AGRO-RATNA V2 (AI based Multipurpose Agriculture Robot)

Shafat Majeed[1]

Robotics instructor in DPS school Srinagar

Syed Daniyal Ahmad shah[2]

Student of DPS school Srinagar

Shuhaab u zamaan[3]

Student of DPS school Srinagar

Mohd Amaan[4]

Student of DPS school Srinagar

Abstract— Agriculture today faces unprecedented challenges due to population growth, climate variability, and labour shortages. To meet the rising global food demand and increase farming efficiency, Farming is under pressure like never before, with more people, less stable weather and a shortage of labour. In order to match the ever-growing global food demand and improve farming productivity, we have developed Argo Ratan V2, advanced generation multifunctional agriculture robot at Atal Innovation Lab, this smart robot combines AI and automation to mechanize key farm functions, such as ploughing, sowing seeds, watering, lawn cutting, and weeding. Perhaps the most notable featureofArgoRatnaV2 is its AI based camera system that is able to identify weeds and plant diseases in real time and facilitate early diagnosis and targeted farming. Also have NPK SENOR TO DETECT THE POTTASIUM NITROGEN AN PHOSPOUROUS IN SOIL With controlled control, soil and environmental sensors, and intelligent imaging, ArgoRatnaV2is aimed at enabling farmers with a scalable, affordable, and sustainable solution, which will pave the way for a technologically driven agriculture industry.

Keywords— **Agricultural Robotics, Smart Farming, AI Camera, Plant Disease Detection, Weed Detection, Arduino, Soil Moisture Sensor, Precision Agriculture, Autonomous Farming, Seed Sowing Mechanism, , Ploughing Robot, Automated Irrigation System, NPKSENSOR.**

I. INTRODUCTION:

The world agricultural scenario is changing at a very fast pace to cope with the increasing population expected to become 9.7 billion by 2050. In India, where agriculture employs more than 50% of the population but generates 15% of GDP (2022– 23), the sector is facing pressure through dwindling profitability, shortage of labor, and climate-induced disruptions. Besides, low yield, pest infestations, disease attacks, and destruction of crops, due to failure to act in time are still affecting farmers.

Technologies like artificial intelligence, automation, and intelligent sensing systems are being incorporated in farming to combat these problems now. But the availability and ease of use of such technologies for small and marginal farmers pose a problem.

Agro Ratna V2 fills this gap by providing an AI-enabled, multipurpose robotic system specific to Indian farms. Developed and designed by students at the Atal Lab, the robot is not only able to operate in fields autonomously but can monitor crops intelligently and provide smart farming *intervention.*

II. METHODOLOGY

Agro Ratna V2 was developed through a rigorous engineering design process that included the steps of problem identification, component selection, system design, hardware integration, software development, and functional testing. The methodology is comprised of the following stages:

a. Problem Identification and Requirement Analysis

A thorough diagnosis of Indian farmers' issues—e.g., lack of labourers, reducing crop output, and wastage of farming resources—was done. Surveys and case studies presented the necessity of an integrated, automated, and smart robotic farming solution with multiple capabilities to allow minimal human interference.

b. System Design and Architecture

The architecture of the robot was modular, making it easy to maintain, upgrade, and scale. The system consists of the following integrated modules:

Mechanical Modules: Plough unit, seed sowing device, grass cutter, weed removal

Sensing Modules: Soil moisture sensor, motion sensor, AI camera module

NPK Sensor: To analyse nutrient content (Nitrogen, Phosphorus, Potassium) in the soil

Control Units: Arduino Uno for execution of main task, Arduino Nano for management of subsystem

AI Processing Unit: Raspberry Pi 4 for image processing and Abased weed/disease detection

Power System: Rechargeable battery pack with voltage regulation for various modules

c. Hardware Implementation

All the functional modules were implemented using respective hardware components:

Ploughing: Mini plough blade attached to a servo motor for tilling soil

Seed Sowing: Bottle-based gravity-feed system operated by servo motor

Soil Monitoring: Capacitive soil moisture sensors connected to Arduino for live reading

NPK Sensor: To analyse nutrient content (Nitrogen, Phosphorus, Potassium) in the soil

Irrigation: Water pump setup driven by relay modules depending on soil moisture readings

Grass Cutting: Blade module driven by DC motor

Weed Remover: Mechanical rotary brush/gripper mechanism activated by AI recognition

d. AI Camera Integration

An OpenCV and Raspberry Pi 4-driven AI camera system was designed for:

Weed Detection: A set of crop and weed images were utilized to train a convolutional neural network (CNN) model. The model identifies the detected objects as crops or weeds.

Disease Detection: The AI takes plant photos and matches characteristics like colour, texture, and shape against disease models to detect issues.

