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Design Of Mobile Agriculture Data Collection Equipment Based On Raspberry PICO

Vamsi Rani[1] , MD.Awadh Patel[2], Shaik.Mukthar[3], MD Kabir[4], MD.Rashad khan[5],

Assistant professor[1], Student[2,3,4,5] ,Department of Electronics and Communication Engineering,

Lords Institute of Engineering and Technology, Hyderabad, Telangana, India-500091

ABSTRACT:

The development from traditional agriculture to intelligent agriculture needs to be driven by data. Acquiring agricultural environmental data through sensors and using advanced means such as wireless data transmission and IoT technology make agricultural data collection more refined and intelligent. In this paper, we design a prototype of controller-based mobile agricultural data collection device. The Microcontroller development board is connected to a DC stepper motor driver board, a tri-color LED module and a buzzer. Using the driver module to drive two DC motors, the microcontroller development board is connected to a temperature and humidity sensor, a photoresistor sensor and a gas sensor. After compiling in the controller environment and networking using the controller development board, the device is controlled through a software application to receive and view the collected data. The four SG90 servos are controlled by connecting the breadboard power module and the Bluetooth module through the microcontroller development board. After the Bluetooth connection, the four servos are controlled by the software application to achieve the robotic arm grasping function. The test experiment results show that the device runs smoothly, the light illumination, alarm and robotic arm grasping functions can be realized, and the movable collection of specific data about the environment where the crops are located, such as temperature, humidity, light level and gas can be smoothly realized, and the collected datas meet the objective regular changes.

INTRODUCTION:

Modern agriculture increasingly relies on precise, real-time data to optimize crop yields, manage resources efficiently, and adapt to changing environmental conditions. Traditional methods of agricultural data collection—often manual, time-consuming, and error-prone—pose limitations in terms of scale, accuracy, and responsiveness. To address these challenges, the integration of low-cost, portable, and efficient electronic systems has become a crucial area of development in smart farming practices.

This project focuses on the design and implementation of mobile agricultural data collection equipment using the Raspberry Pi Pico microcontroller. The Raspberry Pi Pico, based on the RP2040 chip, offers a cost-effective, flexible, and power-efficient platform well-suited for field-based sensing applications. It provides sufficient processing power and input/output capabilities to interface with a variety of environmental sensors including soil moisture, temperature, humidity, and light sensors.

The objective is to create a portable, battery-powered device that can collect, store, and optionally transmit agricultural data for later analysis or real-time decision-making. By leveraging the capabilities of the Raspberry Pi Pico, this system aims to provide farmers and agricultural researchers with an accessible tool for improving crop monitoring and management strategies.

This introduction outlines the motivation behind the project, highlights the potential impact of low-cost sensor systems in agriculture, and introduces the Raspberry Pi Pico as the core component for developing a scalable and efficient mobile data collection platform.

LITERATURE REVIEW :

The application of embedded systems in agriculture has gained substantial attention in recent years due to the growing demand for precision farming and resource optimization. Researchers and developers have explored a range of microcontrollers and sensors to design systems capable of monitoring various agricultural parameters such as soil moisture, temperature, humidity, and light intensity. This section reviews key studies and technologies relevant to mobile agricultural data collection systems, with a focus on low-power microcontrollers and sensor integration.

1. Embedded Systems in Precision Agriculture

Previous studies have shown that the integration of embedded systems into agricultural practices can significantly improve productivity and sustainability. For instance, microcontroller-based systems using Arduino, ESP8266, or Raspberry Pi boards have been widely employed in monitoring soil and

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environmental conditions. These systems often use sensors such as DHT11 for temperature and humidity, YL-69 or capacitive sensors for soil moisture, and BH1750 for light intensity measurement.

2. Wireless Sensor Networks and IoT

Several researchers have incorporated wireless sensor networks (WSNs) and Internet of Things (IoT) technologies to enable real-time data transmission and remote monitoring.

