Asian Journal of Applied Science and Technology (AJAST)
Volume 1, Issue 5, Pages 17-21, June 2017


# Patrolling System using Unmanned Ground Vehicle for War Field and Border Security

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*Article Received: 12 May 2017* *Article Accepted: 01 June 2017* *Article Published: 04 June 2017*

ABSTRACT

The subject of unmanned patrolling vehicles (both air and ground) has been extensively researched upon over the past decade. These vehicles are integrated with space, civil, commercial and military applications such as ground surveillance, reconnaissance, target acquisition, autonomous tour guides, search and rescue mission, NASA's Mars Explorations Rovers SPIRIT and OPPPORTUNITY etc. The conventional border patrol systems suffer from intensive human involvement and are not adequate to be used in extreme climatic conditions. This paper discusses the navigation, guidance and control system of an Unmanned Ground Vehicle (UGV). The goal of this system is to develop autonomous robots for routine patrolling with the available technology to make such autonomous automatic system technically feasible.

**Keywords:** DTMF, RFID identification, PIR sensors, ultrasonic rangefinder, UGV, UMPV, reed switch and MQ5.

## 1. INTRODUCTION

Unmanned Patrolling Vehicle (UMPV) is specifically designed to be used in war field and for border security. Such autonomous vehicle determines its own course using onboard sensor and processing resources; the name supervisory control is often given to the myriad of control schemes which combine inputs from both an external human operator and onboard sensors to determine the path. That is, such vehicles are employed with several sensors to monitor the surrounding environments and using this information it makes its own autonomous decisions or passes the information to a human operator present at a far away location who will suitably control the vehicle through tele-operation. The main aim behind this work is to design a robotic vehicle that will help our soldiers to monitor the border areas especially in extreme weather conditions where it is onerous for the soldiers to survive, it also help to replace humans from perilous situations like handling explosives and in bomb disabling vehicles where small size is needed or where humans cannot easily go. Such vehicles can also be used to monitor war field to determine the presence of any harmful gases, magnetic fields etc. [1].

## 2. EXISTING SYSTEM

The quest into the field of robotics began several decades ago. People since then were really fascinated with the very idea and the development of the robots. As the time progressed there has been a huge advancement in the field of robotics. In Dec 2003,"Mobile Autonomous Robot Software" research program was started by the Pentagon in an attempt to develop more advanced military robots. Since 2005, the US army has been working on an experimental robotic weapons system famously known as Autonomous Rotorcraft Sniper System. It consists of a remotely operated sniper rifle attached to an unmanned autonomous helicopter. Recently the US Defence Department has already begun work on a bullet called EXACTO with fins that adjust its trajectory in mid-air. US Mechatronics has produced a working automated sentry gun (A **sentry gun** is a gun that is automatically aimed and fired at targets that are detected by sensors) and is currently developing it further for commercial and military use.

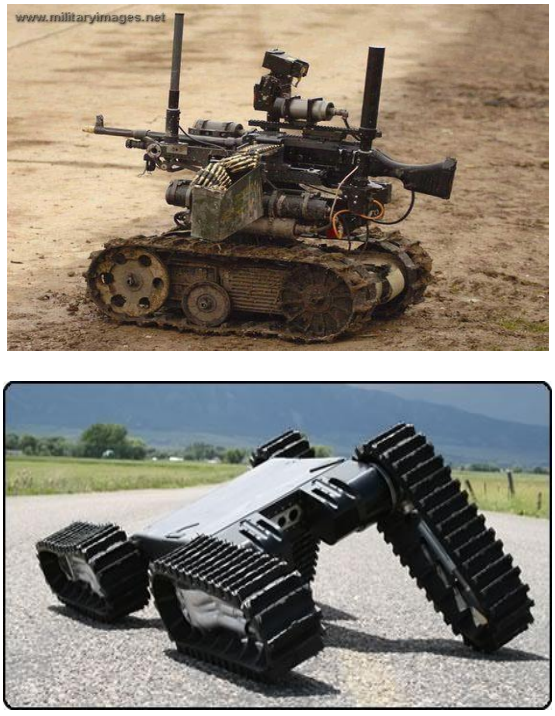


Fig.1. Existing system of UMPV

***Drawbacks***

- ❖ The initial cost for development is very high.
- ❖ Any circuit failure results in great loss to man, material and machinery.

## 3. PROPOSED SYSTEM

In our work, the unmanned patrolling vehicle is designed in such a way that it can be controlled wirelessly from the

 

control room using DTMF (dual tone multi-frequency signaling) of mobile phones. The robot is fitted with a PIR sensor to find the human presence in border areas. Once the presence of human is detected it checks if the human detected is our soldier or not. To do so, a unique RFID (radio frequency identification) tag is provided to our soldiers that will help to identify our soldiers and enemies in border area.

