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Development of an Eco-Friendly Mechatronic Prototype for Precision Weed Control and Crop Safety

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ABSTRACT: This project proposes a development of an eco-friendly mechatronic prototype for precision weed control and crop safety. Utilizing a combination of sensors and control systems, the prototype aims to automate the process of weed removal with precision, reducing the need for harmful herbicides and promoting eco-friendly agricultural practices. The system's core is an Arduino Uno (ATmega328P) microcontroller, which receives input from various sensors, including a DHT-11 sensor for monitoring environmental temperature and humidity, an ultrasonic sensor for object detection, a voltage sensor to monitor power levels, and a proximity sensor to identify obstacles in real-time. The gathered data is transmitted via a NodeMCU WiFi module to an IoT platform, allowing remote monitoring of system parameters such as temperature, humidity, object detection, and motor status.

KEYWORDS: Mechatronic, Arduino, Node MCU, DHT-11.

I. INTRODUCTION

The development of an eco-friendly mechatronic prototype for precision weed control and crop safety is vital in modern agriculture. This initiative addresses the increasing need for sustainable farming practices that minimize chemical use and enhance crop yield. Traditional weed control methods often rely on herbicides, which can have detrimental effects on the environment, soil health, and non-target species. By integrating mechatronics, this prototype aims to employ advanced sensors and robotics to identify and selectively eliminate weeds, reducing chemical dependency. Furthermore, precision agriculture enhances resource efficiency, ensuring that inputs like water and fertilizers are applied only where needed, thus conserving resources.

II. EXISTING SYSTEM

In this existing system a fuzzy logic algorithm derived mechatronic concept prototype for crop damage avoidance during eco-friendly eradication of intra-row weeds is implemented. The system uses an Arduino Mega microcontroller as its main control unit, which receives input from various sensors, including a DHT-11 sensor for monitoring temperature and humidity, an ultrasonic sensor for object detection, a voltage sensor to monitor power levels, and a proximity sensor to identify obstacles in real-time. The gathered data from these sensors is then transmitted via a NodeMCU WiFi module to an IoT platform, allowing remote monitoring and control of the system parameters. The Arduino Mega controls a motor driver and a relay driver, which are used to power the DC motor that drives the mechanical weed removal mechanism. An LCD display provides on-site feedback, displaying information such as temperature, humidity, object detection, and motor status. The integration of fuzzy logic enables the system to precisely target weeds while ensuring the safety of the crops. This automated system reduces the need for manual labor and heavy reliance on chemical herbicides, promoting eco-friendly and sustainable agricultural practices.

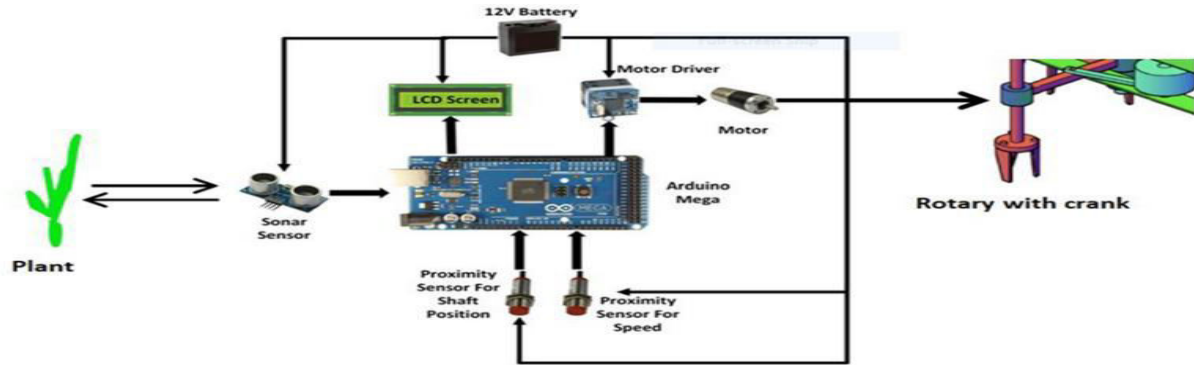


Fig 2 Existing system block diagram

III. PROPOSED METHODOLOGY

In this project, development of an eco-friendly mechatronic prototype for precision weed control and crop safety is proposed. The system is powered by a 5V power supply, which is connected to the Arduino Uno microcontroller. The Arduino Uno acts as the central control unit, receiving input from various sensors. The DHT-11 sensor monitors temperature and humidity levels, while the ultrasonic sensor detects objects in proximity. The voltage sensor monitors the power supply, and the proximity sensor tracks the position and speed of the mechanical components.

