

# Design and Implementation of an Unmanned Ground Vehicle for Fumigation Purpose

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**Abstract-** This paper focuses on the design and implementation of an unmanned ground vehicle (UGV) for fumigation purpose. An Arduino Uno board, four DC motors, one servo motor, sprayer and Bluetooth module were used for the successful testing of the system. The Arduino Uno board with an on board ATmega328P microcontroller was used to serve as the entire brain of the system which holds the C code that controls the robot car movements, the spraying and the rotation of the sprayer. The Bluetooth module was used to establish a wireless control of the vehicle, the spraying and sprayer tank rotation. Consequently, with this kind of system presented in this paper, the fumigation or spray of pesticide, insecticide on agricultural farmlands and hostile animals' like snakes can be done easily by sending the vehicle to do the spray without any human spraying, thereby reducing the dangers of human exposure to pesticides during spraying. The system prototype designed was tested under different case scenarios to verify its reliability.

**Index term-** Arduino Uno, Bluetooth module, DC motors, Servo Motor, Sprayer, UGV

## 1.0 INTRODUCTION

Globally, unmanned ground vehicles (UGV) have played a very vital role in replacing humans in hazardous scenarios like insurgence control, hostage situation, law enforcement, border patrol, surveillance, security service, etc [1].

An Unmanned Ground Vehicle (UGV) is a vehicle operating in contact with the ground, carrying equipment or materials and supplies, without human presence on board. [2]. UGVs have been used extensively for space exploration- exploring planets like Mars and Saturn [3]. Similarly, regarding dangers of human exposure to pesticides; UGVs can be used to replace humans in pesticide

application as the World Health Organization reports that greatest exposure to highly hazardous pesticides is for agricultural and public health workers during handling, dilution, mixing and application. Exposure is mainly through the preparation of sprays and by inhalation during application. Humans might be exposed to the sprayed pesticides dermally and via inhalation [4]. Consequently, the aim of the system presented in this paper is to design and implement an unmanned ground vehicle (UGV) for fumigation purpose in order to reduce human direct exposure to pesticides or insecticides during spraying, thereby saving the human from fatigue, brain disorder, blood disorders, skin irritations, nausea, vomiting, breathing problems, cancer, and death [5]

## 2.0 PROPOSED SYSTEM

Figure 1 shows the entire proposed system block diagram where the Arduino Uno board with an onboard ATmega328P microcontroller stores the C code that controls the vehicle, the sprayer movement and the spraying. The four DC motors move the vehicle forward, backward, left and right, the servo motor rotates the sprayer tank in clock and anti-clock wise direction, the Arduino Uno Motor shield serves as the DC motors driver board, the Bluetooth module establishes a wireless communication between the android phone application and the Arduino Uno board thereby making the unmanned control of the vehicle possible. The sprayer motor driver circuit drives the motor that pushes the sprayer heads down for the spraying purpose using the TIP 122 high current NPN transistor.

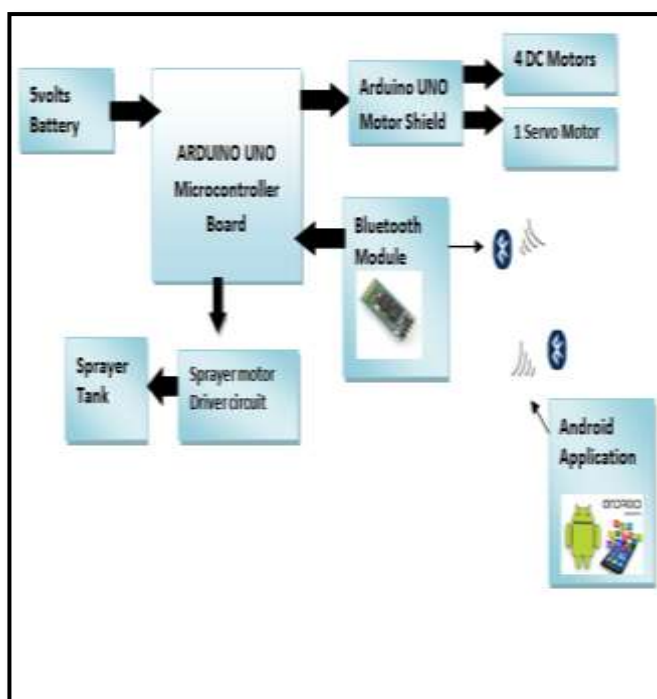


Figure1 Proposed System

### 2.1. Main Controller

The main control section was built with the Arduino Uno board. The Uno is a microcontroller board based on the Atmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. [6] The Arduino Uno board with an on board Atmega328P microcontroller stores the C code that controls the vehicle, the sprayer movement and the spraying.



