

# Design and Development of Solar Based Android Controlled Pesticide Dispenser

P Bhargavi, M Madhusudan Reddy

**Abstract**— Pesticide dispensing systems in agriculture are becoming technology-driven due to the human health hazards involved in spraying toxic chemicals. Conventional pesticide dispensing systems are operated by humans in the agricultural fields. In this paper, we present design and development of solar based android controlled pesticide dispensing robot. The design of the system includes three parts: design of solar charging system, android pesticide spraying system and pesticide flow control system. Shortage of non renewable fuel is an upcoming global issue, so renewable solar energy has replaced non renewable energy. Solar charge circuit is designed to charge the system. This pesticide dispensing robot in android controlled mode is controlled using remote buttons on android app. We use Bluetooth as communication media to interface controller to the android. Pesticide flow quantity is controlled through android mobile while the robot is moving in the path defined by the user. The proposed pesticide dispensing system efficiently covers the plants evenly with spray in set dosage using the concept of PWM.

**Index Terms**— Autonomous system, Flow control system, Pesticide dispensing robot, PWM, Solar charge circuit.

## I. INTRODUCTION

In the recent years, environmental issues are prominently increasing with rapid economic and social development. One such issue in agriculture is pesticide spraying. Chemical pesticide spraying is the most powerful process in agricultural fields and greenhouse to protect the plants from the pests. In conventional pesticide dispensing method many human health hazards are involved in spraying potentially toxic chemicals by humans in the agricultural fields and greenhouses. An engineering solution to this problem is by the design and development of a mobile robot for pest control and human health hazard prevention [1]-[3].

Robots are taking functions of humans where repeatability and precision in routine tasks are needed and where humans are exposed to dangers. Mobile robots have become part of the precision agriculture, here they aim to optimize and manage issues involved in the pesticide spraying. Recent advances in embedded control systems allowed the

development of a cooperative mobile robot with optimized pesticide spraying systems on it, which reduces the human effort and protect the humans from health hazards [4].

The main application of mobile robots in the commercial sector has been concerned with the substitution of humans by robots or mechanised systems to make the work more efficient, accurate, uniform and less costly [3]-[5]. The existing pesticide dispensing robots [1]-[6], presented several efficient robot automation techniques and pesticide dispensing techniques. However, these systems can be applied to a large scale, the pesticide quantity is not controlled and robot control was not so efficient.

To overcome the drawbacks of existing system, we propose an efficient system for dispensing pesticides in agricultural fields and greenhouses with advanced features included. One of the advanced features is android controlled mode. Internet of things is a new technology system and it is an important part of modern service industry. Internet of things connects the smart phone of android system with service oriented robot by wireless communication [7]-[8].

Spraying control and Robot guidance are the key technology of pesticide spraying work. Considering the bumpy and floppy roads in agricultural field, four wheel driving is usually adopted for the robot to improve loading and driving capacity. The rpm of motor plays a vital role in controlling the motion of the robot. Based on the system speed and the vehicle balancing capacity the rpm of the motors will be selected.

The proposed pesticide dispensing system performs two control operations: Robot Direction Control and Flow Control. In android control system the system is controlled with mobile device like smart phone or a tablet that runs Android operating system, which contains Bluetooth module [7]-[10]. Recently many new spraying methods such as variable rate spray with on-line mixing pesticide are used in the field of agriculture [12]-[13]. In the proposed system the user is provided with an option to control the robot direction and flow quantity of pesticide spraying system. This variable flow quantity of pesticide is achieved by the concept of Pulse Width Modulation.

Power supply plays a vital role in an embedded system. Batteries are used to provide power to the system. But, the batteries when depleted cannot be recharged, thus affecting the performance of the system [16]. To overcome this, the

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rechargeable solar powered robotic systems are introduced in the proposed pesticide dispensing system.

In this project, we design and develop a solarised android controlled/autonomous pesticide dispensing system. Solar rechargeable battery is used to power up the system. The battery is charged by the energy coming from the solar panel through solar charging system. The proposed system is effectively and efficiently designed for dispensing pesticide in an agricultural field. This system performs two operations: Vehicle Motion Control and Pesticide Flow Control. To make the system more efficient, user is provided with pesticide flow control feature.

## II. BLOCK DIAGRAM OF PROPOSED SYSTEM

Figure 1 shows the block diagram of solarised android controlled/autonomous pesticide dispenser. Control unit consists of a microcontroller. Micro controller process the data from the bluetooth module and mode & quantity selection switches. The dc motors used in the robot and the sprinkler motor in the spraying system are controlled based on the data processed by the controller.

