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AN INNOVATIVE METHOD FOR WIRELESS ROBOT SURVEILLANCE USING LIVE VIDEO AND AUTOMATION FOR HUMAN MONITORING AND CONTROL

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ABSTRACT
In this work, the software architecture for an Android-powered Smartphone and an Arduino Uno microcontroller-based four-wheeled surveillance robot is suggested. The security robot's camera is positioned above the robot and records and transmits footage to a mobile device. A person may control a robot's movement using a camera and a CPU. The live broadcast from the robot's camera allows the user to keep an eye on and track of events. For frequently monitoring private or academic organisations, this design may be extremely helpful. This study recommends an automated monitoring system as a consequence, which lessens the need for direct human monitoring**.**
Keywords *:* video surveillance, Arduino IDE software, NRF module, L298 motor drive, joystick shield

1. INTRODUCTION

By placing employees close to sensitive areas, it is possible to conduct human surveillance while continually monitoring for changes. However, given the limits of people, deployment in hostile environments is not always practical. Additional risks include losing men in the event that the enemy is found. However, robots can be employed to remotely monitor crucial areas in place of people. The requirement to include cutting-edge technology has motivated research into different embedded based system solutions. The surveillance robot was built using an embedded platform and an ATmega328P CPU. It accurately and continually detects dangers that may be presented by surveillance robots and establishes a place among them. The robot's surroundings are continually monitored by an AV camera, which provides visual data to the control station. In various areas there is a need of constant surveillance. The current surveillance system includes monitoring by using CCTV cameras and other monitoring system. Mostly these systems are stationary and they can cover a limited area. These systems are mostly control manually or through a computer. They cannot be used to cover a larger area as well as they cannot be controlled using any mobile device.

In this paper, we developed a sustainable surveillance robot that is cost effective using an Arduino microcontroller Together with a motor shield and an Android smart phone that runs the Operating System. The robot consists of a video camera and WiFi robot link. Smart phones come with superb hardware that satisfies the above needs. This can be leveraged upon through the use of APIs (Application Programming Interfaces) that is provided for the operating system. However, the building cost for the robot with a smartphone is greatly reduced. The robot can be remotely controlled using the wifi module and a microcontroller, smart phone interface embedded on the robot. The camera on the robot is used to capture and record real time video from the robot. The robot can be controlled based on visual feedback from the same smart phone. The four wheeled dc motors help to navigate the robot and ultrasonic sensor to avoid obstacles. The camera is attached to the wifi robot link which enables it to capture the environment or any object of concern. Experimental results with varied positions of obstacle show the flexibility of the robot to avoid it and have shown a decent performance and it is getting a communication range of nearly 50m, which is good enough for many surveillance applications. Surveillance is the process of monitoring a situation, an area or a

person. This generally occurs in a military scenario where surveillance of borderlines and enemy territory is essential to a country's safety. However, building a small robot for testing and research purposes proves to be extremely expensive. Primarily because a security robot would require certain components such as motor drive, Nrf24l01, Arduino Uno Satellite communication makes it possible to communicate seamlessly with the robots and obtain real-time audiovisual feedback. Thus, in recent times, surveillance technology has become an area of great research interest. Apart from the obvious advantage of not having to risk any personnel, terrestrial and aerial robots can also pick up details that are not obvious to humans. By equipping them with high resolution cameras and various sensors, it is possible to obtain information about the specific area remotely.

This project is aimed at developing a surveillance system which can be controlled remotely by using an Android App. It includes a robot with a Wireless Camera attach to it. This robot captures the high resolution video feed and transmits it to the connected Android device which is used to control the robot. For implementing the modern technology it should be known by all the users to make use of it. To reach and to full-fill all these needs we are using android mobile as a multimedia, user friendly device to control the robot.

This idea is the motivation for this project and the main theme of the project. In this modern environment everybody uses smart phones which are a part of their day-to-day life. They use all their daily uses like newspaper reading, daily updates, social networking, and all the apps like home automation control, vehicle security, human body anatomy, health maintenance, etc has been designed in the form of applications which can be easily installed in their hand held smart phones.

