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SMART SENSORS BASED TEMPERATURE COMPENSATED FOR AGRICULTURAL INDUSTRY

[#1]UPPARA GOVINDARAJULU, PG STUDENT
[#3]Y.RAVI SHANKAR, ASSOCIATE PROFESSOR
DEPT OF ECE
BHEEMA INSTITUTE OF TECHNOLOGY AND SCIENCE, ADONI, AP

ABSTRACT: In this paper, we proposed system it has water level sensors and sensors to monitor temperature and humidity. The Agricultural field section like Nytrate Soil moisture, humidity and water sensors. The sensors values sends the information to the web page and then plot the sensor data as graphical statistics.The data updated from the implemented system can be accessible in the internet from anywhere in the world.

In this project ARM LPC2148 communicates with LCD, sensors and wifi modem. In the Sensor section it has Nytrate Soil moisture,humidity and water level sensor are continuously monitoring on lcd. If the sensor value gets abnormal then buzzer will be on.If soil moisture get abnormal the motor pump will be on automatically.When empty level occurred in dam then outlet motor will on .

I. INTRODUCTION

In an agricultural country like India, the concentration of nitrate in surface and groundwater is concerning and has been identified as a critical issue facing India's future [1]. Dairy farming, disposal of human and animal sewage, urban runoff and industrial waste to land or into waterways has been identified as sources of nitrate [2]. Nitrate-nitrogen (NO3–N) is a fundamental element for the growth of all plants and animals, as it is a major component of the supply of protein. It is used in the agricultural sector to increase plant and livestock production. However, nitrate can become an issue if its concentration in surface water rises above a certain threshold, and this issue is commonly associated with agricultural areas [3, 4]. In India, cattle urination from dairy farming is the largest source of nitrate contamination [5] as the highly concentrated nitrate deposits leach into groundwater, which ultimately increases the nitrate concentration of surface water.

Concentrations in surface waters can stimulate the growth of unwanted algae and aquatic plants [6]. High nitrate-N concentrations change the pH of the water and lower oxygen concentrations, affecting aquatic life and degrading fish habitats [7]. Elevated nitrate concentrations in drinking water, can also lead to blue baby syndrome [8]. According to Environment Protection Agency (EPA), the acceptable level of nitrate-N in drinking water is 10 mg/L [9]. The spectrophotometric method is commonly used to detect nitrate-nitrogen (NO3-N) in water using specific chemical reagents [10, 11]. In other research, vanadium has been utilized for the reduction of nitrate ions by acidic Griess reaction . Other detection methods include ion chromatography palladium nanostructures , planar electrode sensors ion selective electrodes and optical fiber sensors. In situ detection of nitrate in nitrate moisture using impedance spectroscopy, have also been reported. The regional councils around India monitor water samples from rivers, lakes and groundwater in a routine manner. The samples are collected by staff at a regular interval of time, usually on a monthly basis.

The concentrations of nitrate-N are measured by spectrophotometric method. Typically, nitrate-N concentrations change with increasing and decreasing stream or river flows. Therefore, a monthly sampling regime may not adequately represent the actual nitrate-N profile.

This could influence the understanding of the seasonal effects on nitrate-N loss as well as total loads of nitrate-N estimated to be leaving a catchment. This information is critical for regional councils to implement policy and management accurately. Although high-frequency nitrate sensors are commercially available, these sensors cost in the order of $7,500-35,000 USD and are designed to measure nitrate concentrations of > 1 mg/L, which is often not sensitive enough for India waterways. Therefore, there is a clear need for low-cost, low concentration, real-time, smart nitrate sensors and sensing systems, to measure nitrate concentrations in water. The objective of this research is to extend our earlier work to develop a low-cost, in-situ real-time monitoring system based on the planar interdigital sensor.

