Solar Automatic Pesticide Sprayer using Zigbee

S.Kiran¹, R.Madhan Raj², A.Manikandan³, S.N.Khissor Kumar⁴, A.Sridhar⁵
Student¹,²,³,⁴, Assistant Professor⁵
Department of Mechanical Engineering
KSR College of Engineering, KSR Kalvi Nagar Thokkavadi, Tiruchengode, Tamilnadu, India

Abstract:
This is a project which can be viewed as a viable alternate to these methods. The Automatic sprayer is a three wheeled vehicle which sprays pesticide in any given vineyard with almost nil human assistance. The vehicle is powered using an onboard solar powered battery which brings down the running cost. The control of the vehicle is achieved using an inbuilt microcontroller unit which is programmed to respond to the Zigbee wireless device

Keywords: Agro-mechanical Equipment, Autonomous Robot, Pesticide Sprayer, Solar Powered, Remote Controlled Robot, ZIGBEE.

I. INTRODUCTION

Agriculture is a profession of many tedious processes and practices, one of which is spraying of insecticides in the vineyards. Sprayers are mechanical devices that are specifically designed to spray liquids quickly and easily. They come in a number of different varieties. In this project we’ll take a look at solar operated mechanical sprayers. A sprayer of this type is a great way to use solar energy.

II. STORAGE OF SOLAR ENERGY

Solar energy can be stored to utilize at night and when there is a cloudy conditions. Storage is an important issue in the development of solar energy because continuous availability is a vital requirement of modern energy use. Solar energy is only available in the hours of daylight. Solar energy is stored in form of heat or electrical energy. Solar energy is also stored as Mechanical energy in the form of flywheel.

III. WORKING OF SOLAR PANEL

Photovoltaic principles:

The photo-voltaic effect can be observed in nature in a variety of materials that have shown that the best performance in sunlight is the semiconductors as stated above. When photons from the sun are absorbed in a semiconductor, that create free electrons with higher energies than the created there must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work. A junction of materials, which have different electrical properties, provides the electric field in most solar cells for the photon interaction in a semiconductor. A solar cell consists of

(a) Semi-conductor in which electron hole pairs are created by the absorption of incident solar radiation.

(b) Region contacting a drift field for charge separation

(c) Charge collecting fronts and back electrodes.

1.4. ADVANTAGES OF SOLAR ENERGY

- Solar power is low-emission.
- Solar power is suitable for remote areas.
- Solar power provides green jobs.
Solar panels contain no moving parts and thus produce no noise. Wind turbines, by contrast, require noisy gearboxes and blades.

In the long run, solar power is economical. Solar panels and installation involve high initial expenses, but this cost is soon offset by savings on energy bills. Eventually, they may even produce a profit on their use.

Solar power takes advantage of net metering, which is the practice of crediting homeowners for electricity they produce and return to the power grid.

**IV. PREVIOUS WORKS IN THIS FIELD**

Autonomous service robots for orchards and vineyards: 3d simulation environment of multi sensor based navigation and applications Linz, A. Ruckelshausen and E. Wunder (2014),[1] - The authors are working in the fields of unmanned or remote controlled autonomous field robots, navigation, image-based sensors fusion as well as agricultural applications. Within an interdisciplinary research group these technologies are transferred to robot applications in vineyards and orchards. The goal is the availability of an autonomous service robot, whereas first applications are site-specific plant protection (e.g. precise spraying), mulching and picking up fruit boxes. A first version of the robot with electrical drives and precise sprayers has already been developed. The applications, however, show a large range of field conditions which have to be considered for the vehicle application design. Thus the authors have developed a 3D simulation environment which allows the virtual test of the robot platform prior to its application.

**V. EXISTING SYSTEM:**

The solar powered pesticide sprayer in general has to be sprayed manually. In the commonly available ones, the user needs to exert a lot of effort to push the lever up and down to create the pressure to spray. Sometimes when the pressure becomes uneven, the nozzle gets blocked and the farmer has to spend time to rectify it. Also the pesticide is harmful and it also affects the farmers and cultivators due to their presence while spraying in the vineyard. As shown in the figure below the farmer sprays pesticide manually.

**VI. PROPOSED SYSTEM**

The proposed system Automatic Pesticide Sprayer Robot which is expected to achieve better results compared to the previous methods without any nil human assistance. This would be an automatic mechanical model that would work automatically powered by solar energy and reduce drudgery and also protect the farmers and cultivators from harmful pesticides and chemicals.

**VII. METHODOLOGY**

**BLOCK DIAGRAM**

![Figure 3. Block diagram of Transmitter](image)

![Figure 4. Block diagram of Receiver](image)
VIII. REQUIREMENTS

SOLAR PANEL

Solar panel refers to a panel designed to absorb the sun’s rays as a source of energy for generating electricity or heating. A photovoltaic (in short PV) module is a packaged, connected assembly of typically 6×10 solar cells. Solar Photovoltaic panels constitute the solar array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions, and typically ranges from 100 to 365 watts. There are a few solar panels available that are exceeding 19% efficiency.

