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Sustainable Agriculture for Crop-Field Monitoring and Irrigation Automation using Internet of Things (IOT)

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***Abstract* — Agriculture is the back bone of India and nearly 70% of people in our country depend on agriculture. The yield of agriculture should be increased rapidly to fulfill the food requirements of population throughout the world. Now days internet of things (IOT) used for solving many real time problems. WSN plays vital role in many field like transport, medical, military, mobile phones, home appliances and so on. Agriculture is one of the important sources for all living things. But nowadays agriculture crops are affected due to many environmental changes. To overcome this WSN takes important role in the field of agriculture. WSN helps the farmer to produce the crop with high quantity and reduce the cost of yield. Agriculture gets affected by climatic change, environmental change, and natural disaster. Using WSN the soil and water management can be done. Here wireless sensors are used so the cost of implementation is very low. In this paper wireless sensor nodes are used to monitor the crops. This helps to increase the productivity of agriculture. The human effort is reduced by automatic process and it encourages the farmer to develop the farm land.**

***Keywords*— Ultra-modern, Enhance, Internet of things(IOT),Water management, Scalability.**

INTRODUCTION

A global grid is a futuristic demand solution that collects data from numerous digital Internet of Things (IoT) sensors. Key findings from such a data are then utilized to successfully handle resources, mineral wealth, and operations; the info is being used to enhance operations throughout the city. It includes information gathered from residents, gadgets, houses, and property, which is centrally managed but also handle urban mobility systems, energy plants, utility services, water system networks, waste, surveillance, data management, institutes, library resources, healthcare facilities, and other social service. One of the most popular applications in the IoT paradigm is the smart home.

Smart Things by Samsung, HomeKit by Apple, and Android Things by Google are three of the top home IoT systems that have developed in recent years. These systems save power, link disparate protocols and devices, provide Automation and online control, and also enables third force software development. The increased need for smart home devices is propelling the Internet of Things forward. Majorly smart home gadgets, for example, such as smart televisions, refrigerator, kitchen appliances, air conditioners, and heater units, are connected to the Internet to make people's lives more pleasant and convenient.

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OBJECTIVES:

Utilizing IoT sensors to monitor and control environmental factors such as temperature, humidity, soil moisture, and light levels within the greenhouse.An IoT-based system can monitor soil moisture levels and automate irrigation systems to deliver water precisely when and where it's needed, reducing water waste and promoting water conservation.With IoT technology, farmers can remotely monitor and control greenhouse conditions from anywhere with an internet connection. This capability enables farmers to stay informed and responsive to changing conditions without needing to be physically present on-site at all times.The system should be scalable and adaptable to accommodate changes in greenhouse size, crop types, or environmental conditions

Data-driven decision-making:
IoT sensors can collect vast amounts of data on environmental conditions such as temperature, humidity, and light levels. This data can be analyzed to gain insights into optimal growing conditions for specific crops, leading to informed decision-making and improved crop yields.

Predictive maintenance:
IoT-enabled devices can also monitor the health and performance of equipment within the greenhouse, such as ventilation systems and climate control mechanisms. By detecting signs of wear and tear early on, predictive maintenance can be performed, reducing the risk of equipment failure and downtime.

Integration with other smart technologies:
IoT systems in greenhouses can be integrated with other smart technologies such as AI-powered analytics platforms and robotics. This integration allows for more efficient resource allocation, crop management, and labor utilization, ultimately enhancing productivity and profitability.

Remote monitoring and troubleshooting:
In addition to monitoring environmental conditions, IoT systems can also track the overall health of plants through techniques like remote sensing and imaging. Farmers can remotely monitor plant growth, detect signs of pests or diseases, and take corrective actions in real-time, thereby minimizing losses and maximizing yields.

Optimization of resource usage:
By continuously monitoring environmental factors and plant health, IoT systems can optimize resource usage within the greenhouse. This includes not only water and energy but also fertilizers and pesticides, leading to more sustainable farming practices and reduced environmental impact.

Enhanced traceability and compliance:
IoT technology enables the tracking of environmental conditions and inputs throughout the entire crop lifecycle. This ensures compliance with regulatory standards and certifications, as well as providing transparency for consumers who are increasingly interested in knowing the origins of their food.

Customization and personalization:
IoT systems can be tailored to the specific needs and preferences of different crops or growing conditions. Farmers can create custom profiles for each crop type, adjusting parameters such as temperature, humidity, and light levels to optimize growth and quality.