The purpose is to achieve continuous assessment of nitrate-N in water to improve our understanding and measurement of seasonal and annual losses of nitrate to waterways [21, 22]. The earlier work as reported in [21] provides experimental results of the prototype sensor, which are obtained under laboratory environmental condition. The earlier reported system provided good accuracy under a controlled environment. However, the ambient temperature under field conditions vary considerably. Therefore, the performance of the developed system suffered due to temperature fluctuations. Therefore, a compensation of the effect of temperature was required in the current system. The system can transfer measured data to a cloud server for further analysis, saving staff time in collecting samples.

The availability of Internet of Things (IoT) allows the system to be developed as part of a distributed network. The main contributions of this paper are 1. The use of a temperature compensated interdigital capacitive sensor to measure nitrate at low concentrations and 2. The development of a low-cost (the estimated amount of the whole system's cost is less than $100 USD) sensing system for continuous nitrate measurement which links to an IoT-based cloud server through an integrated WiFi connection. The experimental development, evaluation and validation of the systems performance are explained.

II. LITERATURE REVIEW

Wireless Sensor Networks (WSN), sometimes called Wireless Sensor And Actuator Network (WSAN) is a wireless network consisting of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. To cooperatively pass their data through the network to a main location. The more modern networks are bidirectional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. When deployed in the field, the microprocessor automatically initializes communication with every other node in range, creating an ad hoc mesh network for relaying information to and from the gateway node. This negates the need for costly and ungainly wiring between nodes, instead relying on the flexibility of mesh networking algorithms to transport information from node to node.

In this paper a Precision Agriculture has the benefit of providing real time feed-back on a number of different crop and site variables. As its name implies, Precision Agriculture is precise in both the size of the crop area it monitors as well as in the delivery amounts of water, fertilizer, etc. This technology can isolate a single plant for monitoring in the tens or hundreds of square feet. The WSN system requires a centralized control unit with user interface. Precision Agriculture requires a unique software model for each geographical area, the intrinsic nitrate type and the particular crop or plants. For example, each location will receive its own optimum amount of water, fertilizer and pesticide. It's generally recommended that data collection be done on an hourly basis.

Frequent data collection doesn't't provide additional useful information for the software model and becomes a burden to the Wireless Sensor Network in terms of power consumption and data transmission. Less frequent monitoring may be acceptable for certain slow growth crops and areas that have very stable, uniform climate conditions.

The data collection, monitoring and materials application to the crops allows for higher yields and lower cost, with less impact to the environment. Each area receives only what is required for its particular space, and at the appropriate time and duration. A general Agricultural application can be employed for: Large crop area monitoring, Forest / Vegetation monitoring, Forest fire prevention, Biomass studies, Tracking Animals, Crop Yield Improvement

III. DESIGN OF HARDWARE

This chapter briefly explains about the Hardware implementation of authentication. It discuss the circuit diagram of each module in detail.

3.1 LPC2148 (ARM7) MICROCONTROLLER:

The LPC2148 microcontrollers are based on a 32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory of 512 kB. For critical code size applications, the alternative 16-bit Thumb mode reduces the code by more than 30 % with minimal performance penalty.

Due to their tiny size and low power consumption, LPC2148 microcontrollers are ideal for the applications where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, SSP to I2Cs and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit

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ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems.

3.1.1. FEATURES OF LPC2148 MICROCONTROLLER:

¢ 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.

¢ 8 to 40 kB of on-chip static RAM and 32 to 512 kB of on-chip flash program memory.

¢ 128 bit wide interface/accelerator enables high speed 60 MHz operation.

¢ In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader software. Single flash sector or full chip erase in 400 ms and programming of 256 bytes in 1 ms.

¢ Embedded ICERT and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high speed tracing of instruction execution.

¢ USB 2.0 Full Speed compliant Device Controller with 2 kB of endpoint RAM.

¢ In addition, the LPC2146/8 provide 8 kB of on-chip RAM accessible to USB by DMA.

