battery capacity. To make things even simpler, as the discharge of the batteries increases, so does the capacity of the batteries.
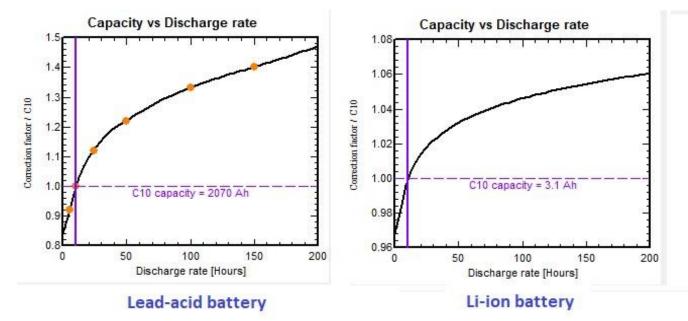

Fig. 10 Capacity & discharge rate

- If we need to charge the robot in 12 hours, so we need capacity 2.3*12 = 27.6 ≈ 28A/h. So, **the required capacity of battery is 35A/h.**
- If we need to charge need charge the robot in 12 hours, so we need capacity 2.3*12 = 27.6 ≈ 28A/h. So, **the required capacity of battery is 35A/h.**

IV. SENSORS

• The importance of sensors

To begin, we must understand what the sensor is and why it is important. A sensor is a device that generates an output signal in order to detect a physical phenomenon. It measures the rate of change in a substance and transmits the data to another device, such as a computer, to perform a specific function. Sensors of various types, such as light, smoke, and fire sensors, are used in the manufacture of electronic devices. We can use the characteristics of the sensors in our project (a security robot) to detect risks that threaten the entity to be secured, as this robot is supposed to serve as the facility's security guard. In this study, we will discuss the sensors that will be present in this robot in order for it to perform its function, as well as their characteristics and the reasons for their use .

• Flame Sensor

The flame sensor is a sensor that detects the presence of a fire by measuring the increase in flame and then sounding an alarm. This sensor detects flames with wavelengths ranging from 760 to 1100 nm. If it is too close to the fire, it will be easily destroyed, so there must be some distance between it and the fire. The flame can be detected from a distance of 100cm, with a detection angle of 600 degrees. This sensor emits either an analogue or a digital signal. These sensors are used as a flame alarm in firefighting robots.

Fig.11 Flame Sensor

When the photodiode detects IR waves emitted by the flame; its resistance decreases. The decrease in resistance is proportional to the intensity of the infrared waves produced by the flames. If the flames emit a lot of IR waves, the photodiode will short circuit and provide the least resistance to the incoming voltage. The voltage at the noninverting terminal will now be equal to ground potential. The voltage at the inverting terminal can be changed by adjusting the pot connected to it. This is done to fine-tune the sensitivity of the sensor. (The module is said to be highly sensitive when the potentiometer is set to its smallest value. If the potentiometer is set to its maximum setting, the module is said to have low sensitivity.) At this point, the voltage at the non-inverting terminal is less than that at the inverting terminal (assuming the inverting terminal voltage is greater than the GND potential), resulting in a low LM393 output (0V). Because of the potential difference between its anode and cathode terminals, the indicator LED connected between Vcc and Output will begin to glow at this point. The output is generated by the LM393 pin. When there is no flame, the photodiode detects no infrared waves. This results in maximum resistance to incoming voltage and an open circuit.

• Smoke detector

A smoke detector is a device that senses smoke emanating from fires and then gives alerts. This sensor can be constructed in two ways. The first method involves the use of small quantities of radioactive materials. These materials cause particle ionization and the generation of a small electric current between two metal plates by igniting the air molecules between the plates. When smoke particles enter the device, the ionized particles attract them, weakening the current until it reaches a certain level, at which point an alarm for the presence of smoke is triggered. The photoelectric method is the second type of detection technology. The light reflected off the particles in the sensing chamber by the light beam is detected by this technology. If there are no smoke particles and the detected light level falls below a certain threshold, the sensor detects smoke and issues an alert.

Fig.12 Smoke detector

• Ultrasonic sensors

An ultrasonic sensor, as shown in Fig.13, is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal [6].To calculate the distance between the sensor and the object, the sensor measures the time it takes from the transmitter's sound emission to its contact with the receiver. D = 1/2 T x C (where D is the distance, T is the time, and C is the sound speed of 343 meters/second) is the formula for this calculation. For example, if a scientist aimed an ultrasonic sensor at a box and the sound bounced back in 0.025 seconds, the distance between the ultrasonic sensor and the box would be: D = 0.5 x 0.025 x 343 (approximately 4.2875 meters).

