SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM

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ABSTRACT:

Now a days, every system is automated in order to face new challenges in the present day situation. Automated systems have less manual operations, so that the flexibility, reliabilities are high and accurate. Hence every field prefers automated control systems. Especially in the field of electronics automated systems are doing better performance increasingly.

The project is designed to implement a SCADA system, to monitor and control the various environment parameters. Here, the parameters are temperature, humidity, smoke and light. These parameters are sensed by using relevant sensors. Basically, the sensors are physical quantities, which are giving values in analog form. But microcontroller is a digital circuit, which understands the values in digital format only. So, by using ADC, which can convert the values from analog to digital will interface to microcontroller.

Now, the microcontroller has the values of parameters and this will be displayed on PC as well as LCD.

Indexterms:SCADA,DHT11,TCPtelnet,16*2 LCD,ESP 32 CAM,ESP8266,MQ6.

INTRODCUTION

SCADA is an acronym that stands for Supervisory Control and Data Acquisition. SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations and then sends this data to a central computer which then manages and controls the data. SCADA is a term that is used broadly to portray control and management solutions in a wide range of industries. Some of the industries where SCADA is used are Water Management Systems, Electric Power, Traffic Signals, Mass Transit Systems, Environmental Control Systems, and Manufacturing Systems.

Identification: SCADA systems are used in a variety of industries such as traffic systems, electric power utilities and mass transit systems where equipment functions must be closely monitored and controlled automatically. SCADA systems can collect data from sensors as well as send control signals back to the equipment being monitored.

SCADA schematic overview:

Data acquisition begins at the RTU or PLC level and includes meter readings and equipment status reports that are communicated to SCADA as required. Data is then compiled and formatted in such a way that a control room operator using the HMI can make supervisory decisions to adjust or override normal RTU (PLC) controls. Data may also be fed to a Historian, often built on a commodity Database Management System, to allow trending and other analytical auditing. In many cases the applications that run at that level are becoming more important than the user interface stuff. The user interface is an area where there is lots of competition. A spreadsheet can even provide a decent user interface for some situations. However, applications like batch tracking and leak detection are a SCADA vendor's advantage. Those applications are becoming modularized and contain many man-years of experience. And they usually run only on a SCADA system. In a world of "economic rationalism" SCADA vendors become a pool of experience from all of their customers. Not that trade secrets are being passed around, it's just that no one wants to or should, fund a new application 100%. A large SCADA vendor can play a role in reducing the cost of an application that in turn provides cost saving benefits to the customer. Meanwhile many utilities are looking more to their marketing side to get the advantage over the competition than the operations side so sharing resources (informally) isn't perceived as a problem. SCADA systems typically implement a distributed database, commonly referred to as a tag database, which contains data elements called tags or points. A point represents a single input or output value monitored or controlled by the system. Points can be either "hard" or "soft". A hard point represents an actual input or output within the system, while a soft point results from logic and math operations applied to other points. (Most implementations conceptually remove the distinction by making every property a "soft" point expression, which may, in the simplest case, equal a single hard point.) Points are normally stored as value-timestamp pairs: a value and the time stamp when it was recorded or calculated. A series of value-timestamp pairs gives the history of that point. It's also common to store additional metadata with tags, such as the path to a field device or PLC register, design time comments, and alarm information.