2. ARDUINO UNO ANALYSIS

The Arduino Uno is a ATmega328P micro controller based board [10]. It has 14-pin digital input / output (from which 6 can be used as PWM outputs), 6 analog inputs, a ceramic resonator 16 MHz, a USB connection, a power jack, ICSP header, and a reset button. It contains everything needed to support the micro controller; so that we can simply connect it to a computer with a USB cable or power or battery AC-DC to start. 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, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. The software used for writing, compiling & uploading code to Arduino boards is called Arduino IDE (Integrated Development Environment), which is free to download from Arduino Official Site. Arduino UNO supports 3 types of communication protocols, used for interfacing with third-party peripherals, named: Serial Protocol, I2C Protocol, SPI Protocol. The main reasons for choosing Arduino UNO are:

1. Our requirement for PWM pins to control stepper motor
2. Works on low power as well as further modifications are possible.
3. Sufficient number of I/O pins.
4. Small size which can be easily assembled and work on open source
5. It also has 6 analog pins starting from A0 to A5
6. It comes with a crystal oscillator of 16MHz, which is its operating frequency
7 Arduino UNO has a maximum current rating of 40mA, so the load shouldn't exceed this current rating or you may harm the board

Programming Arduino

Once arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code

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by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking Arduino programs are written in the Arduino Integrated Development Environment (IDE). Arduino IDE is special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino boards.

A circuit diagram of the motor driver circuit

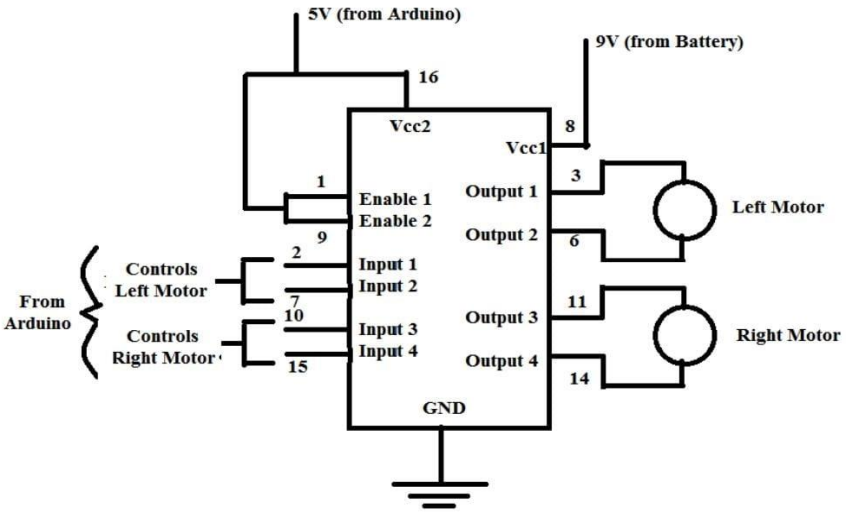

Fig.1. Motor Driver Circuit

L298 MOTOR DRIVE

L293D H-bridge driver is the most commonly used driver for Bidirectional motor driving applications. This L293D IC allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Because it has two H-Bridge Circuit inside .The L293D can drive small and quiet big motors as well. There are various ways of making an H-bridge motor control circuit such as using transistors, relays, and using L293D/L298. Before going into detail, first we will see what H-Bridge circuit is if you are planning on assembling your new robot friend; you will eventually want to learn about controlling DC motors. One of the easiest and inexpensive ways to control DC motors is to interface L298N Motor Driver with Arduino. It can control both speed and spinning direction of two dc motors .At the heart of the module is the big, black chip with chunky heat sink is an L298N.The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot platforms.

L298N Motor Driver Module Pin out

The L298N Motor Driver module consists of an L298 IC Dual H-bridge, 5V 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper. L298N Motor Driver Module Pin out Before diving into hookup and example code, let's first take a look at its PinoutL298N motor driver IC has many applications in the embedded field, especially on the robotics side. Most of the microcontrollers operate on very low voltage (5v)

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and current while the motors require higher voltages and current so, the microcontrollers cannot provide them such higher current. For this purpose, we use motor driver ICs.