Figure 2 Arduino Uno

### 2.2. Arduino Motor Shield

The shield contains two L293D motor drivers and one 74HC595 shift register. The shift register expands 3 pins of the Arduino to 8 pins to control the direction for the motor drivers. The output enable of the L293D is directly connected to PWM outputs of the Arduino. The shield controls the four DC motors and the servo motor used for controlling the robot car and the sprayer rotation respectively. [7]



Figure 3 Arduino Uno Motor Shield.

### 2.3 HC-06 Bluetooth

This module permits any microcontroller with a standard RS232 serial port to communicate with a PC or a Smartphone equipped with a Bluetooth Master module. Its main specifications are: Bluetooth number: JY-MCU-HC-06, surface mounts with integrated antenna. Operating Voltage: 5 volt, reduced to 3.3 volts, @ 8 mA. Default baud rate: 9600 bps. Default pin: 1234 Default name: BlueBolt. Class: 2, with up to 10 meter coverage.

The Bluetooth HC-06 module in this project is used to provide the wireless communication between the unmanned vehicle and the Android Phone App. [8]



Figure 4 HC-06 Bluetooth Module

### 3.0 SYSTEM FLOWCHART

The flowchart of the system is shown in Figure 5, which represent the sequential events of the entire system. From the diagram, the program starts by initializing the ports and the UART. Subsequently, the code enter the loop and wait until a character 'A', 'B' or 'C' is received by the microcontroller UART through the android phone app and compared with the stored character. Whenever the received character is the same with the stored character in the Microcontroller ROM, the microcontroller moves the vehicle to forward, backward, left and right etc. For instance, when 'A' is received from the android phone app, the Arduino microcontroller moves the car forward, when 'F' is received, the microcontroller rotates the sprayer clockwise, when 'G' is received, the microcontrollersprays the pesticide etc.

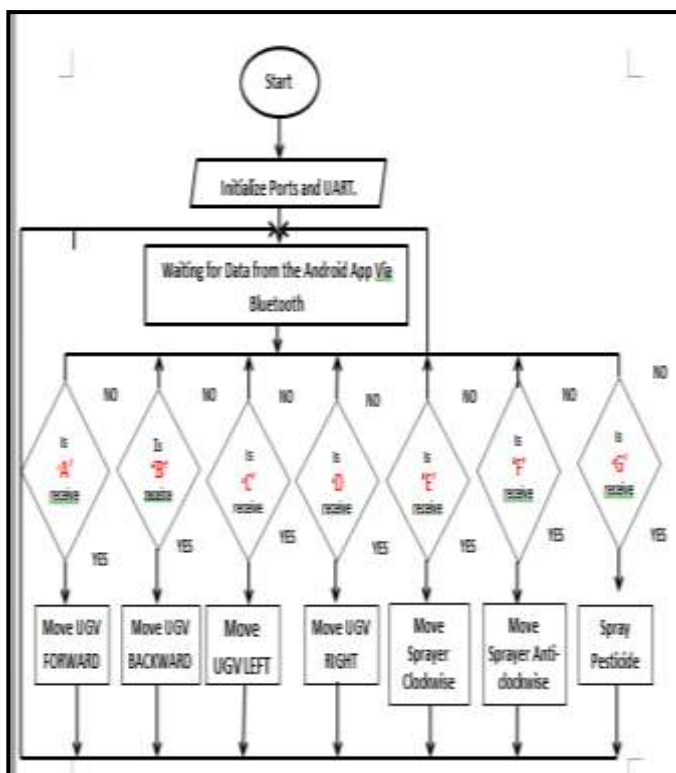


Figure 5 System flowchart

### 4.0 RESULTS

The performance of the unmanned ground vehicle for fumigation purpose hardwareprototype wastested during thereal time test. It was found that the system was perfectly working on both smooth and rough surface. The dynamic stability of the four wheel robot carrying the fumigating tank was maintained.The system could receive command remotely via Bluetooth from up to radius of 8 metres coverage. The sprayer is capable of spraying chemicals up to 2 meters radius. The battery system can work for 4 hours without recharging. The entire body of the system is 20x20x35cm which enables the system to enter almost every corner without any obstruction.



Figure 6 Various Test Stages of the System

## 5.0 CONCLUSION AND FUTURE RECOMMENDATION

### 5.0 Conclusion

This paper presents a technical overview on the implementation of an unmanned ground vehicle for fumigation purpose. A prototype was designed for easy demonstration of the system and it has been concluded that with this kind of system designed, fumigation of pesticides and dangerous chemicals can be done with less human direct exposure during spraying, thereby saving the human from fatigue, brain disorder, blood disorders, skin irritations, nausea, vomiting, breathing problems, cancer, and death

### 5.1 Future Recommendation

For future works, some recommendations have been listed in order to improve the performance.

#### Use of Xbee module for wireless communication

Using xbee module for long range wireless communication, range of up to 1.6km can be achieved.

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