3. Raspberry Pi and Raspberry Pi Pico in Agriculture

The Raspberry Pi series has been used extensively for smart farming applications. However, the Raspberry Pi Pico, a newer addition based on the RP2040 microcontroller, is particularly appealing due to its low cost, dual-core processing, low power usage, and flexible I/O support. Studies have demonstrated the Pico's ability to efficiently handle real-time sensor data acquisition and peripheral control, making it a viable option for mobile agricultural applications.

4. Mobile Agricultural Monitoring Systems

Mobile data collection systems are increasingly being developed to provide flexibility and ease of deployment across diverse field environments. Research has focused on developing handheld or cart-mounted units capable of collecting and storing data from multiple points in a field. These systems prioritize energy efficiency, portability, and durability, aligning well with the capabilities of microcontrollers like the Raspberry Pi Pico.

5. Gaps and Opportunities

While numerous systems have been developed using general-purpose microcontrollers, there remains a gap in the use of the Raspberry Pi Pico for low-cost, mobile, and offline-capable agricultural data collection systems. Most existing platforms either rely on static installations or involve higher costs and power requirements.

This literature review underscores the potential of leveraging the Raspberry Pi Pico to build a compact, energy-efficient, and affordable mobile data collection system tailored for agricultural

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environments. It sets the foundation for the proposed design, which aims to bridge the gap between portability, performance, and affordability in field data acquisition..

PROPOSED SYSTEM :

In this paper, we design a prototype of Microcontroller mobile agricultural data collection device.The controller development board is connected to a temperature and humidity sensor, a photoresistor sensor and a gas sensor. After compiling in the controller environment and networking using of the controller development board, the device is controlled through a software application to receive and view the collected data. The four SG90 servos are controlled by connecting the breadboard power module and the Bluetooth module through the microcontroller development board. After the Bluetooth connection, the four servos are controlled by the software application to achieve the robotic arm grasping function. The test experiment results show that the device runs smoothly, the light illumination, alarm and robotic arm grasping functions can be 4 realized, and the movable collection of specific data about the environment where the crops are located, such as temperature, humidity, light level and gas can be smoothly realized, and the collected datas meet the objective regular changes.

Block Diagram :