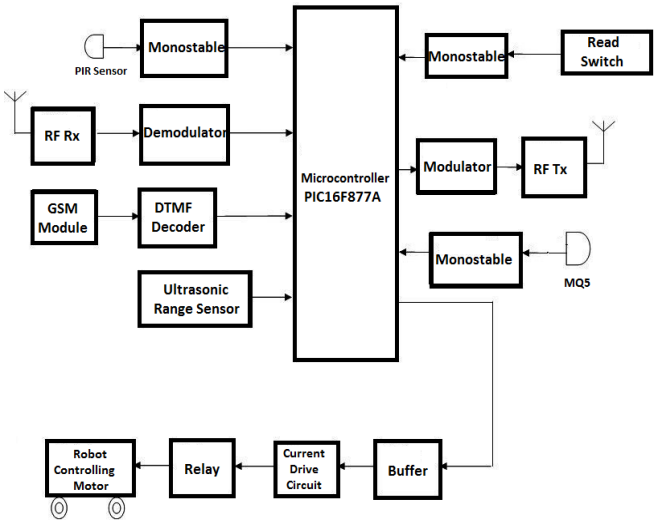


Fig.2. Block diagram of UMPV

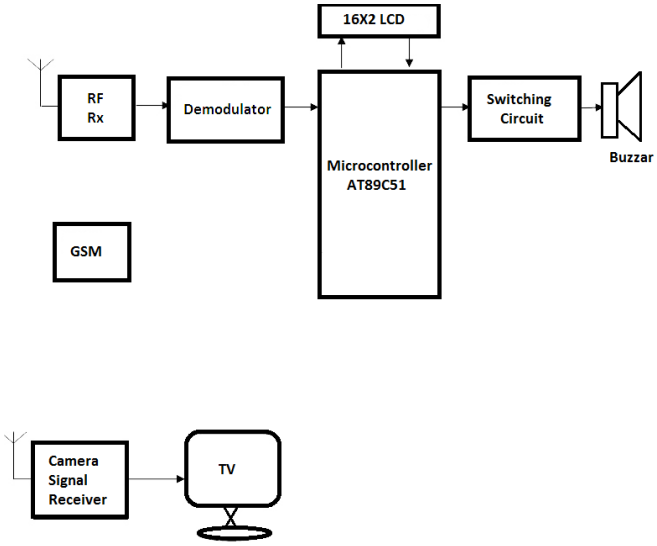


Fig.3. Block diagram at controlling station.

The robot is fitted with a RFID reader to detect the RFID tag. When the robot detects any human presence, it will check for the RF ID tag to identify whether the person detected is our soldier or an enemy and accordingly the information is sent to the control station. The distance of the detected obstacle is determined using the range finder. The robot is also embedded with a wireless camera which will capture the live video and transmit it to the control station. With the help of this camera we can capture the image and track the movement of the enemy in border area. The poisonous gases and the presence of magnetic field in the border areas are also checked using suitable sensors

## 4. DESCRIPTION

### *4.1 RFID TAGS AND RECEIVERS*

As Radio Frequency Identification (RFID) is suitable for various applications in different fields, it has become pre-eminent part of our daily lives. Currently, there is a wide range of RFID applications available in the contactless chip market for various fields such as aviation, healthcare, shipping, library system, product security, supply chain. An RFID system typically includes three parts: RFID tag, RFID reader and database. While the tag keeps information about an item, the reader can write and read the tag data recorded in a database [2]. With the recent advancements in RFID technology, active tags are more preferred. On the other hand, as an active tag has a built-in battery, it has a limited lifetime. Thus, effective utilization of energy is crucial for active tags [2].

This RFID uses electromagnetic fields to automatically identify and track tags that are attached to the objects [2]. This RFID tags can be active, passive or battery-assisted passive. In this project, we are providing unique RFID tag for our soldiers that will help to identify our soldiers and enemies in border areas. The robot is fitted with a RFID reader to detect the RFID tag. When the robot detects presence of a human, it checks for the RFID tag to identify whether the person detected is our soldier or an enemy.

RF module (Tx/Rx) is used for making the wireless communication. At a particular frequency and baud rate the radio frequency signals are transmitted using RF module. The signals are tuned at this frequency is only received. This system employs a four-channel encoder/decoder pair. Four switches are used at the transmission end to receive the incoming signals.

