Design and Implementation of Solar Powered Automatic Pesticide Sprayer for Agriculture

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Abstract—An automatic pesticide mixing and water level control of irrigation system powered by solar, using PLC and nrf24l01 module is focussed. The proposed system consist of pesticide mixer which automatically mixes the pesticide and water in particular ratio and the mixer is automatically sprayed to the field on the programmed date with the help of PLC. This system will also be useful in monitoring the soil moisture condition and level of the water in the field via moisture sensors and ultrasonic sensor which is connected in the transmitter side of the RF module. The system proposes a soil moisture sensor and ultrasonic sensor at each place in the field where the moisture content of the soil and water level in the field has to be monitored which is powered by solar. When moisture content in the soil is low or water level in the field is below certain level, the transmitter RF sends a signal to the receiver RF and accordingly the motor is turned ON/OFF with the help of PLC.

Keywords—PLC, nrf2L01 module, Moisture sensor, Ultrasonic sensor, Pesticide mixer, solar

1. INTRODUCTION

In today’s world, agriculture and technology are the backbone of economy. Agriculture plays an important role in the economic development of the developing countries. Technology guides the economic prosperity of the developed countries. Agriculture should yield double the current food production by 2050 as the global population is expected to reach 9.6 billion people.

Climate change will have a huge impact on agriculture which includes extreme weather conditions, intense storms and heat waves, floods, whilst water shortages in certain parts of the world could become critical.

Agricultural progress not only feeds the increasing population but also provides raw materials to industries and back the development of other sectors. Hence industrial and agricultural developments complement and not contradict each other to achieve food security.

The challenges faced by today’s agricultural sector can be overcome by adopting automation techniques in the field. This project consists of an automatic pesticide mixer, and uses PLC and sensors at different field locations for water management. These sensors are interfaced to the PLC via RF module and control actions are taken by switching the motor ON/OFF depending upon the farm conditions.

2. NEED OF AUTOMATIC PESTICIDE MIXER

In general, pesticides are used in the agriculture field to deal with pests. In recent years, there is a significant increase in the usage of pesticides. There are several benefits to the use of pesticides, such as increased yield, increased profits for farmers and the prevention of diseases. Pesticide is applied to field by use of conventional type mechanical and hydraulic sprayers. Hydraulic sprayers consist of a tank, a pump, a lance, a nozzle. The sprayers convert a pesticide formulation, which consists of
mixture of water and pesticide into tiny droplets. This conversion is accomplished by forcing the spray mixture into spray nozzle under pressure.

According to type of crops, pesticide spraying can be classified as pre-emergent and post emergent pesticide spraying. But, all these conventional type of pesticide spraying has many issues. Even though protection equipment like head masks are used while spraying pesticide into field, humans are still exposed to harmful chemical which leads to serious health issues.

Besides health issues, manual spraying has other drawbacks. Manual spraying is a tedious work and it cannot be done efficiently always. The use of Automatic pesticide mixer overcome all the above issues and provides an efficient and a healthy way for spraying the pesticide mixer into the field.

3. NEED FOR WATER LEVEL CONTROLLED IRRIGATION SYSTEM

Generally, the water level of the crops are monitored manually by the farmers. This method may have possibilities for inaccuracy. It is absolutely essential to monitor the water level throughout the crop cultivation. There are difficulties in monitoring the water level when done manually. The major setbacks in manually operating the water level are that it causes inconvenience, wastage of water and electricity and stress for farmers.

The other difficulties are long distance travel during odd hours, excess water causing loss of fertilizer, electric shocks and soil erosion.

Hence automation in water level monitoring helps to overcome the above problems

4. PROPOSED SYSTEM INTRODUCTION

The proposed system consists of an Automatic pesticide mixer which automatically mixes the water and pesticide in the required ratio and sprays the mixer automatically into field on the programmed date and time. The date and time on which pesticide mixture needs to be sprayed is programmed in the PLC. In addition to this application this system also controls the water level in the field for the crop development. The water level in the field needs to be maintained throughout the crop growth. The moisture sensor and the ultrasonic sensor monitors the water level during sowing and planting sessions, respectively. The water levels required in these two stages are different. PLC which is programmed with the required water levels at these two stages ensures that the field is not left with excess water or water deficient conditions. When the field contains less water than the required level, the water pump is turned ON with the help of the PLC. When the water level is more than the required level, the water pump is turned OFF.
5. BLOCK DIAGRAM