VCC Pin

Supplies power to the motor. Voltage anywhere between 5 to 35V can be applied. Remember, if the 5V-EN jumper is in place, you need to supply 2 extra volts than the motor's actual voltage requirement, in order to run the motor at its maximum speed.GND is the common ground pin.5V pin supplies power to the switching logic circuitry inside the L298N IC. If the 5V-EN jumper is in place, this pin acts as output and can be used to power up the Arduino. If the 5V-EN jumper is removed.

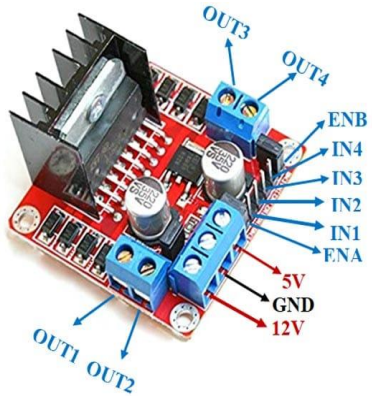

Fig 2.Motor Driver Module

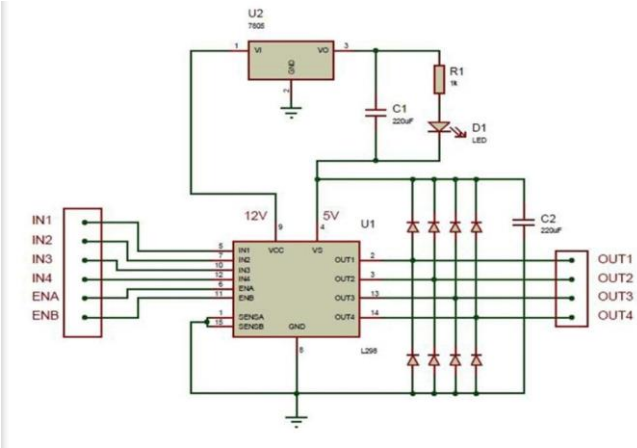

Fig.3. Motor Driver Circuit Diagram

Circuit Connection of L29N with Arduino Uno

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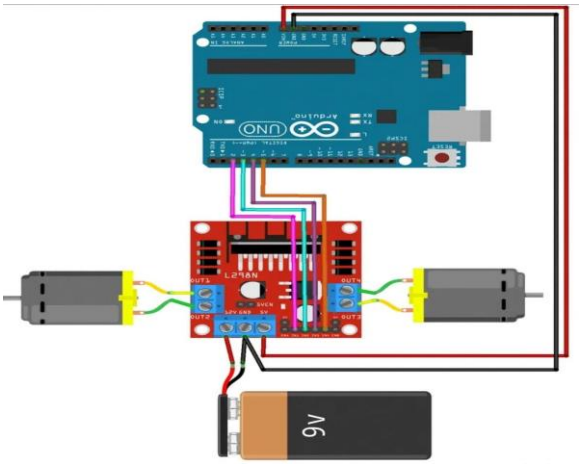

Fig.4. Circuit Connection of L29N with Arduino Uno

3. PROPOSED SYSTEM

NRF24L01 TRANSCEIVER

The nRF24L01 is a single chip RF Transceiver IC developed by Nordic Semiconductor. It operates in the License-free 2.4GHz ISM band (ISM – Industrial, Scientific and Medical) with support for data rates of 250kbps, 1Mbps and 2Mbps.For data rates of 250kbps and 1Mbps, the channel bandwidth is approximately 1MHz. So, taking the minimum and maximum operating frequencies of 2400MHz and 2525MHz, you can implement a maximum of 126 RF Channels if your data rate is limited to 250kbps or 1Mbps.NRF24L01 is a wireless transceiver module (works on SPI Protocol), which is used for sending and receiving data at an operating radio frequency of 2.4 to 2.5 GHz ISM band. This transceiver module consists of a frequency generator, shock burst mode controller, power amplifier, crystal oscillator modulator, and demodulator. When transmitting power is zero dBm it uses only 11.3 mA of current, while during receiving mode, it uses 13.5 mA of current. This module is designed for long distance and fast transmission of data. It is designed to work through an SPI protocol. Air data transmission rate of NRF24L01 is around 2 Mbps.Its high air data rate combined with power saving mode makes it very favourable for ultra-low power applications. Its internal voltage regulator controls a high power supply rejection ratio and power supply range. This module has a compact size, and can easily be used in confined spaces. This module is designed to operate at 3.3 volts. This module has an address range of 125 and it can communicate with six other modules. By using this feature, we can use it in mesh networks and other networking

