International Journal of Advanced Multidisciplinary Research and Educational Development
Volume 2, Issue 2 | March – April 2026 | www.ijamred.com
ISSN: 3107-6513

Design and Implementation of An Advanced Solar Powered Sprayer

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Abstract:
By dispersing germicides, diseases, and nutrients, agrarian spraying is essential to crop productivity. Conventional spraying styles use either energy- powered outfit or homemade labour, which leads to high operating costs, health hazards, erratic scattering patterns, and environmental damage. This work presents the design and development of a slice- edge solar- powered sprayer that uses automated detector control and renewable energy sources to overcome these problems.
A photovoltaic solar panel, rechargeable battery, Arduino- grounded regulator, DC pump, and a number of detectors, similar as inflow, temperature- moisture (DHT22), soil humidity, ultrasonic, and current detectors, are all included in the system. The microcontroller analyses real- time data from these detectors and automatically manages the scattering process, icing effective chemical use while reducing mortal involvement. This approach improves energy effectiveness, minimizes chemical destruction, enhances driver safety, and promotes sustainable husbandry styles.

Indicator Terms — Solar Energy, Automatic Sprayer, Arduino, DC Pump, Soil Moisture Sensor, Flow Sensor, Sustainable husbandry, Renewable Energy

I INTRODUCTION

Numerous arising countries are erected on husbandry, especially India, where a sizable section of the crowd makes their living from husbandry. Germicides, diseases, and fungicides must be scattered in order to cover crops and increase yield. Conventional spraying ways, still, have a number of downsides, similar as high labour costs, unstable distribution, inordinate energy use, and significant health pitfalls associated with chemical exposure.

While energy- powered sprayers are more precious and contribute to air pollution, homemade sprayers need constant physical exertion that wears people out. There's critical need foreco-friendly and energy-effective druthers due to rising energy prices and growing environmental enterprises. A clean, sustainable, and readily accessible power source, solar energy is particularly profitable in pastoral areas. When integrated with robotization and intelligent seeing technologies, solar- powered systems can greatly ameliorate effectiveness and trustability. This paper suggests an advanced solar- powered sprayer that combines solar energy, detectors, and microcontroller-grounded robotization to reduce chemical waste, ameliorate safety, and minimize homemade intervention

II PROPOSED METHODOLOGY

A. Solar Power Generation Unit

Solar Power Generation Unit The primary energy source is the solar generation unit. It has a rechargeable battery, a charge regulator, and a photovoltaic (PV) panel. Through the photovoltaic effect, the PV panel transforms sun into electrical power; nonetheless, the affair fluctuates according to temperature, panel exposure, and the intensity of the sun. A charge regulator controls the voltage and current transferred to the battery since the panel affair is unstable. It stabilizes voltage, guards against overcharging, and stops rear current inflow in low sun.

In certain situations, the panel voltage is lowered to a safe charging position using a buck motor. A rechargeable battery (either lithium- ion or lead- acid) stores the energy generated, guaranteeing performing at night or in heavy situations. trustability in field situations is increased since the battery supplies a harmonious power source to all system corridor, including the pump, motor motorist, detectors, and
microcontroller

B. Control Unit (Arduino Microcontroller)

Control Unit (Arduino Microcontroller) The Arduino Uno, the central processing unit of the control system, is its foundation. Detector data is continuously gathered, reused using preprogrammed sense, and also used to control the scattering medium. The Arduino determines whether the pump should run by comparing detector readings with preset threshold situations. The motor motorist that controls the DC pump is turned on or off grounded on these factors.
The control unit's primary duties include:

- To conserve energy, only run the pump when needed.
- Making it possible for scattering to be fully automated without homemade control
- relating anomalous conditions to guard system factors

ISSN: 3107-6513

- Cutting down on chemicals that humans are exposed to Because of its rigidity, low power consumption, and interoperability with a wide range of detectors, Arduino is a good choice for agrarian robotization.

C. Sensor Unit

Sensor Unit To make the system intelligent and automatic, multiple detectors are used:

1) Soil humidity Detector-
   This detector measures the humidity content in the soil. If the soil humidity position is below a predefined threshold, the system initiates scattering. This avoids gratuitous spraying and reduces chemical destruction.
2) Flow Sensor-
   The inflow detector measures the rate of liquid flowing through the pipe. It ensures invariant spraying and helps descry blockages or leakage in the channel.
3) Ultrasonic Sensor-
   The ultrasonic detector detects obstacles in front of the, if a handicap is detected within a certain distance. Spraying is temporarily stopped to avoid chemical loss and ensure safety.
4) DHT22(Temperature and moisture Detector)-
   This detector measures ambient temperature and moisture. Spraying is optimized grounded on rainfall conditions, as high temperature or wind conditions may beget fungicide evaporation or drift.
5) Current Detector-
   The current detector monitors the current drawn by the DC pump. This protects the system from overcurrent conditions and helps in energy operation.