Fig.13 Ultrasonic HC-SR04

• **Gas Sensor**

The gas sensor, as shown in Fig. 14, is a device used to detect gas leakage in the place so as not to cause a fire or suffocation for individuals [6]. The ability of the chemoreceptors to conduct current determines a Gas sensor's ability to detect gases. The most common chemoreceptor is tin dioxide (SnO2), an n-type semiconductor with free electrons (also called as donor). In most cases, oxygen outnumbers combustible gases in the atmosphere. The free electrons in SnO2 are drawn to the surface by the oxygen particles. The output current is zero because there are no free electrons available. The animated gif below shows oxygen molecules (blue) attracting free electrons (black) inside SnO2 and preventing current flow.When the sensor is exposed to toxic or combustible gases, the reducing gas (orange color) reacts with the adsorbed oxygen particles, breaking the chemical bond between oxygen and free electrons and releasing them. Because the free electrons have returned to their original position, they can now conduct current; this conduction will be proportional to the number of free electrons available in SnO2, with more free electrons available if the gas is highly toxic.

Fig.14 Gas Sensor

• **PIR Motion Sensor**

Because there are multiple variables that affect the sensor's input and output, PIR sensors are more complicated than many of the other sensors explained in these tutorials (such as photocells, FSRs, and tilt switches). We'll start by explaining how a basic sensor works using this rather nice diagram. The PIR sensor itself has two slots, each of which is made of an IR-sensitive material. Because the lens used here isn't doing much, we can see that the two slots can 'see' out past a certain distance (basically the sensitivity of the sensor). When the sensor is turned off, both slots detect the same amount of IR, which is the ambient amount radiated from the room, walls, or outdoors. When a warm body, such as a human or animal, passes by, one half of the PIR sensor is intercepted, causing a positive differential change between the two halves [6]. When the warm body moves away from the sensing area, the sensor produces a negative differential change. These pulses of change are what are detected. To improve noise/temperature/humidity immunity, the IR sensor is housed in a hermetically sealed metal can as shown in Fig.15.
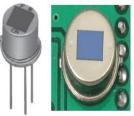

Fig.15 PIR Sensor

V – Monitoring

• WLAN

A wireless LAN (WLAN) is a wireless computer network that connects two or more devices via wireless communication to form a local area network (LAN) within a specific geographic area, such as a home, school, computer laboratory, campus, or office building. Because a Wi-Fi network is a type of WLAN, we need a device to create a WLAN (Access point).An access point is a device that establishes a wireless local area network (WLAN) that allows devices to communicate with one another.

• How to Set Up a LAN Web Server

Turn on your router or network switch after connecting it to the computer with an Ethernet cable. If this is your first time setting up a network, the "Set up a network" wizard will do it for you. If it does not appear, perform the following steps and Select "Set up a new connection or network." **And Configure Your Wi-Fi.**

If you want your devices to connect to your network wirelessly, you must configure Wi-Fi; otherwise, ethernet cables can be used. To enable Wi-Fi, follow the instructions in your router/network switch manual. Do the following to make it as secure as possible:

- Consider changing the default SSID (network name), Wi-Fi login, and password. This can be done by logging onto your router, either by going through the network's settings, or a web browser on your PC.
- Be sure to choose the most advanced security protection – currently, it's WPA2.
- Now for the changes to take effect, restart your PC.
- Connect Your LAN to the Internet and Connect your router and modem to the main phone line via the WAN port for LAN web access.
- -Connect Your Devices to the LAN and do the following whether you've connected your devices to the LAN via Wi-Fi or Ethernet cable:
- On your devices, turn on Wi-Fi

There are several ways to share and give access to resources in a LAN, including: Right-clicking on files or folders > "Share with…" by Adding files to public folders and switch on "Public Folder Sharing" via the Network and Sharing Centre.

• Webpage

The Flask Web Framework will be used to create the webpage for controlling the Robot. The website will include controls for moving the robot to the left, right, forward, and backward. Webservers are used in Iota-based applications to control or monitor any sensor values via web browsers on port 8081. (192.168.1.207:8081).