¢ One or two (LPC2141/2 vs. LPC2144/6/8) 10-bit A/D converters provide a total of 6/14 analog inputs, with conversion times as low as 2.44 ?s per channel.

¢ Single 10-bit D/A converter provides variable analog output.

¢ Two 32-bit timers/external event counters (with four capture and four compare

channels each), PWM unit (six outputs) and watchdog.

¢ Low power real-time clock with independent power and dedicated 32 kHz clock input.

¢ Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus

¢ (400 kbit/s), SPI and SSP with buffering and variable data length capabilities.

¢ Vectored interrupt controller with configurable priorities and vector addresses.

¢ Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.

¢ Up to nine edge or level sensitive external interrupt pins available.

¢ 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 ?s.

3.2. BLOCK DIAGRAM OF LPC2148 MICROCONTROLLER:

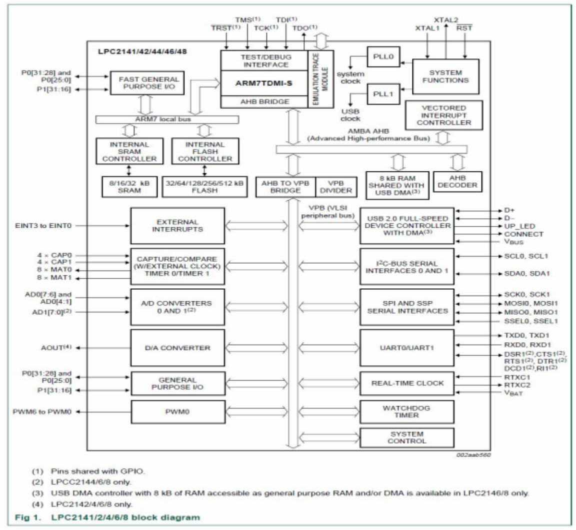

Fig: 1. Block Diagram Of Lpc2148 Microcontroller

3.2.1. DESCRIPTION ABOUT THE BLOCK DIAGRAM:

¢ On chip Flash Program Memory :

" LPC 2148 is having 512kB Flash memory. This memory may be used for both code and data storage. Programming of the flash memory may be accomplished in several ways(ISP/IAP).

¢ On chip Static RAM :

" On-chip static RAM may be used for code and/or data storage. The SRAM may be accessed as 8-bit, 16-bit, and 32-bit. An 8 kB SRAM block intended to be utilized mainly by the USB

¢ **Interrupt Controller :**

" The Vectored Interrupt Controller (VIC) accepts all of the interrupt request inputs and categorizes them as Fast Interrupt Request (FIQ), vectored Interrupt Request (IRQ), and non-vectored IRQ as defined by programmable settings.

¢ Analog to Digital Converter :

" LPC2148 contains two analog to digital converters(ADC0 & ADC1). Total number of available ADC inputs is 14. These two ADC's are 10 bit successive approximation analog to digital converters. Measurement range of 0 V to VREF. Global Start command for both converters.

¢ Digital to Analog Converter :

" The DAC enables to generate a variable analog output. The maximum DAC output voltage is the VREF voltage. 10-bit DAC. Buffered output. Power-down mode available.

¢ USB 2.0 Device Controller :

" The USB is a 4-wire serial bus that supports communication between a host and a number (127 max) of peripherals. Enables 12 Mbit/s data exchange with a USB host controller. A DMA controller (available only in LPC2146/48) can transfer data between an endpoint buffer and the USB RAM.

¢ UART :

" LPC2148 contains two UARTs(UART0 & UART1). In addition to standard transmit and receive data lines, the LPC2148 UART1 also provides a full modem control handshake interface. 16 byte Receive and Transmit FIFOs. It contains Built-in fractional baud rate generator covering wide range of baud rates without a need for external crystals of particular values.