Power Consumption

The operating voltage of the module is from 1.9 to 3.6V, but the good news is that the logic pins are 5-volt tolerant, so we can easily connect it to an Arduino or any 5V logic microcontroller without using any logic level converter.The module supports programmable output power viz. 0 dBm, -6 dBm, -12 dBm or -18 dBm and consumes unbelievably around 12 mA during transmission at 0 dBm, which is even lower than a single LED. And best of all, it consumes 26 µA in standby mode and 900 mA at power down mode. That's why they're the go-to wireless device for low-power applications.

Radio Frequency

- The nRF24L01+ transceiver module is designed to operate in 2.4 GHz worldwide ISM frequency band and uses
- GFSK modulation for data transmission. The data transfer rate can be one of 250kbps, 1Mbps and

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2Mbps.The

- operating voltage of this module is from 1.9 to 3.6V but the other pins are 5V tolerant which means that the other
- Pins can be directly connected to the Arduino. The nFR24L01 is a transceiver module which means that it can both
- Send and receive the data.These modules are very cheap, smaller in size and have a lot of specifications. Some of the
- Specifications of these modules are as follows each channel occupies a bandwidth of less than 1MHz. This gives us
- It has 125 possible channels with 1MHz spacing. So, the module can use 125 different channels which give a possibility to have a network of 125 independently working modems in one place.

NRF24L01 with Arduino Uno

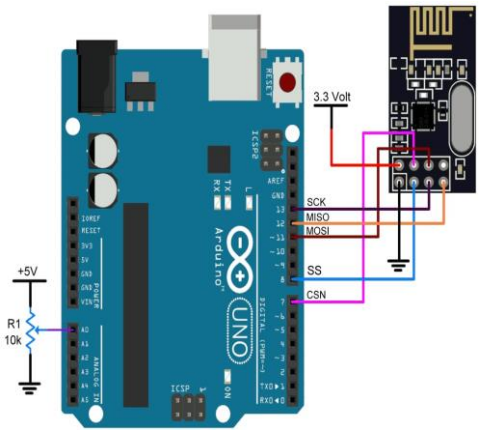

Fig.5. NRF24L01 with Arduino Uno

NRF24L01 PIN DIAGRAM

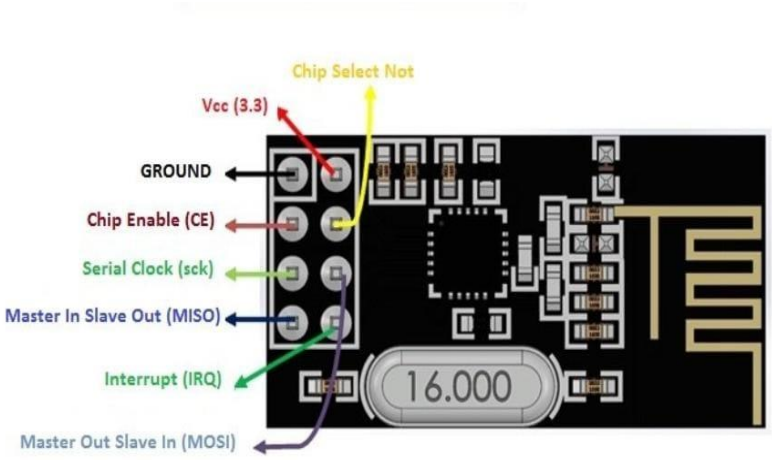

Fig.6. NRF24l01 Pin Diagram

One of the drawbacks of the NRF24L01 series is that they do not offer the full-duplex communication as SX1278 therefore it is not favorable in conditions where bi-directional communication is preferred. The