- In the python code, there are five functions for moving the robot Forward, Left, Right, Reverse, and Stop.
- Five different integers are assigned to these five functions. Received integer from the web page will be saved in a variable named change Pin, and it will be compared with all the functions.
- So when we press the Forward button on the web page, it will send one and based on that, the robot will move in the forward direction.
- Armin Conacher of Pocono created the well-known Python web framework Flask. It is a Python library that is used by a third party to develop web applications. Flask is a micro-framework based on the Pocono projects Werkzeug and Jinja2 and is classified as such.

To control the robot and display the video feed, an HTML webpage is created. We've assigned different integers to different direction buttons in this HTML code. For example, 1 represents forward and 2 represents left. As a result, whenever the Forward button on the web page is pressed, it will send 1.
The full HTML code for controlling the robot via webserver is provided below. Make a directory called Surveillance Robot, and then make a folder called templates within it. Then copy the following code and save it as index.html in the templates folder.

VI- GUI

• The importance of GUI

The main windows are interacted with directly by the user. The phrase "client-side" is commonly used to describe it. The GUI consists of everything that the user sees when using the desktop application, such as text colours and styles, images, graphs, and tables, as well as buttons, colours, the navigation menu, and much more. When you open a desktop application, GUI developers provide the organisation, visual style, behaviour, and content of everything that appears on the screen. Performance and responsiveness are the primary focal points of GUI development.

Two main targets for creating desktop applications
1. Make it easier to use.
2. Better Performance.

• Visual Studio

How open a new project in visual studio code?
1. Ensure that you have installed Python into Visual Studio Code before doing this.
2. Using the keyboard shortcut Ctrl+Shift+P (Command+Shift+P on a Mac), you may access the command palette and see a list of the available commands.
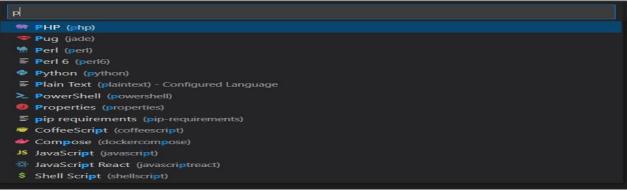

Fig.16 Visual Studio PHP

3. Select the command 'python: New Project'.
4. Enter the name of the new project:
5. Select a folder to create the project in.
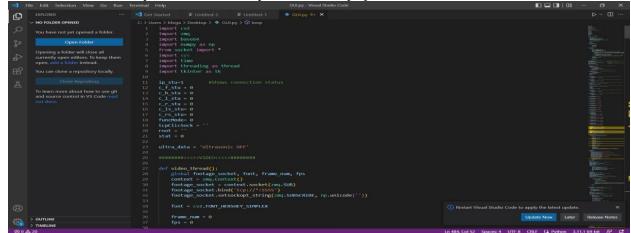6. The editor will take a couple of minutes to setup the files in the project
3. Select the command 'python: New Project'.
4. Enter the name of the new project:
5. Select a folder to create the project in.
6. The editor will take a couple of minutes to setup the files in the project

Fig.17 Visual studio code

37

Fig.18: Main window

When a member of staff opens the Application main window, the IP of the microcontroller is entered, and the IP is valid. The video stream will be activated, and he will be able to monitor the robot. If the IP address is invalid, it will return to the valid IP address.

VII- VEHICLE MOTION • MOTION OVERVIEW

It employs an ultrasonic sensor mounted on a servo to detect objects in front of and on either side of the car, as well as an L293D DC motor driver shield to power four geared motors, one on each wheel. An Arduino-Uno underneath the motor driver controls the motor shield, ultrasonic sensor and the servo.

Fig.19: diagram of the vehicle motion process

Because all four wheels are driven, we can drive two on one side of the car forward and two on the other side backwards in order to turn the car, so we don't need a steering mechanism and the car can turn based on RFID or ultrasonic.

Fig.20 the direction of motion

The L293D is a Motor Driver IC that allows a DC motor to be driven in either direction. The L293D is a 16-pin integrated circuit that can control two DC motors in any direction at the same time. It means that a single L293D IC can control two DC motors. The main application is for controlling the four motors. It is critical to understand how the ultrasonic sensor works because it will play a critical role in detecting obstacles.