A. Transmitting Module 1

Fig. 1: Block Diagram of Transmitting module 1

B. Transmitting Module 2

Fig. 2: Block Diagram of Transmitting module 2
C. Control Panel

Fig 3: Block Diagram of Control panel

6. FLOW CHART

Fig.4: Flow chart for Automatic pesticide control
7. WORKING

There are two stages of irrigation process:

A. The nursery or primary stage

The nursery stage or the primary stage is where the seeds are sowed. At this stage the soil should have just enough moisture content in it. To monitor the moisture content in the soil, the moisture sensor is used. When the seeds are sowed the moisture sensor senses the moisture content in the soil and sends the signal to the plc. Now there are two possibilities here

- When there is enough moisture content in the soil, the output of the moisture is sent to the plc which is in the control panel through RF module such that the water pump remains turned OFF.
- When there is less moisture content than the expected level, the output of the moisture is sent to the plc which is in the control panel through RF module such that the water pump remains turned ON.

B. The secondary or post transplanting stage

It is in this stage where the crops are transplanted in the field. This stage requires more water than in the previous stage. Ultrasonic sensor is employed for this stage. After transplanting the ultrasonic sensor senses the water level in the field and sends the signal to the plc. Once again there are two possibilities here

- When the water level in the field attains the expected water level as programmed the motor is turned OFF with the help of plc. The signal is transmitted from ultrasonic sensor to the plc through RF module.
- When the water level is less than the expected water level as programmed the motor is turned ON with the help of plc. The signal is transmitted from ultrasonic sensor to the plc through RF module.
The data of water levels for different crops at different stages is given below:

**Table 1: Water level requirement for different crops at different stages**

| S.NO | CROP               | STAGES OF GROWTH                  | DURATION | WATER LEVEL |
|------|--------------------|-----------------------------------|----------|-------------|
| 1    | Paddy field        | Nursery                           | 30 days  | 4cm         |
|      |                    | Main field preparation            | 1 day    | 20cm        |
|      |                    | Planting                          | 2 days   | 45.8cm      |
|      |                    | Flowering & Weeding               | 2 days once (for 90 days) | 41.7cm |
|      |                    | Matured crops prior to harvest    | 1 week   | Dry         |
| 2    | Plant field        | Nursery                           | 30 days  | 8cm         |
|      |                    | Main field preparation            | 1 day    | 10cm        |
|      |                    | Flowering and weeding             | 30 – 1 hr everyday | 2cm depth |
| 3    | Tree field         | Nursery                           | 1 year   | 4m depth    |
|      |                    | After growth                      | 10 days once | 4m depth |

**Fig.6: Laboratory set up for Control panel**

The automatic pesticide mixer contains two containers. One container has pesticide solution while the other is filled with water. Each container is connected to the PLC through the solenoid valve. The ratio of pesticide solution and water mixture for different crops is stored in the PLC. Based on this ratio the solenoid valve of two containers is opened and closed. The PLC is programmed with the date and time for the automatic pesticide mixer operation. The PLC has a real time clock which helps the PLC to operate the Automatic pesticide mixer when the programmed date and time arrives.
This proposed system also contains Manual mode. In this mode the water pump can be switched ON and switched OFF manually. The automatic pesticide mixer can also be operated manually i.e., even before the programmed date arrives it can be switched ON in times of emergency.

Fig.7: PLC programming for manual mode

8. BENEFITS OF THESE SYSTEM

This proposed system provides relief to Farmers

- Monitoring the water level regularly is not necessary
- Travelling long distance in the field during odd hours can be avoided
- Risk to life from electric shocks is reduced
- Labour problem can be reduced
- Required water level is maintained
- Reduces pressure for farmers
- Economically beneficial for farmers
- Farmers are saved from hazardous side effects which can be produced by pesticide solution

9. CONCLUSION

The solar powered automatic pesticide mixer replaces the conventional backpack type sprayers. It reduces the manual work load and it also provides efficient way of spraying the pesticide into the field. In addition to this, the project also consists of a smart water level control system. This system allows circulating water in the field whenever required. Thus, the whole system reduces manual intervention into the field and therefore the agricultural development can be easily achieved. The various salient features of this project are, it can be implemented in gardens or nurseries for proper utilization of the available resources and it helps in saving time and energy.

Thus, the project helps to combine technology and agriculture so that, manual operation in the field can be minimized.

In future, monitoring and controlling of the above scheme can be achieved using SCADA. By using SCADA real time monitoring and controlling of the field is possible.
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