¢ I2C-bus serial I/O controller :

" I2C is a bidirectional. It is a multi-master bus, it can be controlled by more than one bus master connected to it. It supports bit rates up to 400 kbit/s. Bidirectional data transfer between masters and slaves. Serial clock synchronization allows devices with different bit rates to communicate via one serial bus. Serial clock synchronization can be used as a handshake mechanism to suspend and resume serial transfer.

¢ SPI serial I/O control :

" It is s a full duplex serial interface, designed to handle multiple masters and slaves connected to a given bus. Synchronous, Serial, Full Duplex Communication.

¢ SSP serial I/O control :

" Supports full duplex transfers. Data frames of 4 bits to 16 bits of data flowing from the master to the slave and from the slave to the master. Synchronous serial communication. Master or slave operation. 8-frame FIFOs for both transmit and receive. Four bits to 16 bits per frame

¢ Timers :

" LPC 2148 has two 32-bit timer/counters with a programmable 32-bit prescaler. It also having external External event counter. Four 32-bit capture channels per timer/counter that can take a snapshot of the timer value when an input signal transitions. A capture event may also optionally generate an interrupt.

¢ Watchdog Timer :

" The purpose of the watchdog is to reset the microcontroller within a reasonable amount of time if it enters an erroneous state. When enabled, the watchdog will generate a system reset if the user program fails to 'feed' (or reload) the watchdog within a predetermined amount of time.

¢ Real Time Clock :

" The RTC is designed to provide a set of counters to measure time when normal or idle operating mode is selected. The RTC has been designed to use little power, making it suitable for battery powered systems where the CPU is not running continuously (Idle mode).

3.3 PIN DIAGRAM OF LPC 2148 MICRO CONTROLLER:

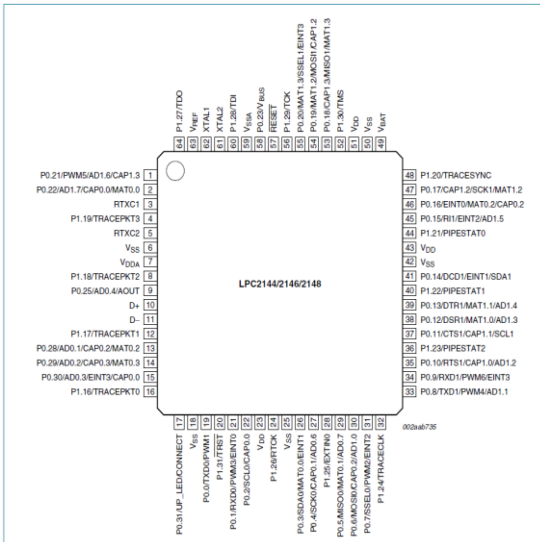

Fig 4. LPC2144/2146/2148 pinning

Fig:3. Pin Diagram Of Lpc2148 Microcontroller

3.4 RS232 CABLE:

To allow compatibility among data communication equipment, an interfacing standard called RS232 is used. Since the standard was set long before the advent of the TTL logic family, its input and output voltage levels are not TTL compatible. For this reason, to connect any RS232 to a microcontroller system, voltage converters such as MAX232 are used to convert the TTL logic levels to the RS232 voltage levels and vice versa.

3.5. MAX232 IC:

Max232 IC is a specialized circuit which makes standard voltages as required by RS232 standards. This IC provides best noise rejection and very reliable against discharges and short circuits. MAX232 IC chips are commonly referred to as line drivers.

To ensure data transfer between PC and microcontroller, the baud rate and voltage levels of Microcontroller and PC should be the same. The voltage levels of microcontroller are logic1 and logic 0 i.e., logic 1 is +5V and logic 0 is 0V. But for PC, RS232 voltage levels are considered and they are: logic 1 is taken as -3V to -25V and logic 0 as +3V to +25V. So, in order to equal these voltage levels, MAX232 IC is used. Thus this IC converts RS232 voltage levels to microcontroller voltage levels and vice versa.

