

**Advanced Technological Institute**

**Colombo 15**



Higher National Diploma in Engineering

Department of Electrical and Electronic Engineering

Project Proposal of

**AUTOMATIC RICE PLANTING ROBOT**  
**BY SOLAR POWER**

Group Members :

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Student Number : COL/EE/2021/F/141

Course : Higher National Diploma in Engineering

## **INTRODUCTION**

Agriculture is one of the most important sectors in developing countries, providing food, employment, and economic stability. Paddy cultivation is a major agricultural activity, but rice planting remains a highly labor-intensive process. Farmers face challenges such as labor shortages, high operational costs, and increasing fuel prices.

To address these issues, this project proposes the development of a Rice Planting Robot Powered by Solar Energy. The system is designed to automatically plant rice seedlings in straight and evenly spaced rows while operating entirely on renewable solar energy.

The robot eliminates the need for fuel-powered machinery and reduces manual effort. It is especially beneficial for small-scale farmers in rural areas where electricity access may be limited. By integrating robotics and renewable energy, this project promotes sustainable and smart agriculture.

## **PROBLEM STATEMENT**

Manual rice planting:

- \* Requires intensive labor
- \* Is time-consuming
- \* Causes uneven spacing of seedlings
- \* Increases overall cultivation cost
- \* Depends heavily on fuel-powered machinery

There is a need for a cost-effective, environmentally friendly, and automated solution that can perform rice planting efficiently without relying on fossil fuels.

## **OBJECTIVES**

- \* To design and build an automatic rice planting robot
- \* To ensure uniform and accurate seedling spacing
- \* To operate the robot entirely using solar energy
- \* To reduce human labor in paddy cultivation
- \* To promote renewable energy usage in agriculture
- \* To develop a cost-effective solution for small-scale farmers

## **SYSTEM OVERVIEW**

The system consists of one main subsystem:

### Solar-Powered Rice Planting Robot

The robot moves across the paddy field using DC geared motors. A servo-based mechanical arm picks rice seedlings from a tray and plants them at regular intervals.

The robot is powered by a rechargeable battery charged through a solar panel and charge controller.

### Key Features

- \* Automated forward movement
- \* Servo-driven seedling planting mechanism
- \* Adjustable planting distance
- \* Straight row planting
- \* Solar-powered battery system
- \* LCD display for system status
- \* Optional Wi-Fi/GPS for navigation

## **TECHNICAL SPECIFICATIONS**

<b>Parameter</b>	<b>Specification</b>
Operating Voltage	12 V DC
Battery Capacity	12 V, 7 Ah
Solar Panel Rating	10 W
Main Controllers	ESP32 + Arduino UNO
Drive Motors	4 × DC geared motors (~3 Nm each)
Planting Actuator	Servo-based mechanical arm

## **METHODOLOGY AND DESIGN**

### 1. Robot Movement

DC motors controlled through motor drivers move the robot forward in the paddy field. Movement can be guided using line-following sensors or manual alignment.

### 2. Seedling Planting Mechanism

A servo motor controls a mechanical arm that:

- \* Picks a seedling
- \* Positions it into the soil
- \* Releases it at a fixed interval

The spacing is controlled using time-based motor control.

### 3. Solar Power System

The solar panel charges a 12V battery through a charge controller.

The battery supplies power to:

- \* Microcontroller
- \* Motor drivers
- \* DC motors
- \* Servo motor

This ensures fully renewable operation

## **SYSTEM BLOCK DIAGRAM**

Solar Panel → Charge Controller → 12V Battery

From Battery →

\* Motor Driver → DC Motors

\* Servo Motor

\* ESP32 Microcontroller

The following components and their connections form the core of the rice planting subsystem:

- Power Harvesting & Storage Layer:
  - Solar Panel (10W): Collects solar energy.
  - Charge Controller: Regulates energy from the panel to safely charge the battery.
  - 12V, 7Ah Battery: The primary storage unit that supplies power to all high-current and low-power components.
- Control Layer:
  - Main Controllers (ESP32 + Arduino UNO): These act as the "brain," receiving signals from sensors and managing the planting logic.
  - Motor Drivers (L298N or IBT-2): Receive signals from the microcontrollers to drive the motors for movement and planting.
- Actuation Layer:
  - Drive Motors (4 × DC Geared Motors): Provide movement across the field with a torque of approximately 3 Nm each.
  - Planting Actuator (Servo-based Mechanical Arm): Three servo motors control the mechanical arm to pick seedlings from a tray and place them into the soil.
- Navigation & Monitoring Layer:
  - Guidance Sensors: Uses line sensors or GPS navigation to guide field movement.

## **FINAL OUTCOME**

The final prototype will be a fully functional Solar-Powered Rice Planting Robot capable of:

- \* Moving across a paddy field
- \* Planting rice seedlings in straight rows
- \* Maintaining uniform spacing
- \* Operating without fuel
- \* Using renewable solar energy

The system will reduce labor dependency and operational cost while increasing planting accuracy.

## **PERFORMANCE ANALYSIS**

- \* Planting Speed: 0.2 – 0.4 m/s
- \* Spacing Accuracy:  $\pm 3-5$  cm
- \* Operating Time: 45–60 minutes
- \* Solar Recharge Time: 8–10 hours
- \* Suitable for small-scale paddy fields

The robot demonstrates stable mobility and acceptable planting precision for prototype-level agricultural automation.

## **ENVIRONMENTAL AND SOCIAL IMPACT**

Environmental Benefits:

- \* Reduces fossil fuel use
- \* Zero carbon emissions during operation
- \* Promotes renewable solar energy

- Social Benefits:
- \* Reduces manual labor dependency
  - \* Helps aging farmers
  - \* Encourages modern agricultural technology
  - \* Affordable for small farmers

## **COMMERCIAL FEASIBILITY**

The estimated prototype cost is approximately LKR 69,300.

With mass production:

- \* Cost can be reduced
- \* Components are locally available
- \* Maintenance is simple
- \* System is scalable

Potential commercialization through:

- \* Agricultural subsidy programs
- \* Farmer cooperatives
- \* Local manufacturing partnerships

## **LIMITATIONS AND FUTURE IMPROVEMENTS**

Limitations:

- \* Limited battery backup time
- \* Not suitable for deep flooded fields
- \* Open-loop spacing control

Future Improvements:

- \* GPS-based autonomous navigation
- \* Encoder-based motor control
- \* AI-based field mapping
- \* Higher wattage solar panel
- \* Lithium battery integration

## **BUDGET REPORT**

Item	Quantity	Unit Price (LKR)	Total (LKR)
Solar Panel	1	3750	3750
10A Solar charger	1	1720	1720
12V DC Battery	1	3600	3600
12V To 5V Buck converter	1	15000	15000
Arduino Mega	1	4850	4850
Arduino Uno	2	2550	5100
ESP 32 Board	1	1150	1150
ESP 32 Camera	1	300	300
Gear Motor	4	1900	7600
Motor Drive	2	850	1700
Servo motor Full set	1	1920	1920
Remote Mix Item	1	2760	2760
Structure, Frame & Wiring	1	7360	7360
Color print and stickers	1	3270	3270
Other	1	10431	10431
<b>Total Estimated Cost</b>			<b>70,511/=</b>

Supervised By,

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Date

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Signature

## **CERTIFICATION**

This is to certify that the project titled “Rice Planting Robot by Solar Power” is a record of the work carried out by the following students in partial fulfillment of the requirements for their academic program.

This project has been completed under the guidance and supervision of the instructor. The work presented in this report is the result of the collective effort of the group members under the leadership of the project leader. It is also declared that this project has not been submitted previously to any other institution for any academic qualification.

We hereby certify that the project has been successfully completed and submitted for evaluation.

### **Project Leader**

Name : K.A.A. Eranda

Student Number : COL/EE/2021/F/141

Signature : \_\_\_\_\_

Date : \_\_\_\_\_

### **Group Members**

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