The basic principle underlying ultrasonic sensor operation is to record the time it takes the sensor to transmit ultrasonic beams and receive ultrasonic beams after they hit the surface. The main use is for the rotation of the ultrasonic sensor with 3 different angles Also; Gear motor x 4 & Robot wheels x 4 which is required for the movement of the robot.
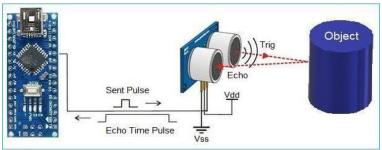

Fig.21: Ultrasonic sensor motion

VIII- CONCLUSION

The use of Interactive Surveillance Patrol Robot Vehicles (ISPRVs) has become increasingly popular in recent years due to the advances in robotics technology. These vehicles are designed to monitor and patrol areas that are difficult or dangerous for human security personnel to access, such as industrial plants, military installations, and public events. One of the main benefits of ISPRVs is their ability to provide real-time surveillance and intelligence gathering capabilities. They can be equipped with a variety of sensors, including cameras, microphones, and environmental sensors, which allow them to detect and report on potential threats and hazards. This information can then be relayed back to a control center where human operators can make informed decisions about how to respond. ISPRVs are also more cost-effective than traditional security measures, as they require fewer human resources and can operate 24/7 without the need for breaks or downtime. Additionally, they can be programmed to perform a variety of tasks, such as patrolling a perimeter, escorting personnel, and even responding to emergencies. However, there are also some potential drawbacks to the use of ISPRVs. One concern is the potential for these vehicles to malfunction or be hacked, which could compromise the security of the area they are monitoring. Additionally, there are concerns about privacy violations, as these vehicles are capable of collecting and storing large amounts of data about individuals and their activities. In conclusion, while there are certainly benefits to the use of Interactive Surveillance Patrol Robot Vehicles, it is important to carefully consider the potential risks and drawbacks before implementing them in any security or surveillance system. Effective security requires a balance between technological innovation and respect for individual privacy and safety.

REFERENCES

[1] N. Dalal and B. Triggs "Histograms of oriented Gradient for human detection" in proceeding of the 2005 IEEE computer society conference on computer vision and pattern recognition (CVPR'05), vol. 1, pp. 886– 893, San Diego, CA, USA, June 2005.

[2] Proudfoot, J.G.; Jenkins, J.L.; Burgoon, J.K.; Nunamaker, J.F. "Deception is in the eye of the communicator: Investigating pupil diameter variations in automated deception detection interviews". In Proceedings of the IEEE International Conference on Intelligence & Security Informatics, Baltimore, MD, USA, 27–29; pp. 97–102.May 2015

[3] Ramon Pallas-Areny and John G. Websterm,"Sensors and Signal Conditioning", 2003.

[4] Sergey Yurish ,"Smart Sensors and MEMS",Proceedings of the NATO Adavanced Study Institute, 2003

[5] Munzer S.Y. Ebaid a,⇑, Hasan Qandil b,1, Mahmoud Hammadb, "A unified approach for designing a photovoltaic solar system for the underground water pumping well-34 at Disi aquifer", Elsevier Energy Conversion and Management,Volume 75, Pages 780-795, November 2013

[6] John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC Press; 1st edition, 1998

[7] Rik DeGunther, "Solar Power Your Home For Dummies", 2nd edition, 2010

[8] Deutsche Gesellschaft für Sonnenenergie (DGS), "Planning and Installing Solar PV Systems: A Guide for Installers, Architects and Engineers" , Routledge; 3rd edition, 2013

[9] Chetan Singh Solanki "Solar Photovoltaics: Fundamentals, Technologies and Applications", Prentice Hall; 3rd edition, 2015

[10] Arno Smets, Klaus Jäger, and René van Swaaij,"Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems",UIT Cambridge Ltd., 2016

[11] Jacob Fraden , "Handbook of Modern Sensors Physics, Designs, and Applications" Fifth Edition.Springer; 5th ed, 2015

[12] Modern Tkinter for Busy Python Developers: Quickly learn to create great looking user interfaces for Windows, Mac and Linux using.

[13] Reiner Korthauer,"Lithium-Ion Batteries: Basics and Applications", Springer, 2018

[14] Robert A. Huggins,"Advanced Batteries: Materials Science Aspects", Springer, 2009

[15] H.J. Bergveld, W.S. Kruijt, P.H.L Notten,"Battery Management Systems: Design by Modelling", Springer; edition, 2005