This radio frequency (RF) transmission system utilizes Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 434 MHz. The serial input is given to the transmitter module and it is being transmitted via RF. The receiver is kept away from the source that receives the transmitted signals. The system allows one way communication between two nodes, namely, transmission and reception.

The RF module has been used in synchrony with a set of four channel encoder/decoder ICs. The encoder and decoder used are HT12E & HT12D respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs.

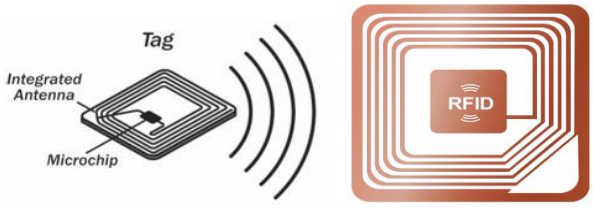


Fig.4. RFID tag containing the integrated antenna and microchip

### *4.2 DTMF (DUAL TONE MULTI FRIQUENCY)*

The movement of the Unmanned patrolling vehicle can be manually controlled using DTMF.In our project we use the

number buttons (2, 4, 6, 8) in mobile phone to control the forward, reverse, left, and right movement of the robot. By using the DTMF technology the analogue signals are converted to digital signals [3]. Each button on the keypad when pressed produces tones of different frequencies. The DTMF decoder basically recognizes the sequences of DTMF tones from the standard keypad of the mobile phone. The internationally accepted frequencies standards that are allocated to the various digits and symbols of a push button keypad are as shown in Fig. 5 [3]. The Power Line Carrier Communication (PLCC) is the most extraordinary element of the telecommunication system. A PLCC works on the principle of varying the line current in proportional to sound. The transducer which converts sound waves to an electrical signal is called a microphone, and the one which does the reverse function is called a speaker/earphone. Signaling is the most critical function of any telecommunication system. The DTMF signals are sparse in the frequency domain [3]. Normally alternating voltages of low value are used for signaling or ringing, as commonly referred. In modern Power Line Carrier Communications, the rotary dial has been replaced by pushbutton matrix dial. These Power Line Carrier Communications use ICs to generate the dc pulses. The pulse dialing is slower and susceptible to noise. To dial a 6-digit number, it takes approximately 10sec. This is very slow as compared to the processing speed of modern electronic exchanges. Besides, it has the following limitations:

The subscriber can signal only up to the exchange, and end to end or subscriber to subscriber signaling is not possible. Only ten codes, i.e. from 0 to 9, are possible. Time required to dial each digit is different [3]. To overcome these limitations, modern telecommunication uses two distinct tones, which correspond to a particular number. This is called the Dual Tone Multi Frequency [DTMF] dialing. The decoded outputs can be suitably used along with certain additional circuitry to design a Call-Line-Identification-Product unit [popularly known as CLIP]. The four-hexadecimal output obtained from the DTMF receiver/decoder IC corresponding to each digit on the FM Communication key-pad together with the associated dual-tone frequencies can be put-it in a table form for easy reference [3].

| **Hi-Group ⟶** <br> **Low-Group ↓** | **1290** | **1336** | **1477** | **1633** |
|---|---|---|---|---|
| **697** | 1 | 2 | 3 | ? |
| **770** | 4 | 5 | 6 | ? |
| **852** | 7 | 8 | 9 | ? |
| **941** | * | 0 | # | ? |

Fig.5. DTMF Matrix Key Pad

### *4.3 ULTRASONIC RANGE FINDER*

A range finder is a device that measures distance from the observer to a target, in a process called ranging [4]. Ultrasonic sensors are employed for measuring the sound waves with frequency above the human audible range [4]. They typically operate by generating at a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse. These range finders operate at best, at an angle of 30 degrees. They have electronic brick compatible interface and operates at 5 V dc supply. They are breadboard friendly and have a dual transducer. Another advantage of the ultrasonic range finder is that it has a ready Arduino library [4].