PROJECT OVERVIEW

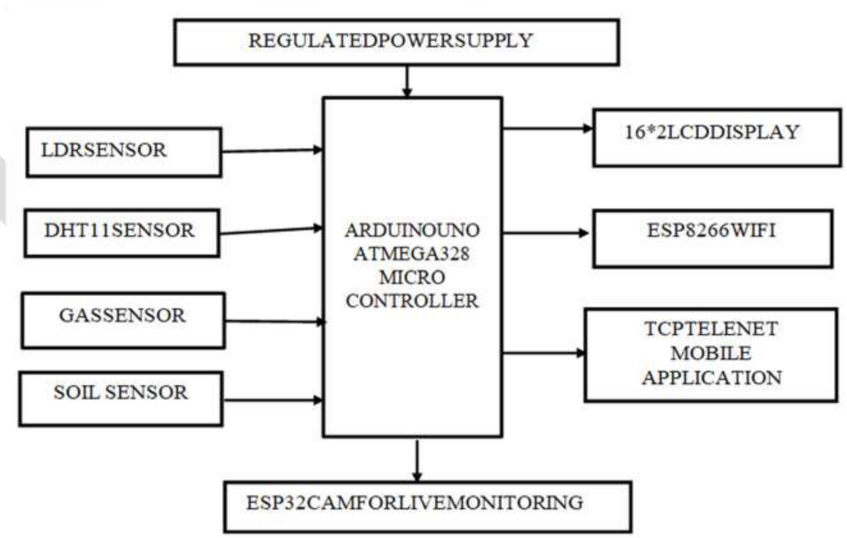

Fig 1: Block diagram

HARDWARE REQUIREMENT

COMPONENTS	QUANTITY
ARDUINO UNO	1
SOIL MOISTURE SENSOR	1
MQ6 GAS SENSOR	1
LDR SENSOR	1
DHT11 SENSOR	1
REGULATED POWER SUPPLY	1
16X1 LCD DISPLAY	1
ESP32 CAM WIFI MODULE	1
ESP3866 WIFI MODULE	1
12V DC ADAPTER	1

Arduino uno

Arduino 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 analoginputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button.
- It contains everything needed to support the microcontroller.

The Arduino UNO is a popular microcontroller board based on the ATmega328P microcontroller. It is widely used in hobbyist and prototyping projects due to its simplicity, versatility, and ease of use.

Fig 2:Arduino Uno

Specifications of the Arduino UNO

Microcontroller: ATmega328P

Operating Voltage: 5V

Input Voltage (recommended): 7-12V

Digital I/O Pins: 14 (of which 6 can provide PWM output)

Analog Input pins: 6

Flash Memory: 32KB (of which 0.5KB is used by the bootloader)

SRAM: 2KB

EEPROM: 1KB

Clock Speed: 16 MHz

USB interface: ATMega 16U2

DIGITAL HUMIDITY AND

TEMPERATURE SENSOR (DHT11)

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

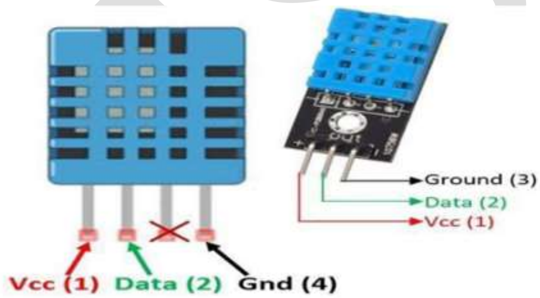

Fig 3:DHT11 Sensor

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%

SOIL MOISTURE SENSOR

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content

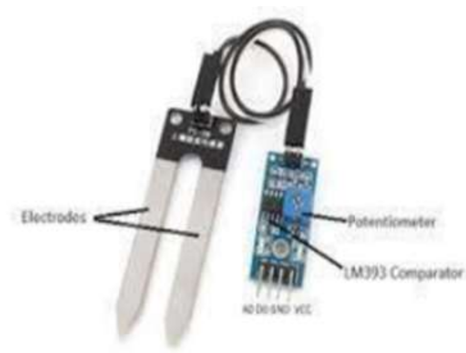

Fig 4: Soil Moisture Sensor

PIN CONFIGURATION IS:

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

LDR SENSOR

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light. It is often used as a light sensor, light meter, Automatic street light, and in areas where we need to have light sensitivity. LDR is also known as a Light Sensor. LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

Fig 5: LDR sensor

ESP8266 SERIAL WIFI TRANSCEIVER

An ESP8266 Wi-Fi module is a SOC microchip mainly used for the development of end- point IoT (Internet of things) applications. It is referred to as a standalone wireless transceiver, available at a very low price. It is used to enable the internet connection to various applications of embedded systems. It can work as either a slave or a standalone application. If the ESP8266 Wi-Fi runs as a slave to a microcontroller host, then it can be used as a Wi-Fi adaptor to any type of microcontroller using UART or SPI. If the module is used as a standalone application, then it provides the functions of the microcontroller and Wi-Fi network.