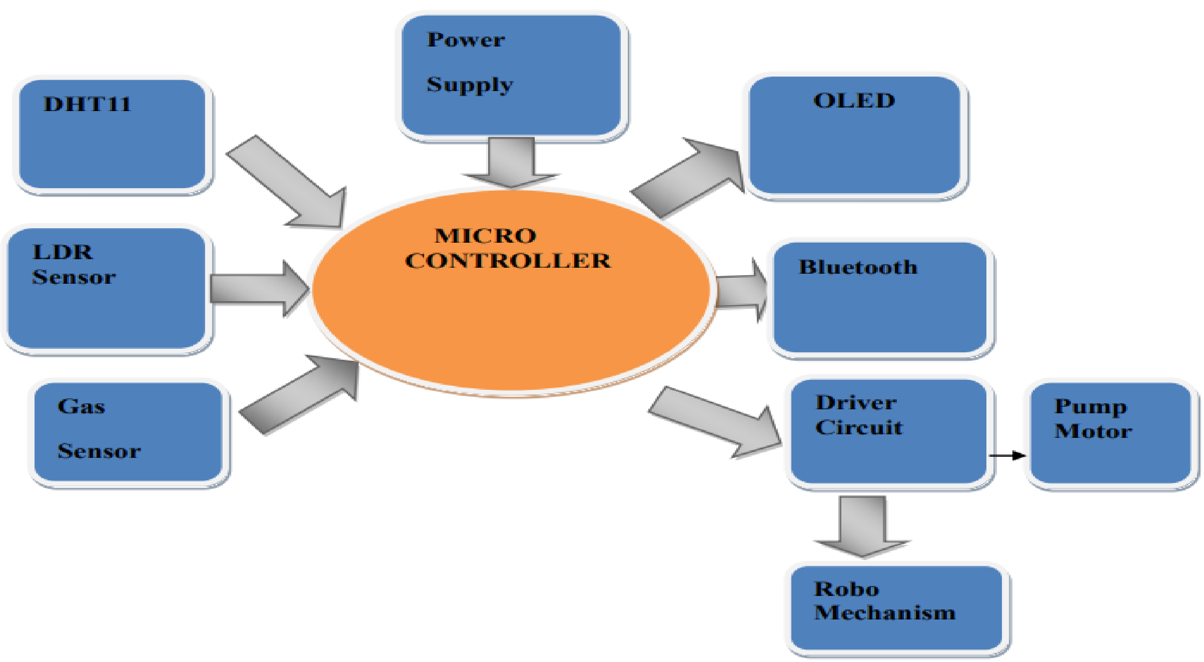

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Fig1-Block diagram of Mobile Agriculture Data Collection Equipment Based On Raspberry PICO

Hardware Components :

Power Supply :

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units .

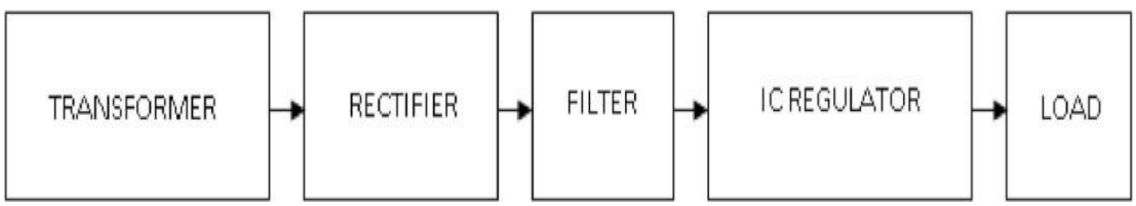

Fig 2-Block diagram of power supply **Transformer**

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

Rectifier :

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

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Voltage Regulators :

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

RASPBERRY PI PICO :

The Raspberry Pi foundation changed single-board computing when they released the Raspberry Pi computer, now they're ready to do the same for microcontrollers with the release of the brand-new Raspberry Pi Pico. This low-cost microcontroller board features a powerful new chip, the RP2040, and all the fixin's to get started with embedded electronics projects at a stress-free price.

The Raspberry Pi Pico is a microcontroller board based on the Raspberry Pi RP2040 microcontroller chip.

2.5 OLED (Organic Light Emitting Diodes)

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future. OLEDs represent the future of display technology!

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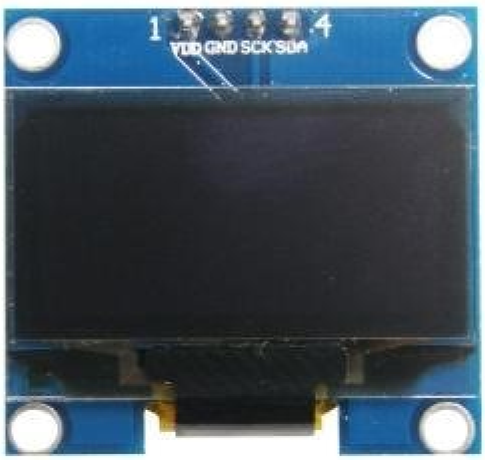
OLED vs LCD

An OLED display have the following advantages over an LCD display:

- Improved image quality - better contrast, higher brightness, fuller viewing angle, a wider color range and much faster refresh rates.
- Lower power consumption.
- Simpler design that enables ultra-thin, flexible, foldable and transparent displays
- Better durability - OLEDs are very durable and can operate in a broader temperature range



The future - flexible and transparent OLED displays

As we said, OLEDs can be used to create flexible and transparent displays. This is pretty exciting as it opens up a whole world of possibilities:

- Curved OLED displays, placed on non-flat surfaces
- Wearable OLEDs
- Foldable OLEDs and rollable OLEDs which can be used to create new mobile devices
- Transparent OLEDs embedded in windows or car windshdields And many more we cannot even imagine today...