Real-time alerts and notifications:
IoT sensors can send real-time alerts and notifications to farmers' devices in case of any deviations from desired conditions or potential issues within the greenhouse. This proactive approach allows for quick intervention and problem resolution, minimizing the impact on crop health and yield.
By incorporating these additional points, the advantages of using IoT technology in greenhouse management become even more comprehensive and compelling.

EXISTING SYSTEM:

The existing paper focusing at Traditional and inefficient agricultural production methods cannot meet the modern agriculture requirements of safe, high quality, efficiency and productivity. The technology of GSM is introduced into the field of agriculture, and the agricultural industrialization and information technology has an unprecedented opportunity. The relevant literature is read, the actual scene is investigated and the needs of agricultural field monitoring are identified. In the meanwhile, the development trend of GSM and facility agricultural monitoring system is analyzed and system performance indicators that meet the actual requirements are developed. Moreover, the overall program of the system is designed and the three-tier architecture of GSM based on sensor technology, wireless communication technology, and configuration monitoring technology is constructed. The structure of the three layers of the sensing layer, transmission layer and application layer is analyzed, and the greenhouse sensor intelligent management system based on GSM designed. The performance of the system is tested in the laboratory. The test items include remote monitoring effect, information acquisition precision and system overall coordination. The results showed that the system is reasonable, the structure is compact, the network layer is reliable, and the performance is stable. Meanwhile, the application layer is rich in functionality, the interface is beautiful, the data processing is intelligent and the operability is strong. As last, it is concluded that the system meets system design requirements and expected performance specifications.

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PROPOSED TECHNIQUE:

Sustainable Agriculture for Crop-Field Monitoring and Irrigation Automation using Internet of Things (IoT)

Expected Advantages:

- Optimized Resource Utilization
- Improved Crop Yield and Quality
- Environmental Sustainability
- Real-Time Monitoring and Controls.

METHODOLOGY

The working of proposed system is based on IOT technology. Initially Moisture sensor used to measure the moisture level in the green house soil. The humidity sensor is used for the measurement atmosphere air. LDR sensor used to measure the greenhouse light illumination. In which the sensors input is given to the amplifier. Then the amplified voltage signal is given to Microcontroller. Here the microcontroller is the flash type re-programmable microcontroller in which we have already programmed with our objectives. It receives the signal from humidity and level sensor and displays the parameters via LCD display. All sense sensor values are continuously monitored by IOT server and Android App.

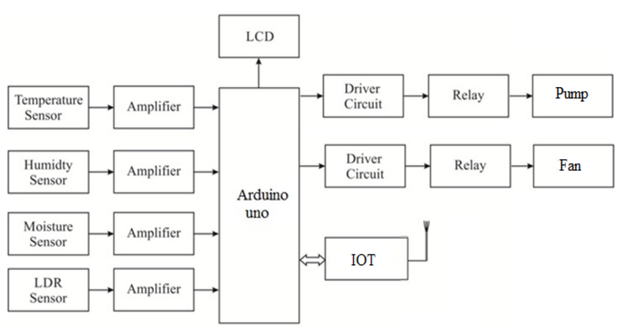

Fig.1:Architecture Diagram

COMPONENTS OF HARDWARE

1 Arduino uno:

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again."Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Fig.2:Arduino Uno

2 .LCD Display:

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly.

Fig.3:LCD Display

They are used in a wide range of applications including: computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have displaced cathode ray tube(CRT) displays in most applications. They are

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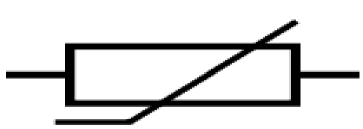
usually more compact, lightweight, portable, less expensive, more reliable, and easier on the eyes. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in.LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. The earliest discovery leading to the development of LCD technology, the discovery of liquid crystals, dates from 1888. By 2008, worldwide sales of televisions with LCD screens had surpassed the sale of CRT units.

3. TEMPERATURE SENSOR:

A thermistor is a type of resistor whose resistance varies with temperature. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range [usually −90 °C to 130 °C].