DC MOTOR (WIPER MOTOR)

The wiper motor is a permanent-magnet direct current (DC) one. It is equipped with the mechanical parts of the worm gear. The worm gear functions to slow down and increase torque. Its output shafts spur four-bar linkage, by which the movement is changed from rotary to swinging. Three-brush structure is adopted to make speed change more convenient. The intermittent relay, by which the interval is controlled, utilizing the return of switch contacts and the charge-discharge function of the resistor-capacitor in the relay, drives the wiper to wipe in a certain cycle.

DC PUMP

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photovoltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern.

ZIGBEE

ZigBee is a low-cost, low-power, wireless mesh network standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications. Low power-usage allows longer life with smaller batteries. Mesh networking provides high reliability and more extensive range. ZigBee chip vendors typically sell integrated radios and microcontrollers with between 60 KB and 256 KB flash memory.

AT89S52 Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The n-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

IX. RESULTS AND DISCUSSION

5.1 FORMULATION AND CALCULATION

5.1.1 POWER CONVERSION EFFICIENCY:

The Solar cell Power Conversion Efficiency can be calculated by using the relation,

\[ \text{Power Conversion efficiency} = \frac{P_{\text{out}}}{P_{\text{in}}} \]

Where, Input Power \( P_{\text{in}} = \text{Incident Solar radiation} \times \text{Area of the Solar Cell in} \]

\[ = I_T \times A \text{ watt} \]

The output power \( P_{\text{out}} = V \times I \)

\[ = 500 \times 10^{-3} \text{ W/cm}^2 \times 20 \text{ cm} \times 13 \text{ cm} \]

\[ = 130 \text{ watt} \]

\[ \therefore P_{\text{out}} = V \times I = 12 \times 7 = 84 \text{ watt} \]

\[ \text{Power Conversion Efficiency} \quad \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{84}{130} = 0.646 \]

\[ = 64.6\% \]

5.1.2 TIME REQUIRED FOR CHARGING

Testing of Charging Time:

Instrument used to measure Sun Radiation=Sun Meter

The Sun Radiation are measured in mW/cm²

Required voltage for charging the Battery=12volt.

Time Measurement:

When the Solar radiation is between 200 to 300 mW/cm² = 3 to 4 hrs.

When the Solar radiation is between 300 to 400 mW/cm² = 2 to 3 hrs.

When the Solar radiation is between 400 to 600 mW/cm² = 1 hour.

We know the Power generated by solar panel= 70 watts.

\[ \therefore \text{Time required for Charging (hrs)} = \frac{\text{Power Generated}}{\text{Power of Solar Panel}} \times \text{Time Measurement} \]

5.1.3 BACKUP TIME OF SPRAYER

Motor- 12V, Current-2.2amp

\[ \text{Backup Sprayer Time} = \frac{\text{Power Stored in Battery} (w - hr)}{\text{Power Consumed} (w)} \]

\[ = \frac{84}{12 \times 2.2} \]

\[ = 3.18 \text{ hrs} \]

*Note-Time varies because of intensity of sun radiations at different days.
5.2 TESTING THE MODEL

5.2.1 SPEED OF VEHICLE

\[ V = \text{Average Speed} = 0.241 \text{m/s} \]

Table 5.1 Speed of vehicle

5.2.2 RATE OF SPRAY

\[ Q = \text{Average flow rate} = 0.556 \text{lpm} \]

Table 5.2 Rate of Spray

5.2.3 OPERATING TIME OF BATTERY

Standard operating time = 100-150 minutes

5.2 RESULTS

1. Average speed of vehicle obtained = 0.241 m/s
2. Average rate of spray = 0.556 lpm
3. Operating time of battery = 100-150 min
4. Average height of spray = 3 m
5. Power efficiency = 64.6%
6. Time required for charging = 3 hrs = 180 min
7. Backup time of sprayer = 3.18 hrs = 191 min

<table>
<thead>
<tr>
<th>QUANTITY (CC)</th>
<th>TIME TAKEN (s)</th>
<th>FLOW RATE (LPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>45.28</td>
<td>0.6625</td>
</tr>
<tr>
<td>250</td>
<td>27.23</td>
<td>0.5508</td>
</tr>
<tr>
<td>125</td>
<td>14.33</td>
<td>0.4417</td>
</tr>
</tbody>
</table>

X. CONCLUSION AND FUTURE SCOPE

This project demonstrates the implementation of robotics and mechatronics in the field of agriculture. This being a test model the robustness of the vehicle is not very high. The performance is satisfactory under laboratory condition. The model gave a fairly good rate of area coverage and the cost of operation as calculated was also reasonably low. In addition the safety and long term health of the farmers is ensured by eliminating human labor completely from this process. It does not compromise the performance of a petrol based pesticide sprayer.

The future scope of this project include –
1. Take up build a full-scale prototype which can be utilized in the fields in real time.
2. Facilitate charging of the battery using a solar charger thus bringing the costs even further down.
3. Battery energy can be saved by using PWM scheme for driving pump.

XI. DEVELOPED MODEL

XII. BIBLIOGRAPHY

[1]. Linz, A. Ruckelshausen and E. Wunder, "autonomous service robots for orchards and vineyards: 3d simulation environment of multi sensor based navigation and applications".