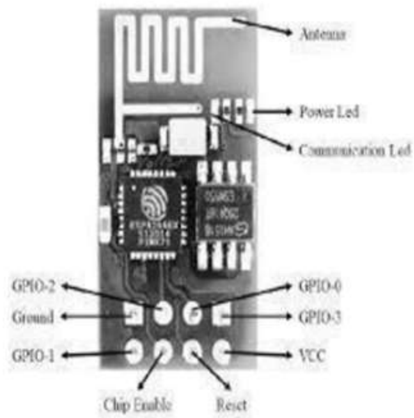

Fig 6: ESP8266 Module

ESP32 CAM WIFI MODULE

The ESP32-CAM is a compact Wi-Fi module that integrates the ESP32-S module and OV2640camera module. It combines the capabilities of the ESP32 microcontroller with a camera interface, enabling developers to create IoT (Internet of Things) applications with camera functionality.

Fig 7:ESP32 CAM Module

16X2 LCD DISPLAY

The model number WH1601 is a 16x1 Character LCD Display. This display is equipped with the ST7066 controller and features a default interface of 6800 4/8-bit parallel. Additionally, it can be configured with SPI and I2C interfaces using the RW1063 controller IC. The LCD Display 16x2 module comes with a PCB board that includes mounting holes, facilitating easy installation in various applications. It operates with a 5V power supply, compatible with 3V, while the negative voltage is limited to 3V. The LED backlight of this 16x2 LCD Display can be driven by PIN1, PIN2, PIN15, PIN16, or the A and K pins. The LCD panels are available in STN, FSTN, and FFSTN types, offering options for polarizer positive and negative modes. Various LED backlight colors are provided, including yellow/green, white, red, blue, green, amber, and RGB LEDs. Additionally, there is an option with no backlight.

Fig 8:16*2 LCD

RESULTS

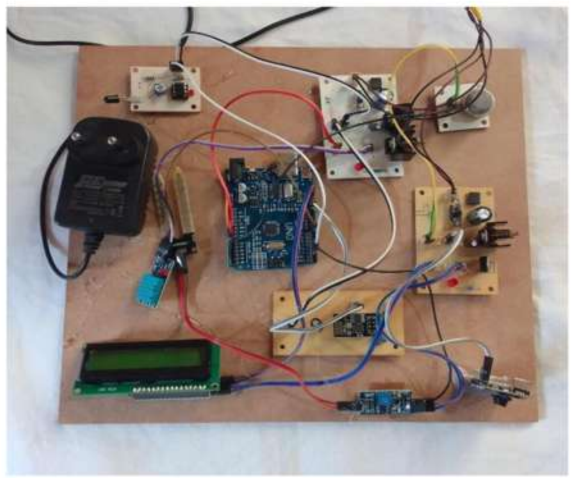

Fig 9: Kit Results

Data acquisition begins at the RTU or PLC level and includes meter readings and equipment status reports that are communicated to SCADA as required. Data is then compiled and formatted in such a way that a control room operator using the HMI can make supervisory decisions to adjust or override normal RTU (PLC) controls. Data may also be fed to a Historian, often built on a commodity Database Management System, to allow trending and other analytical auditing. In many cases the applications that run at that level are becoming more important than the user interface stuff. The user interface is an area where there is lots of competition. A spreadsheet can even provide a decent user interface for some situations. However, applications like batch tracking and leak detection are a SCADA vendor's advantage. Those applications are becoming modularized and contain many man-years of experience. And they usually run only on a SCADA system. In a world of "economic rationalism" SCADA vendors become a pool of experience from all of their customers. Not that trade secrets are being passed around, it's just that no one wants to, or should, fund a new application 100%. A large SCADA vendor can play a role in reducing the cost of an application that in turn provides cost saving benefits to the customer. Meanwhile many utilities are looking more to their marketing side to get the advantage over the competition than the operations side so sharing resources (informally) isn't perceived as a problem. SCADA systems typically implement a distributed database, commonly referred to as a tag database, which contains data elements called tags or points. A point represents a single input or output value monitored or controlled by the system. Points can be either "hard" or "soft". A hard point represents an actual input or output within the system, while a soft point results from logic and math operations applied to other points. (Most implementations conceptually remove the distinction by making every property a "soft" point expression, which may, in the simplest case, equal a single hard point.) Points are normally stored as value-timestamp pairs: a value and the timestamp when it was recorded or calculated. A series of value-timestamp pairs gives the history of that point. It's also common to store additional metadata with tags, such as the path to a field device or PLC register, design time comments, and alarm information