operating voltage of this module is from 1.9 to 3.6V but the other pins are 5V tolerant which means that the other pins can be directly connected to the Arduino. The nRF24L01+ transceiver module transmits and receives data on a certain frequency called Channel. Also in order for two or more transceiver modules to communicate with each other, they need to be on the same channel. This channel could be any frequency in the 2.4 GHz ISM band or to be more precise, it could be between 2.400 to 2.525 GHz (2400 to 2525 MHz).Each channels occupies a bandwidth of less than 1MHz. This gives us 125 possible channels with 1MHz spacing. So, the module can use 125 different channels which give a possibility to have a network of 125 independently working modems in one place. The nRF24L01+ transceiver module is designed to operate in 2.4 GHz worldwide ISM frequency band and uses GFSK modulation for data transmission. The data transfer rate can be one of 250kbps, 1Mbps and 2Mbps. The second version comes with a SMA connector and a duck-antenna but that's not the real difference. The real difference is that it comes with a special RFX2401C chip which integrates the PA, LNA, and transmit receive switching circuitry. This range extender chip along with a duck-antenna helps the module achieve a significantly larger transmission range about 1000m.

Joy Stick Shield

The Joystick Shield enables your Arduino with a joystick the shield sits on top of your Arduino and turns it into a simple controller. Five momentary push buttons (4+ joystick select button) and a two-axis thumb joystick gives your Arduino functionality on the level of old Nintendo controllers.This shield is a great piece of user interface board, it is perfect for gaming and navigating through menu quickly. It has headers for LCDs and RF modules, to communicating and displays easily.

Fig.7. Joystick Shield

Power setting and joystick

The shield has a slide switch that allows you to select whether you are using it with a 5V board like an Arduino Uno or a 3.3V MCU like the Arduino Due. Be sure to set it to the correct voltage for the board you are using. The X-axis potentiometer of the dual-axis joystick is connected to A0. The Y-axis potentiometer is connected to A1. The analog inputs on a microcontroller read values over a range of 0-1023 (for typical 10-bit ADC inputs). The X-axis and Y-axis controls should read somewhere around 512 (midpoint) when the control is at rest. As the joystick is moved, one or both of the controls will register higher or lower values depending on how the control is being moved. The joystick also has a button 'K' which is activated by pressing the joystick down. This button is connected to inputD8.This shield gives your Arduino the functionality found on the old Nintendo controllers. The joystick can be used for controlling outputs such as a melody or pixels on a screen. The buttons can be used for navigation or game control

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Buttons and used inputs

There are a total of 6 buttons on the board (not including the one on the joystick) labeled A-F. The four large (blue/yellow) buttons are typically used for up/down/left/right or similar functions. The two smaller smd buttons are typically used for less commonly used functions such as 'select' or 'start' since they are less accessible and thus less likely to be pressed accidentally. All buttons have pull-up resistors and pull to ground when pressed.

Button A – Connects to D2
Button B – Connects to D3
Button C – Connects to D4
Button D – Connects to D5
Button E – Connects to D6
Button F – Connects to D7
Joystick button K - Connects to D8

The remote control

By equipping the joystick shield with an nRF24L01+ PA/LNA transceiver module, and some fiddling around with the available configuration options from the software, I managed to make a reliable handheld transmitter relatively quickly. As you can see in the picture (and in the video), I have not yet bothered to make a nice casing for it.The power is supplied with a 9V battery in a compartment with an on / off switch. This is attached to the bottom of the print with Velcro. I have made a small support block to give the transceiver module some physical support from the USB terminal. For an nRF24L01+ module without the antenna this may be an unnecessary overkill.

Bluetooth Connector

The RX/TX lines are brought out to a separate 4-pin female header along with 3.3V and Ground. This can be used for connecting a 4-pin 3.3V Bluetooth device or a TTL serial device.

I2C Connector

The I2C SDA and SCL lines are brought out to a separate 4-pin male header along with 5V and Ground. This is in addition to the normal A4/A5 location of these lines. This allows for easy attachment of I2C Devices.

Interface Connector

This dual row yellow male header connector provides another point of access to all the buttons, joystick pots, 3.3V, 5V and Ground. The pin-out of this connector is labeled on the board to the left of the connector.