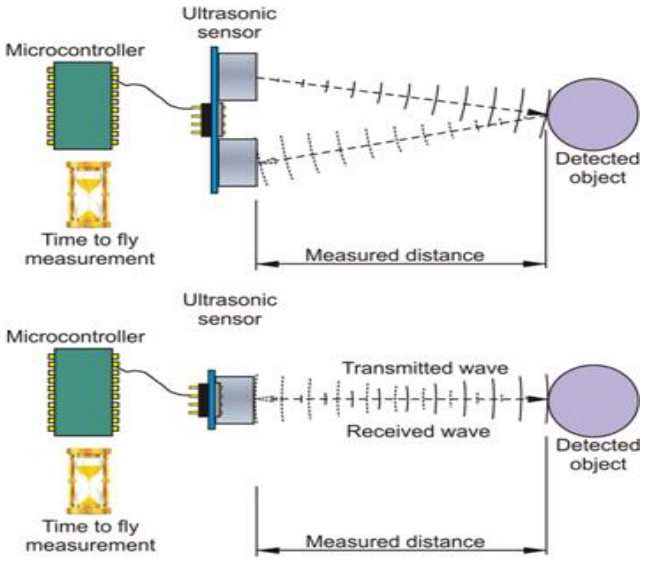


Fig.6. Basic illustration showing how the ultrasonic range finder works

### *4.4 PIR SENSOR*

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view [5]. All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose such as PIR sensors [5].The term *passive* in this instance refers to the fact that PIR devices do not generate or radiate any energy for detection purposes. They work entirely by detecting the energy given off by other objects. PIR sensors don't detect or measure "heat"; instead they detect the infrared radiation emitted or reflected from an object [5].

Therefore, these sensors are used to detect the presence of human beings on the border security areas.

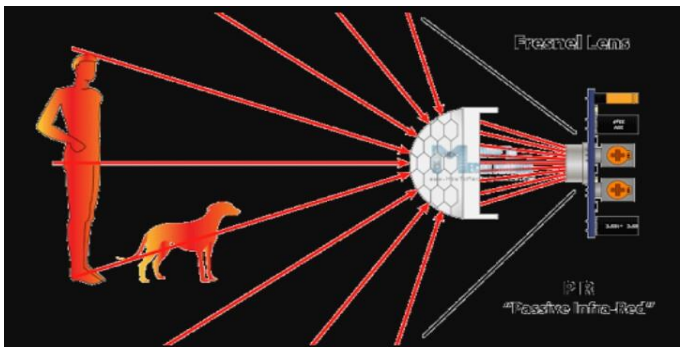


Fig.7. PIR Sensor

### *4.5 REED SWITCH*

The reed switch is an electrical switch operated by an applied magnetic field. It consists of a pair of contacts on ferromagnetic metal reeds in a hermetically sealed glass

envelope. The contacts may be normally open, closing when a magnetic field is present, or normally closed and opening when a magnetic field is applied. Reed switch is used to determine the presence of magnetic field. Reed switches consist of two flexible ferrous metal blades sealed in a glass tube, with a small gap [6] between their tips. When a permanent magnet or a current-carrying coil of wire is brought close by, magnet flux builds up in the contact gap, and once the magnet force attracting the blades together exceeds the spring force tending to pull them apart, the contact gap closes, completing an electric circuit between the two blades [6].

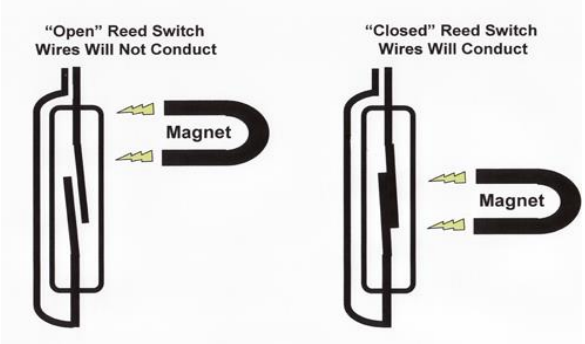


Fig.8. Reed switch sensor operation

### *4.6 MICROCONTROLLER AT89C51*

AT89C51 is an 8-bit microcontroller (ALU). It has 4KB of internal ROM, 128 bytes of internal RAM and zero flash memory. It has 4 Ports, namely Port1, Port2, Port3 and Port4. Each port consists of 8 bits. It contains 32 I/O lines, two 16 bit timers, 1 serial communication port and 5 Interrupts (2 external & 3 internal).

AT89C51 is CISC based and works on Harvard architecture. As compared to 8051 microcontroller it has some additional features such as 4KB internal flash memory, multi time programmable i.e., it can be reprogrammed up to 1000 times and EEPROM. All other features, pin configuration and architecture are same as 8051.