Fig.4:Temperature Sensor

Basic operation:



Thermistor symbol

Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then:

$$\Delta R = k\Delta T$$

Where,

ΔR = change in resistance

ΔT = change in temperature

k = first-order temperature coefficient of resistance

Thermistors can be classified into two types, depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (PTC) thermistor, or posistor. If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (NTC) thermistor. Resistors that are not thermistors are designed to have a k as close to zero as possible, so that their resistance remains nearly constant over a wide temperature range.
Instead of the temperature coefficient k, sometimes the temperature coefficient of resistance α (alpha) or α_T is used. It is defined as[1]

$$\alpha_T = \frac{1}{R(T)}\frac{dR}{dT}.$$

For example, for the common PT100 sensor, α = 0.00385 or 0.385 %/°C. This α_T coefficient should not be confused with the α parameter below.

4. HUMIDITY SENSOR:

A humidity sensor, also called a hygrometer, measures and regularly reports the relative humidity in the air. They may be used in homes for people with illnesses affected by humidity; as part of home heating, ventilating, and air conditioning (HVAC) systems; and in humidors or wine cellars. Humidity sensors can also be used in cars, office and industrial HVAC systems, and in meteorology stations to report and predict weather.

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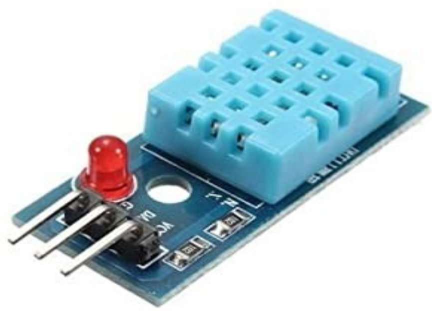

Fig.5:Humidity Sensor

A humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.The most common type of humidity sensor uses what is called “capacitive measurement.” This system relies on electrical capacitance, or the ability of two nearby electrical conductors to create an electrical field between them. The sensor itself is composed of two metal plates with a non-conductive polymer film between them. The film collects moisture from the air, and the moisture causes minute changes in the voltage between the two plates. The changes in voltage are converted into digital readings showing the amount of moisture in the air.

5. SOIL MOISTURE SENSOR:

Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. One common type of soil moisture sensors in commercial use is a frequency domain sensor such as a capacitance sensor. Another sensor, the neutron moisture gauge, utilize the moderator properties of water for neutrons. Cheaper sensors - often for home use- are based on two electrodes measuring the resistance of the soil. Sometimes this simply consists of two bare (galvanized) wires, but there are also probes with wires embedded in gypsum.

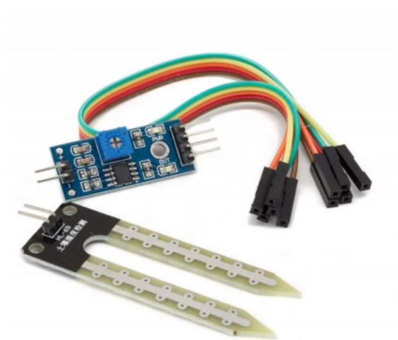

Fig.6:Soil Moisture Sensor

6. LDR SENSOR:

A photoresistor or LIGHT DEPENDENT RESISTOR or cadmium sulfide (CdS) cell is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor.A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, e.g. silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap.

Fig.7:LDR Sensor

A white light that simulates a black body must have a certain temperature, ranging from "warm white" (like an incandescent bulb) around 2700K to "daylight" at about 6500K, for general-purpose illumination.

7. RELAY:

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

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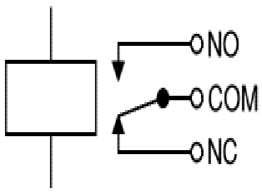
Fig.8:Relay

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.



The relay's switch connections are usually labeled COM, NC and NO:

- **COM** = Common, always connect to this, it is the moving part of the switch.
- **NC** = Normally Closed, COM is connected to this when the relay coil is **off**.
- **NO** = Normally Open, COM is connected to this when the relay coil is **on**.

8. FAN:

A mechanical fan is an electrically powered device used to produce an airflow for the purpose of creature comfort (particularly in the heat), ventilation, exhaust, cooling or any other gaseous transport.

Fig.9:Fan

Mechanically, a fan can be any revolving vane or vanes used for producing currents of air. Fans produce air flows with high volume and low pressure, as opposed to a gas compressor which produces high pressures at a comparatively low volume. A fan blade will often rotate when exposed to an air stream, and devices that take advantage of this, such as anemometers and wind turbines often have designs similar to that of a fan.