Fig:4. Pin diagram of MAX232 IC

3.6. POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as "Regulated D.C Power Supply".

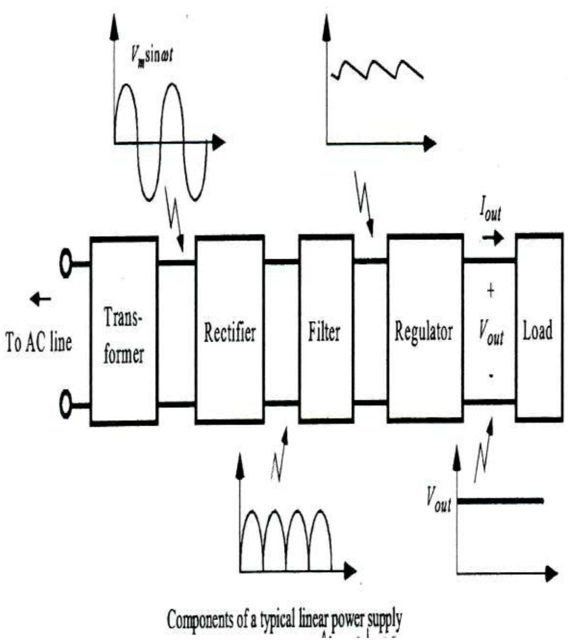

Fig:5 Block Diagram of Power Supply

3.7. WATER LEVEL SENSOR

Water sensor brick is designed for water detection, which can be widely used in sensing the rainfall, water level, even the liquate leakage. The brick is mainly comprised of three parts: An Electronic brick connector, a 1 MΩ resistor, and several lines of bare conducting wires. This sensor works by having a series of exposed traces connected to ground and interlaced between the grounded traces are the sunstrokes. The sensor traces have a weak pull-up resistor of 1 MΩ. The resistor will pull the sensor trace value high until a drop of water shorts the sensor trace to the grounded trace. Believe it or not this circuit will work with the digital I/O pins of your Arduino or you can use it with the analog pins to detect the amount of water induced contact between the grounded and sensor traces. This item can judge the water level through with a series of exposed parallel wires stitch to measure the water droplet/water size . This item can easily change the water size to analog signal, and output analog value can directly be used in the program function, then to achieve the function of water level alarm. This item have low power consumption, and high sensitivity, which are the biggest characteristics of this mdoule. This item can be compatible with Arduino UN0 Arduino mega2560.

3.8 NITRATE MOISTURE SENSOR:

Nitrate moisture sensors measure the volumetric water content in nitrate.[1] Since the direct gravimetric measurement of free nitrate moisture requires removing, drying, and weighting of a sample, nitrate moisture sensors measure the volumetric water content indirectly by using some other property of the nitrate, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and nitrate moisture must be calibrated and may vary depending on environmental factors such as nitrate type, temperature, or electric conductivity. Reflected microwave radiation is affected by the nitrate moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners. Nitrate moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in nitrates called water potential; these sensors are usually referred to as nitrate water potential sensors and include tensiometers and gypsum blocks.

3.9 LCD:

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with

16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

LCD SCREEN:

LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot matrix. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LE diode).

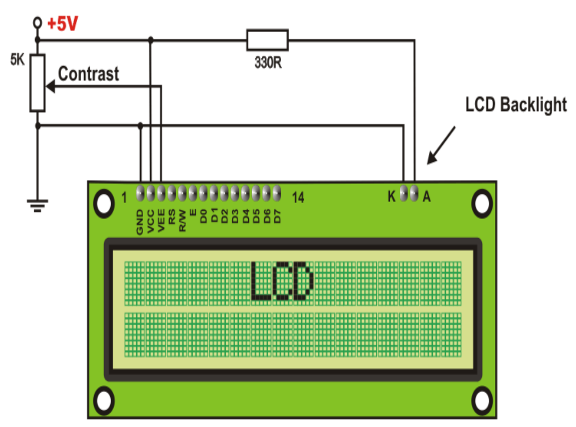

Fig: 6.LCD Screen Circuit Diagram

IV. PROJECT DESCRIPTION

This chapter deals with working and circuits of "**a temperature compensated nitrate sensors for agricultural industry**". It can be simply understood by its block diagram &circuit diagram.