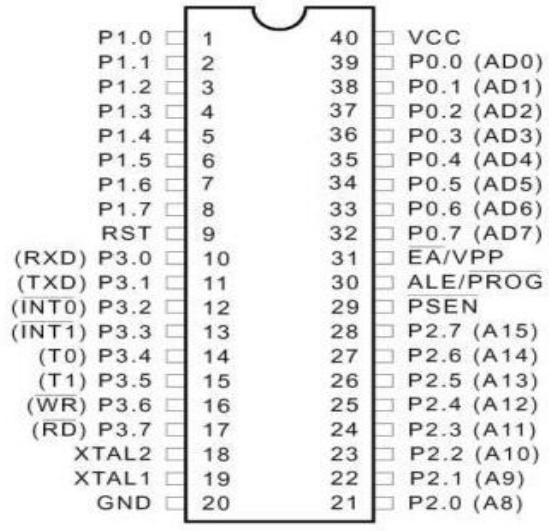


Fig.9. Pin details of AT89C51

***Pins 1 – 8*:** It is recognized as Port 1. Different from other ports, this port doesn't provide any other purpose. Port 1 is a domestically pulled up, quasi bi directional Input/output port.

***Pin 9*:** As made clear previously RESET pin is utilized to set the micro-controller 8051 to its primary values, whereas the micro-controller is functioning or at the early beginning of application. The RESET pin has to be set elevated for two machine rotations.

***Pins 10 – 17*:** It is recognized as Port 3. This port also supplies a number of other functions such as timer input, interrupts, serial communication indicators TxD & RxD, control indicators for outside memory interfacing WR & RD, etc. This is a domestic pull up port with quasi bi directional port within.

***Pins 18 and 19*:** These are employed for interfacing an outer crystal to give system clock.

***Pin 20*:** Titled as Vss– it symbolizes ground (0 V) association.

***Pins- 21-28*:** It is recognized as Port 2 (P 2.0 – P 2.7) – other than serving as input/output port, senior order address bus indicators are multiplexed with this quasi bi directional port.

### *4.7 MICROCONTROLLER PIC16F877A*

It is a powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC architecture into a 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices.

The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions. The synchronous serial port can be configured as either 3-wire Serial Peripheral Interface or the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

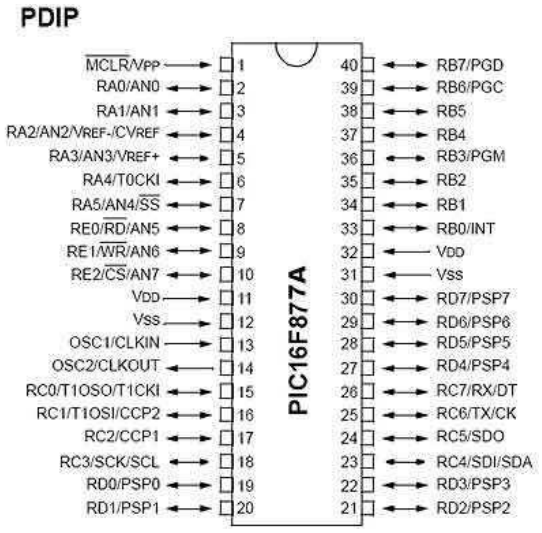


Fig.10. Pin details of PC16F877A

### *4.8 MQ5 SENSOR*

The Gas Sensor (MQ5) is useful for detection of leakage gases (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. The technical features of MQ5 are wide detecting scope, stability, long life, fast response and high sensitivity.


Fig.11. MQ5 Sensor

### *4.9 WIRELESS CAMERA*

In our work the wireless cameras are used for capturing the image of the surrounding environment and to track the movement of the enemy in border area.

A smart camera or intelligent camera is a vision system which, in addition to image capture circuitry, is capable of extracting application-specific information from the captured images, along with generating event descriptions or making decisions that are used in an intelligent and automated system [7,8]. A smart camera is a self-contained, standalone vision system with built-in image sensor in the housing of an industrial video camera. It contains all necessary communication interfaces, e.g. ethernet, as well as industry-proof 24 V I/O lines for connection to a PLC, actuators, relays or pneumatic valves [7]. It is not necessarily larger than an industrial or surveillance camera. A capability in machine vision generally means a degree of development such that these capabilities are ready for use on individual applications. This architecture has the advantage of a more compact volume compared to PC-based vision systems and often achieves lower cost, at the expense of a somewhat simpler (or omitted) user interface [7].

Fig.12. A sample of wireless camera

## 5. RESULT

The proposed system is cheaper, reliable and has good efficiency. It has several future scoops and has several advantages over the older methods used for the same purpose.

## 6. CONCLUSION

UMPV has transformed the idea of the land power in the modern war times. They are less expensive, and they don't put the army at risk during the war field. The enter the atmosphere that is dangerous to human life. They require less fuel for its operation, low maintenance and can be operated for much longer duration with good efficiency.

## 7. FUTURE SCOPE

With advancement in technology more smart vehicles can be built with more reliable and promising features.

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