Steps

- Attach your joy stick shield to the Arduino board.
- Connect your arduino board to your PC.
- The LED will light on your joystick shield, showing that it's working properly.
- Write the sketch and compile it before uploading to your board; it's good practice to compile your sketch before uploading.
- Move joystick in different directions and you will notice that the values on serial monitor will change.
- You can move the joystick in 8 directions: up, right-up, right, right-down, down, down-left, left, left-up. If the values change on your serial monitor, your shield is working properly.

SERVO MOTOR

Servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft; this feedback allows the

servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.

Servo Motor Working Principle

Fig.8. Servo motor

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

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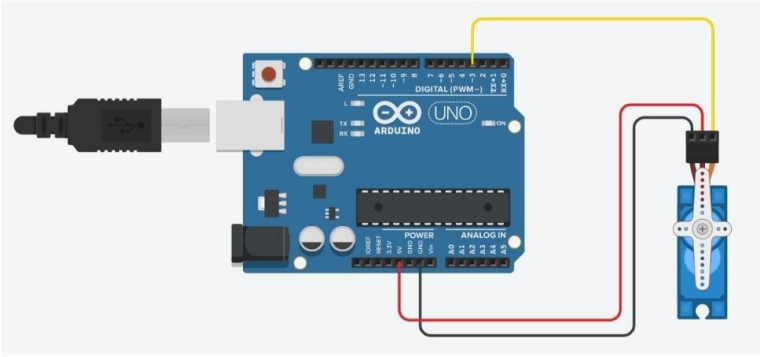

Fig.9. Servo motor connected with Arduino Uno

Controlling Servo Motor

All motors have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn.

Pan tilt camera

Pan-Tilt Mount provides a **340° rotation and 60° tilt** that upgrades the standard 130° field of view on Stick up Cam Plug-In to a complete view of your surroundings. Scan the room from corner to corner so you can check on loved ones or see where pets are scampering around. Create your own default position to easily reorient your device.Pan-tilt-zoom (PTZ) is a name given to a type of IP camera where the user can control

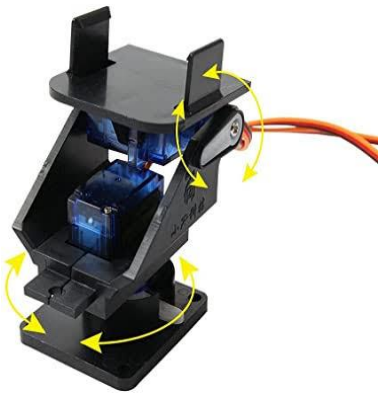

Fig.10. Pan tilt camera

The movement and position of the lens from a remote location using controls on an Internet browser or software application.PTZ Cameras are commonly used in applications such as surveillance, video conferencing, live production, lecture capture and distance learningPTZ is an abbreviation for pan, tilt and zoom and reflects the movement options of the camera. Other types of cameras are PTZ or virtual pan-tilt-zoom (VPTZ) where a high-resolution camera digitally zooms and pans into portions of the image, with no

physical camera movement. Ultra-low bandwidth surveillance streaming technologies use VPTZ to stream user-defined areas in higher quality without increasing overall bandwidth usage.

Camera Wi-Fi module

The dual motor-head design enables the camera to rotate and capture a full 360° horizontal view and 96° vertical view. The camera's shockproof design and quiet motor allow the rotation to remain smooth and silent

Fig.11. Camera Wi-Fi module

Keeping an eye on your home is more vital now than it has ever been. From break-ins to burglary to mail larceny, knowing your home is being watched can provide a great deal of peace of mind. Wi-Fi camera is a tempting choice for your new security system when it comes to home protection. Wi-Fi camera gives convenience without sacrificing all of the typical functions of a traditional security camera.WiFi module, also known as serial to WIFI module, which belongs to the transmission layer of IOT. The function is to convert serial port or TTL level into embedded module which can conform to Wi-Fi wireless network communication standard, with built-in wireless network protocol IEEE802.

CONCLUSION

This research presented a concept for the hardware and software of a four-wheeled video surveillance robot. The hardware implementation of this concept will enable the reduction of human involvement and time constraints. The android application may provide both a hardware and a software output by enabling remote control of the security robot. Hardware includes the robot, which is propelled by DC motors.

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