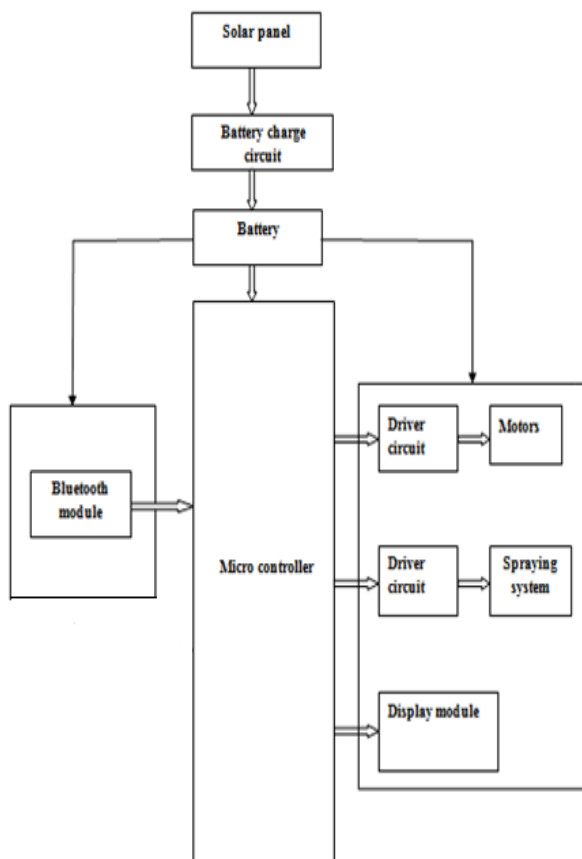


Fig.1. Block diagram of solarised android controlled/autonomous pesticide dispenser

The solar charge system comprises of solar panel, controller, battery charging system and battery. Solar panel tracks the solar energy and generates the electrical energy based on tracked solar energy. Battery charging system charges battery when the charge tracked by the solar panel is more than the battery voltage.

The mobile robot has to be built before it is to be controlled while the Bluetooth module has to be included in the project. Robotic parts for the model included structure (for example car chassis), the controller, Bluetooth module, electric motors, motor driver, sprinkler motor, water tanker, IR sensor and other parts like batteries, power cables, wheels, etc.

In the proposed system can be operated through android mobile. In android mode the android mobile phone uses Bluetooth as a communication media to operate the robotic system. The user sends the commands from the android mobile app. The Bluetooth module connected to the control unit receives commands from the mobile phone. The control unit will process those commands and operate the motors of the robot and the sprinkler motor through driving circuits.

The user can perform two control operations on the system, Robot Motion Control and Pesticide Flow Control. User control the robot motion in four directions: front, back, left and right. The pesticide flow quantity can be set by the user by controlling the speed of the sprinkler motor in the sprinkler system. The sprinkler motor speed is controlled by using the concept of PWM. The control unit process those commands and drives the dc motors that control the movement of the robotic system and the sprinkler motor that control the quantity of pesticide.

Display module is provided in the system to act as an interface between the user and the system. The control unit keeps on monitoring the system and control module will send commands to the display module to display the status of the system.

## III. CONTROL STRATEGIES

The user interfaces will have control over the microcontroller and feedbacks the robot status to the microcontroller. The controller reads the status information and controls the robot movements and the spraying system. The system is powered through rechargeable battery. This battery is charged with the help of solar energy. Solar panel contains photo voltaic cells that tracks solar energy and converts it into electrical energy. The control unit in the battery charge circuit monitors the battery voltage and the voltage from the panel. The battery charge circuit charges the battery only when voltage from the panel is more than the battery voltage. This circuit drives the load only when the battery has sufficient charge in it.

TABLE I  
DIRECTION OF MOTORS

Direction \ Motor	Forward	Backward	Left	Right
Right Motor	Anti Clockwise	Clockwise	Clockwise	Anti Clockwise
Left Motor	Anti Clockwise	Clockwise	Anti Clockwise	Clockwise

In order to achieve the better driving performance of the robot we should choose the motors that can handle system weight. To handle more weight the motors should have low RPM. But if RPM is low the speed of robot will be less. So we should select motor which can handle the system weight as well as which provides good speed.

The spraying system is controlled by the controller based on the user commands. The user can select the flow quantity of the pesticide. Based on this information from the user interfaces the sprinkler motor is operated. The variation in the quantity of pesticide is achieved by varying the speed of the sprinkler motor. Concept of PWM is used to vary the sprinkler motor. PWM signals with different duty cycles are given to the controller to drive the sprinkler motor with different speeds.