Flexible OLEDs are already on the market for many years (in smartphones, wearables and other devices) and since 2019, with the introduction of the Samsung Galaxy Fold, foldable devices are increasing in popularity. In 2019 LG also announced the world's first rollable OLED - its 65" OLED R TV that can roll into its base!

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An OLED is made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. Click here for a more detailed view of the OLED technology. OLEDs are organic because they are made from carbon and hydrogen. There's no connection to organic food or farming - although OLEDs are very efficient and do not contain any bad metals - so it's a real green technology.
OLED is the best display technology - and indeed OLED panels are used today to create the most stunning TVs ever - with the best image quality combined with the thinnest sets ever. And this is only the beginning, as in the future OLED will enable large rollable and transparent TVs!
Currently the only company that produces OLED TV panels is LG Display. The Korean display maker is producing a wide range of OLED TV panels, offering these to LG
Electronics, Panasonic, Sony, Philips and others.

Specifications

- ✓ Use CHIP No.SH1106
- ✓ Use 3.3V-5V POWER SUPPLY
- ✓ Graphic LCD 1.3” in width with 128x64 Dot Resolution
- ✓ White Display is used for the model OLED 1.3 I2C WHITE and blue Display is used for the model OLED 1.3 I2C BLUE
- ✓ Use I2C Interface
- ✓ Directly connect signal to Microcontroller 3.3V and 5V without connecting through Voltage Regulator Circuit
- ✓ Total Current when running together is 8 mA - PCB Size: 33.7 mm x 35.5 mm

Internet of things (IoT)

Internet of things (IoT), is another advance technology in IT sector, provides internetworking for numerous of devices such as sensors, actuators, PLCs and other electronic embedded smart devices and controls, and various software’s’ and provides systems network configuration and connectivity, which enables communication between these numerous devices for information exchanging.

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In 1995, “thing to thing” was coined by BILL GATES. In 1999, IoT (Internet of Things) was come up by EPC global. IOT interconnects human to thing, thing to thing and human to human. The goal of IoT is bring out a huge network by combining different types connected devices. IoT targets three aspects Communication, automation, cost saving in a system. IOT empowers people to carry out routine activities using internet and thus saves time and cost making them more productive. IOT enables the objects to be sensed and/or controlled remotely across existing network model. IOT in environmental monitoring helps to know about the air and water quality, temperature and conditions of the soil, and also monitor the intrusion of animals in to the field. IOT can also play a significant role in precision farming to enhance the productivity of the farm.

Recent advancements, such as the vision of the Internet of Things (IoT), the cloud computing model, and cyber-physical systems, provide support for the transmission and management of huge amounts of data regarding the trends observed in environmental parameters. In this context, the current work presents three different IoT-based wireless sensors for environmental and ambient monitoring: one employing User Datagram Protocol (UDP)-based Wi-Fi communication, one communicating through Wi-Fi and Hypertext Transfer Protocol (HTTP), and a third one using Bluetooth Smart. All of the presented systems provide the possibility of recording data at remote locations and of visualizing them from every device with an Internet connection, enabling the monitoring of geographically large areas. The development details of these systems are described, along with the major differences and similarities between them. The feasibility of the three developed systems for implementing monitoring applications, taking into account their energy autonomy, ease of use, solution complexity, and Internet connectivity facility, was analysed, and revealed that they make good candidates for IoT-based solutions.

Nowadays, IoT is one of the most advanced, efficient, and cost less technological solution which encompasses various hardware and software resources; and allows remotely connected sensing devices to sense with more capabilities, provides efficiency and can be monitored and controlled through deployed of existing systems or infrastructures, resulting the physical World integration with computer controllers (or systems).