9.PUMP:

A pump is a device used to move fluids, such as liquids or slurries.A pump displaces a volume by physical or mechanical action. Pumps fall into five major groups: direct lift, displacement, velocity, buoyancy and gravity pumps. Their names describe the method for moving a fluid.

Fig.10.Pump

A positive displacement pump causes a fluid to move by trapping a fixed amount of it then forcing (displacing) that trapped volume into the discharge pipe. A positive displacement pump can be further classified according to the mechanism used to move the fluid:

- Rotary-type,|internal gear]], screw, shuttle block, flexible vane or sliding vane, helical twisted roots (e.g. the Wendelkolben pump) or liquid ring vacuum pumps.

Positive displacement rotary pumps are pumps that move fluid using the principles of rotation. The vacuum created by the rotation of the pump captures and draws in the liquid. Rotary pumps are very efficient because they naturally remove air from the lines, eliminating the need to bleed the air from the lines manually.

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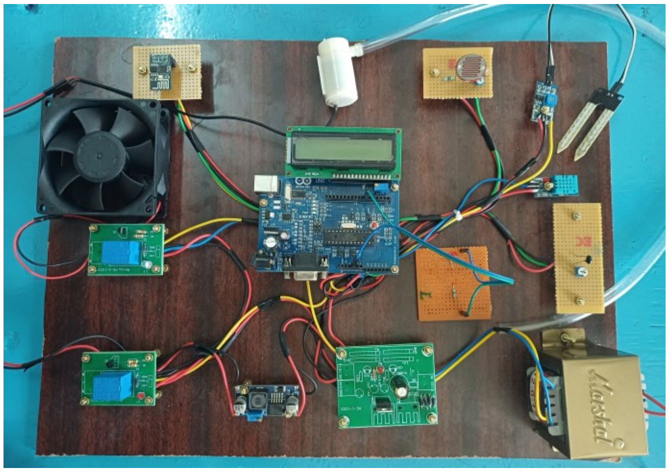

Fig.10.Prototype Model

RESULT AND DISCUSSION:

Development of automatic greenhouse monitoring and controlling system using sensors and direct current (DC) power is completed effectively. The system has been tested under simulated environment successfully and depicted the capability of monitoring and controlling the intensity of the light, humidity of the air and inside temperature and moisture level of the soil. The values of various parameters like temperature, humidity, soil moisture, and light intensity are measured successfully and the measured values are displayed on LCD that is attached with the system. The communication between Ardiuno Uno board and various sensors is done accurately with no interference observed. It can be seen that the device is capable to send data updates that incorporate updated temperature, humidity, light intensity, and moisture of soil to the owner's mobile phone via a dedicated mobile app. The user can access this information by logging into the mobile app. In terms of light intensity, If the value exceeds, the light and fan are automatically switched on and when the value is in normal condition the fan and light remains off.

S.No	Soil Moisture Reading	Threshold Reading	Pump
1	180	200	ON
2	230	200	OFF
3	175	200	ON
4	210	200	OFF
5	240	200	ON

Table.1.Soil Moisture Sensor

S.No	Observed Temperature	Threshold Temperature	Condition of Motor
1	75	50	ON
2	45	50	OFF
3	80	50	ON
4	42	50	OFF
5	60	50	ON

Table.2.Temperature Sensor

S.No	Light Sensor Reading	Threshold Reading	Light ON/OFF
1	40	50	ON
2	55	50	OFF
3	38	50	ON
4	52	50	OFF
5	45	50	ON

Table.3.LDR Sensor

FUTURE SCOPE

By using WSN, the system may be turned wireless.To find too many pesticides, another sensor is employed, like enzyme biosensors. The automatic greenhouse monitoring system's equipment is powered by unconventional energy sources like solar cells and wind turbines. It will start a revolution and has a promising future in the sector of agriculture.

CONCLUSION

Iot will help to enhance smart farming. Using Iot the system can predict the soil moisture level and humidity so that the irrigation system can be monitored and controlled. Iot works in different domains of farming to improve time efficiency, water management, crop monitoring, soil management and control of insecticides and pesticides. This system also minimizes human efforts, simplifies techniques of farming and helps to gain smart farming. Besides the advantages provided by this system, smart farming can also help to grow the market for farmer with single touch and minimum effort.

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