Schematic diagram

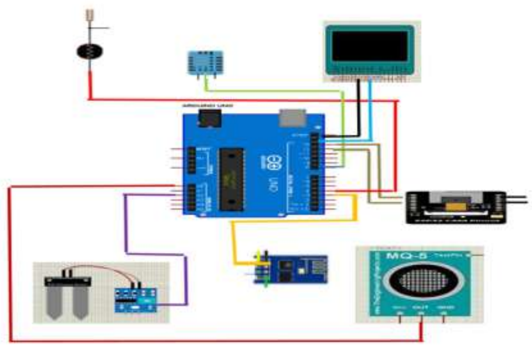

Fig 10: Schematic Diagram Of Supervisory Control And Data Acquisition System

A Supervisory Control And Data Acquisition System is integral to modern industrial and infrastructure management, providing comprehensive monitoring and control systems. For this SCADA project when input voltage is supplied to regulated power supply from an adapter it changes its voltage levels to desired voltage level. Through this input voltage all the components in the SCADA system gets activated. The soil moisture sensor detects the moisture level in the soil, the DHT11 sensor detects the humidity and temperature, the LDR sensor detects the day and night changes, and gas sensor detects hazardous gas present in the air in ppm simultaneously. All these outputs are processed and controlled by Arduino UNO and displayed on to the 16X2 LCD display. Simultaneously the ESP32 CAM WIFI module live streams the data. This data can have retrieved at the host's center with the help of ESP8266 WIFI module through IoT communication protocols by using TCP Telnet Application.

ADVANTAGES, DISADVANTAGES AND APPLICATIONS

ADVANTAGES

1. Remote Monitoring and Control
2. Increased Efficiency
3. Enhanced Safety
4. Data Logging and Analysis
5. Improved Maintenance Planning
6. Integration with Other Systems
7. Scalability
8. Remote Accessibility
9. Regulatory Compliance

10. Cost-Effectiveness

DISADVANTAGES

1. Cyber security Risks
2. Reliance on Communication Networks
3. Compatibility Issues
4. Limited Scalability
5. Single Point of Failure

APPLICATIONS

1. Energy Management
2. Oil and Gas Industry
3. Water and Wastewater Management
4. Manufacturing and Industrial Automation
5. Transportation Systems
6. Building Automation and HVAC Control
7. Telecommunications Networks
8. Environmental Monitoring

CONCLUSION AND FUTURE SCOPE

CONCLUSION

SCADA (Supervisory Control and Data Acquisition) systems represent a critical technological backbone for a wide range of industries and sectors, offering real-time monitoring, control, and data acquisition capabilities. Despite their complexity and potential drawbacks, the benefits of SCADA systems far outweigh the challenges they may pose. From energy management
to manufacturing automation, from transportation systems to environmental monitoring, SCADA systems empower organizations to optimize processes, enhance efficiency, and ensure safety and reliability. They enable remote monitoring and control, facilitate predictive maintenance, support regulatory compliance efforts, and contribute to overall operational excellence. As industries continue to evolve and embrace digital transformation, SCADA systems will remain indispensable tools for managing and optimizing complex systems and processes. With ongoing advancements in technology and cyber security measures, SCADA systems will continue to play a crucial role in driving innovation, sustainability, and resilience across diverse sectors, shaping the future of modern infrastructure and industrial automation.

FUTURE SCOPE

The future of SCADA systems is poised for significant transformation driven by technological advancements and evolving industrial needs. Key trends such as IoT integration, cloud computing, advanced analytics, enhanced cyber security, edge computing, AI and improved interoperability will shape the next generation of SCADA systems.

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These developments promise to enhance the efficiency, reliability and security of industrial operations, ensuring that SCADA systems remain a critical component of modern industrial infrastructure.

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