DHT11 – TEMPERATURE AND HUMIDITY SENSOR

Pin Identification and Configuration:

No:	Pin Name	Description

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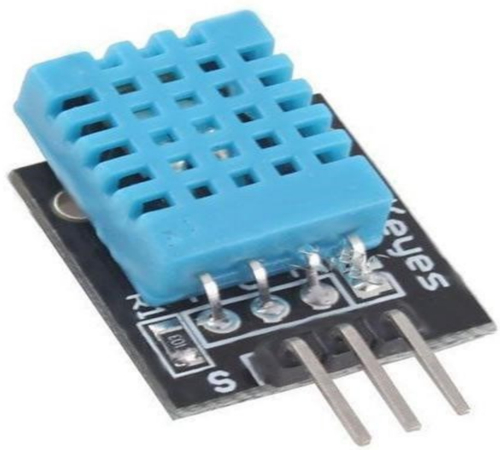
For DHT11 Sensor		
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	NC	No Connection and hence not used
4	Ground	Connected to the ground of the circuit
For DHT11 Sensor module		
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	Ground	Connected to the ground of the circuit



DHT11 Specifications:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

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2.11 BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some ACconnected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

In game shows it is also known as a "lockout system," because when one person signals ("buzzes in"), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as "plungers".

Fig. Buzzer

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RESULT:

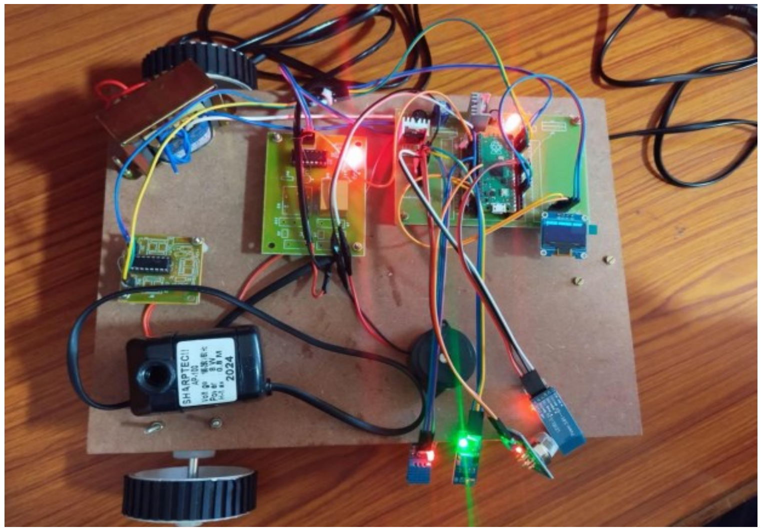

Fig 9-Hardware Kit

The Mobile agriculture data collection equipment was successfully designed and implemented using the Raspberry Pi Pico microcontroller. The system was developed to acquire and log essential environmental parameters such as soil moisture, temperature, humidity, and GPS coordinates. It operates on battery power and stores collected data on an SD card in CSV format for later analysis.

CONCLUSION:

We are aware that farmers salaries are excessively high and that, after working all day in the fields, their output is lower. Hence, we created an automated robot that would assist farmers in the field. This prototype robot can give great efficiency in production and their cultivation, according to the existing situation. When farming is done manually, multitasking takes a lot of time. This robot can do it quickly. It has the ability to pump water and plant seeds.

This project is highly beneficial to farmers who want to engage in agriculture but are having trouble finding workers. The development of a mobile agriculture data collection system using the Raspberry Pi Pico has demonstrated the potential of low-cost, low-power microcontroller platforms in supporting precision farming practices. The system effectively gathers essential environmental data such as soil moisture, temperature, humidity, and GPS location, and stores it locally for further analysis. The compact design, affordability, and reliable performance in field conditions make the Raspberry Pi Pico a practical choice for agricultural monitoring, especially in remote or resource-limited settings. While the current system operates in offline mode with SD card logging, it provides a strong foundation for future enhancements such as wireless data transmission, solar-powered operation, and real-time analytics. This project contributes to the growing field of smart agriculture by offering a scalable and adaptable tool for data-driven decision-making in farming.

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