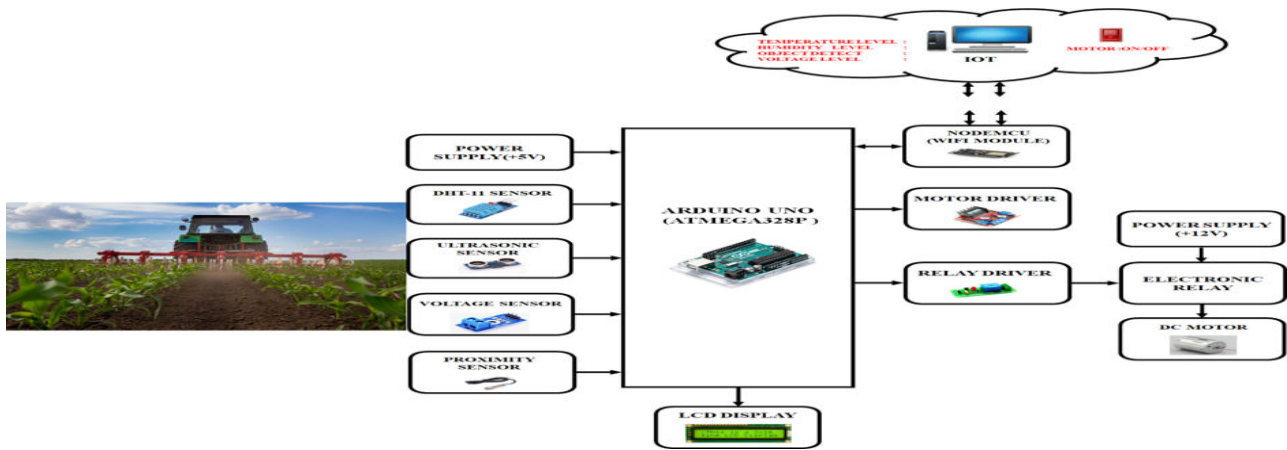


Fig 2 Proposed system block diagram

All the sensor data is transmitted to the Node MCU WiFi module, which connects the system to an IoT platform for remote monitoring and control. The Arduino Uno controls the motor driver and relay driver, which in turn power the DC motor responsible for the weed removal mechanism. An LCD display provides real-time feedback on the system's status, including temperature, humidity, object detection, and motor operation. The integration of fuzzy logic algorithms enables the prototype to precisely target weeds while ensuring the safety of the crops. This automated system aims to reduce the reliance on manual labor and chemical herbicides, promoting eco-friendly and sustainable agricultural practices.

IV. SIMULATION RESULTS

The DHT-11 sensor allows the system to continuously monitor temperature and humidity levels in the agricultural environment, providing essential data for optimizing weed control and crop management. Voltage sensors provide accurate measurements of voltage levels, which is crucial for monitoring the health and performance of electrical systems.

The IoT connectivity and data collection capabilities provide valuable insights for optimizing weed management strategies.

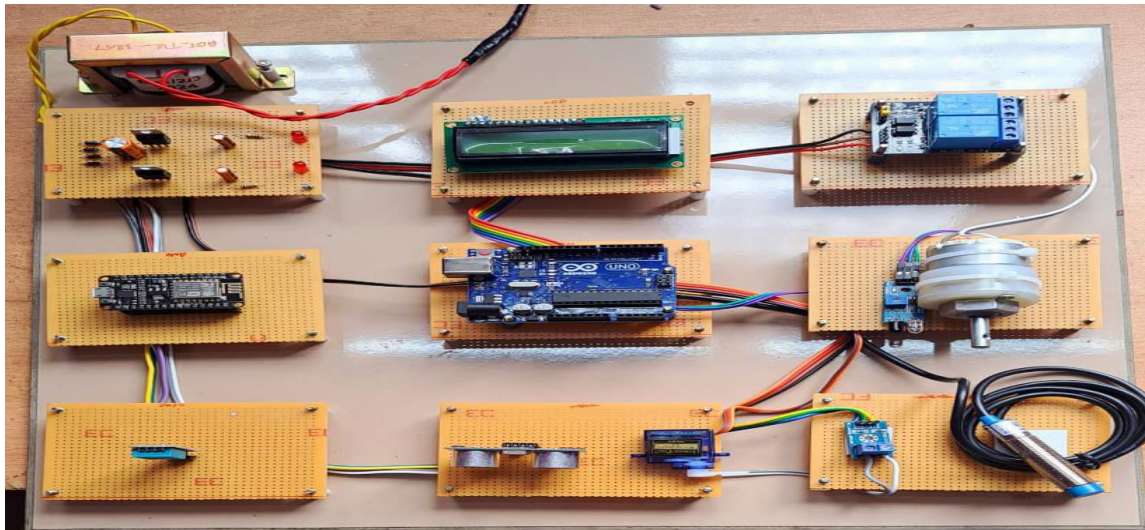


Fig 3 Proposed hardware design

V. CONCLUSION

This eco-friendly mechatronic prototype for precision weed control and crop safety represents a significant advancement in sustainable agriculture. By integrating an array of sensors, an Arduino Uno microcontroller, and IoT connectivity, the system provides real-time monitoring and control, offering farmers the ability to manage weeds with high precision. The use of an ultrasonic sensor, DHT-11 for environmental monitoring, and proximity sensors ensures the system operates effectively without harming crops, while reducing dependency on chemical herbicides. The motor driver and relay driver allow for the automated activation of a mechanical weed removal mechanism, enhancing efficiency.

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