D. Spraying Unit

Spraying Unit, the factual chemical spraying is done by this outfit. It's made up of a spray snoot, motor motorist, and pump powered by a DC motor. Liquid is drawn from the tank by the pump and transferred through the snoot at a regulated pressure.

The high-current motor can be safely controlled thanks to the motor motorist, which serves as an interface between the Arduino and the pump. By conforming the pump's speed and operation duration, precise and harmonious spraying can be achieved with lower trouble and waste.

III DESIGN OF SOLAR PV SYSTEM

A. Electrical Power

$$P = V \times I$$

Where:

- P = Power (W)
- V = Voltage (V)
- I = Current (A)

Solar Panel Efficiency

Efficiency = Output energy / Solar input × 100

Solar panels work best at lower temperatures; efficiency decreases as temperature increases.

Pump Power Requirement

$$P = \frac{\rho g Q H}{\eta}$$

Where:

- ρ = Density of liquid
- g = Acceleration due to gravity
- Q = Flow rate
- H = Total head
- η = Pump efficiency

Flow Rate

$$Q = A \times V$$

Where:

- A = Cross-sectional area
- V = Velocity

Total Pump Head

$$H = H_{stat} + V_h + h_f$$

Where:

- H_{stat} = Static head
- V_h = Velocity head
- h_f = Friction head

BATTERY SELECTION

Battery capacity depends on pump power:

$$I(Ah) = \frac{Power(W)}{Voltage(V)}$$

SOLAR PANEL SELECTION

Panel size depends on:

- Battery capacity
- Available sunlight hours

 ISSN: 3107-6513

Current produced: $I = \frac{\text{Panel Power}}{\text{Battery Voltage}}$

Battery charging time: $T = \frac{Battery\ Capacity}{\text{Charging Current}}$

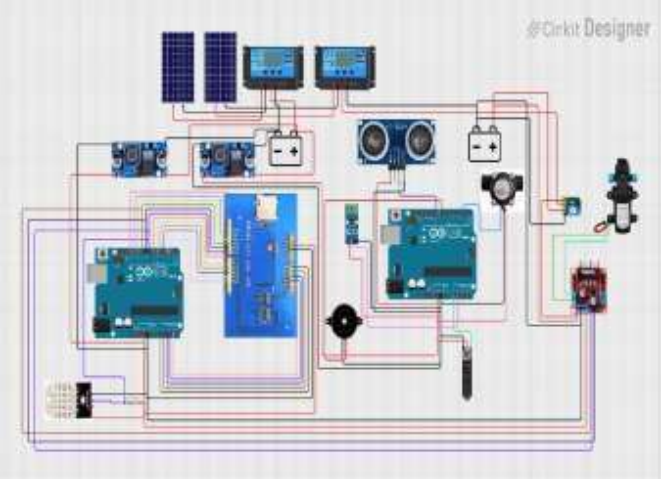

Fig.1.Block Diagram

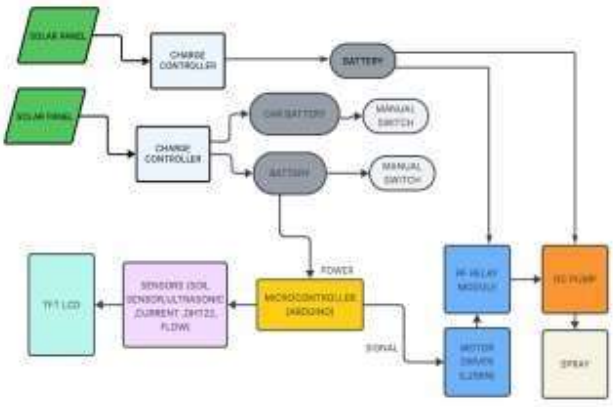

Fig.2.Circuit diagram

IV WORKING

The system operates by integrating solar energy with real- time seeing and automated control in an unrestricted-circle manner. The solar panel converts sun into electricity, which is regulated and stored in the battery. This stored energy powers the Arduino, detectors, motor motorist, and pump, allowing nonstop operation anyhow of sun vacuity.

The Arduino continuously monitors environmental and system parameters similar as soil humidity, temperature, moisture, handicap distance, inflow rate, and current. When humidity is low and conditions are favourable, the pump activates and sprays chemicals slightly.

Spraying stops automatically if:

- Wanted humidity position is reached
- This intelligent control reduces waste, conserves energy, and ensures safe operation.
- Abnormal current is observed
- A handicap is detected

3

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V CONCLUSION

A sustainable and effective answer for contemporary husbandry, the sophisticated solar- powered sprayer uses detector grounded robotization and renewable energy to cut down on energy consumption and physical labour. It improves effectiveness and reduces environmental effect by only scattering chemicals when necessary. trustability is bettered by safety features like current protection, inflow monitoring, and handicap discovery. With the possibility for IoT - enabled remote monitoring and completely independent smart husbandry in the future, this solar - powered device is affordable and perfect for pastoral locales.

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