TABLE II  
SPRINKLER MOTOR SPEED TO GET VARIABLE PESTICIDE QUANTITIES

Quantity PWM \ Signal	Low	Moderate	High
Duty Cycle	30%	50%	80%

The PWM signals with same frequency with different duty cycles are given to the sprinkler motor based on the user commands. The experimental results of the PWM signals that are given sprinkler motor in order to achieve three different quantities is shown in figure 2.

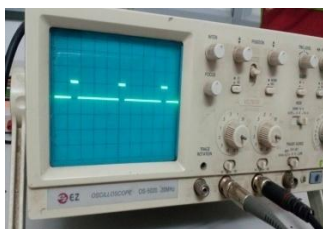


Fig a: PWM for low quantity



Fig b: PWM for Medium quantity



Fig c: PWM for high quantity

Fig.2. PWM signal for pesticide quantity control

#### IV. CONTROL ALGORITHM

All the inputs and outputs of the system are controlled by the on-board microcontrollers in the system. The software running in the controller is embedded C. Embedded C is a set of language extensions for the C programming language. Extra functions and libraries that are related to the specific controller have been added to the original C language.

Figure 3 shows the control program structure of the android controlled spraying system. In program structure user is need to connect the system with the android mobile through Bluetooth. After pairing the Bluetooth module of the android mobile with the Bluetooth module of the system, the android system control the robot motion and the sprinkler motor to dispense the pesticide in the field are controlled through the commands from the mobile using Bluetooth as a communication media. Controller receives commands from mobile and controls the vehicle motion and the sprinkler motor. User can control the vehicle motion in 4 directions: Forward, Backward, Left and Right. The direction of robot motion is controlled by changing the direction of the motors of the robotic system.

User can select the quantity of pesticide. The pesticide quantity can be Low, Medium or High. This variation in the pesticide dispensing quantity is achieved by controlling the speed of the sprinkler motor. The speed of the sprinkler motor is controlled by varying the duty cycle of the PWM signal given to the sprinkler motor.

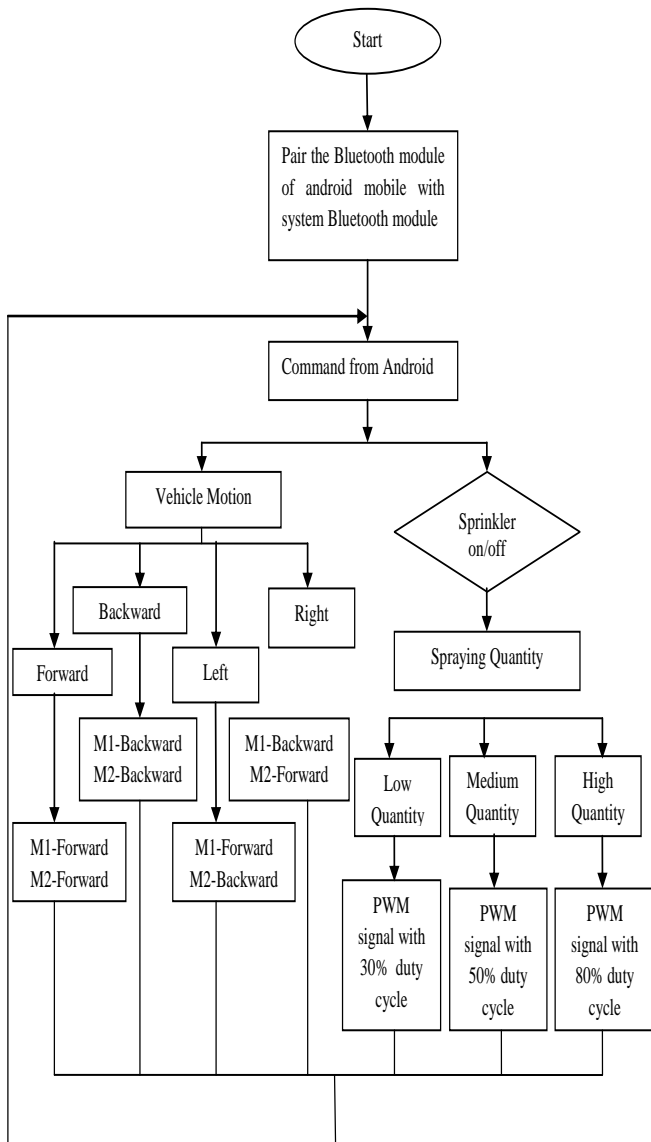


Fig.3.Control Program Structure

## V. CONCLUSION

This paper presents design and the development of the android controlled/autonomous pesticide spraying system with many advantages like safety, low cost, user friendly. This system is provide with features such as solar powered system, works in two operating modes: android and autonomous, pesticide quantity control. Thus the proposed system can be much helpful in the agricultural fields and green houses. This system reduces the work of humans as well as protects them from the dangerous health hazards.

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