The outputs of the AI model are employed in initiating weed removal systems or alerting for farmer action.

e. Software Development

The software modules were coded with:

Arduino IDE: For actuator and sensor control (C/C++)

Python and OpenCV: For AI-powered image analysis and object classification

Serial Communication: Implemented between Arduino and Raspberry Pi for data transfer

Control logic encompasses threshold-based automation for irrigation, event-based actuation for disease and weed responses, and time-scheduled actions for sowing and ploughing.

f. Testing and Validation

Individual module testing was carried out, followed by system integration tests in simulated and real field environments. Validation metrics were:

NPK sensor readings were compared with lab-grade soil test kits to check accuracy. Moisture accuracy compared to manual readings

Seed placement precision and Accuracy of AI disease and weed

Effectiveness and punctuality of the irrigation and grass mowing

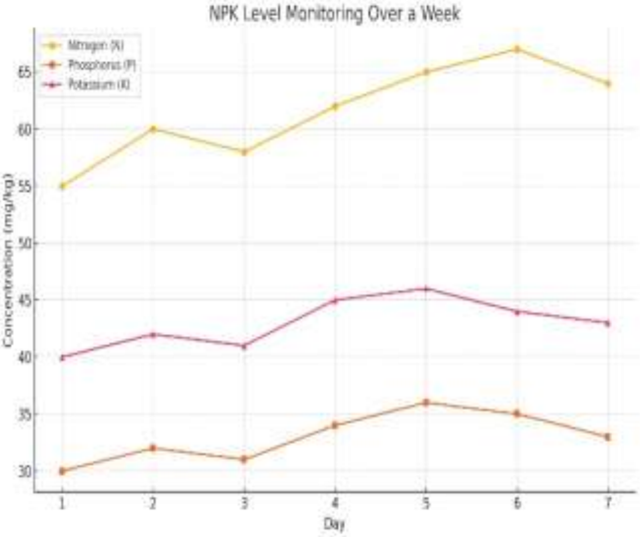

Figure f.1

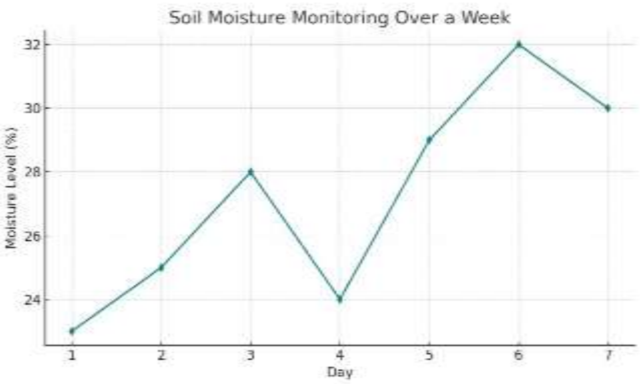

Figure f.2

III. CONCLUSIONS

Argo Ratna V2 represents a significant step forward in the integration of automation and artificial intelligence into the agricultural sector. Designed and developed as a multifunctional robotic farming assistant, the system successfully performs key farming operations such as ploughing, seed sowing, soil moisture monitoring, automatic irrigation, grass cutting, weed removal, and wildlife deterrence. A major advancement in this version is the incorporation of an AI-powered camera system, capable of detecting plant diseases and identifying weeds in real time, allowing for early intervention and more precise farm management.

Furthermore, the inclusion of an NPK sensor enables real-time soil nutrient analysis, enhancing crop planning and promoting sustainable use of fertilizers. Testing results show that Argo Ratna V2 can effectively reduce manual labour, improve operational efficiency, and support data-driven decisionmaking in farming. Its modular, cost-effective design ensures that it is scalable and accessible, especially for small and marginal farmers in rural India. By addressing real-world agricultural challenges with intelligent automation, Argo Ratna V2 has the potential to become a transformative tool in modern farming. It not only supports the economic well-being of farmers but also contributes toward building a more food secure and technologically empowered future for the nation.

Figure III.1

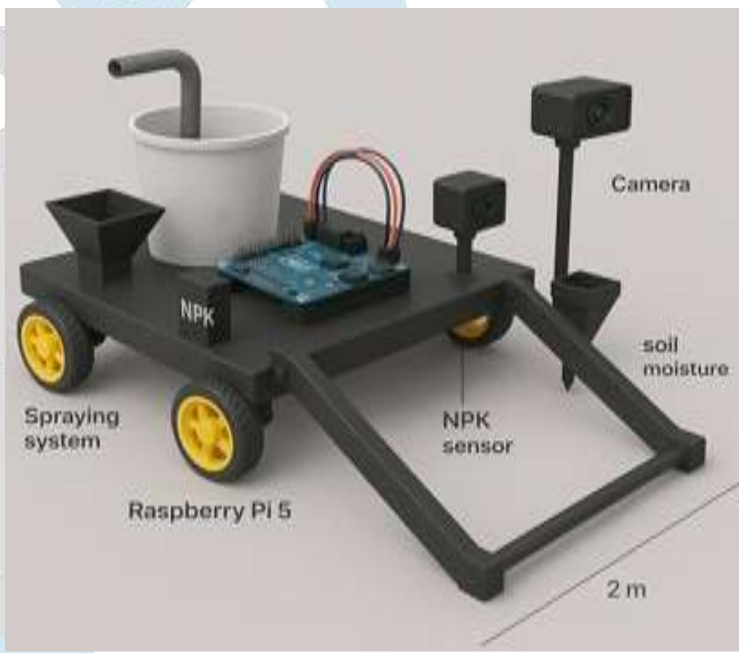

Figure III.2 3D DESIGN

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