4.1. BLOCK DIAGRAM:

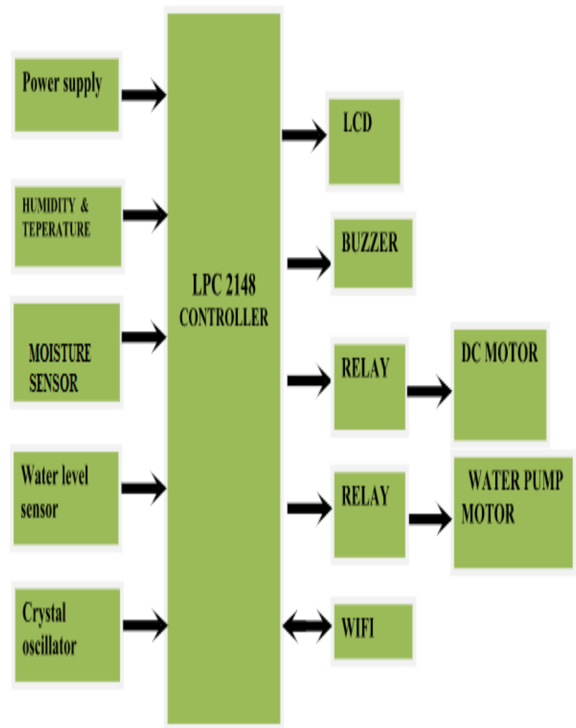

Fig 7: block diagram

4.2. SOFTWARE REQUIREMENTS:

- Keil uVision4 IDE
- Flash Magic
- Embedded c language

4.3. HARDWARE REQUIREMENTS:

- LPC2148 BASED OUR OWN DEVELOPED BOARD
- POWER SUPPLY
- Nitrate Moisture Sensor
- Humidity Sensor
- Wifi modem
- Max232
- Buzzer
- LCD
- RELAYS
- WATER PUMP MOTOR
- Dc motor
- Temperature sensor

4.4. WORKING:

Fig. 6.1 shows the block diagram of the designed system. In this system, the sinusoidal waveform was generated by using PWM (pulse width modulation) output combined with a bandpass filter which is based on the concept of the Direct Digital Synthesis (DDS) method. This method was implemented by breaking a waveform into discrete points digitally [29]. Two hundred and fifty-six (8 bits) points were used to produce a sinusoidal waveform that gave a compromise between resolution and frequency. The operating frequency was fixed at 122.5 Hz. The voltage across Rs is very low. To amplify the voltage as well as to reduce the noise, an amplifier (of gain 10) cum filter circuit. The value of the series resistor is 10-kilo ohms, which is significantly small, compared to total impedance.

The details of the operation of the circuit shown in Fig. has been explained in [21]. The voltage across the series resistor Rs, is alternating in nature. To rectify the amplified voltage, a precision rectifier, as shown in Fig. 6. Block diagram of the designed system Fig, has been used. The operation has been explained in [21]. In order to calculate the real and imaginary part of the impedance of the sensor, the phase difference between the input voltage, Vin and the current, Is is calculated. The calculation is done inside the microcontroller. The phase difference between Vin and Is is calculated by passing the signals Vin and Is through a zero-crossing detector as shown in Fig.6.

The two square waves are connected to external interrupts of the microcontroller and time difference is calculated internally. The time difference is then converted into the appropriate phase angle. After obtaining the phase difference (ϕ) between Vs and Is, the components of impedance are calculated as$R = Z \times \cos\emptyset$ (4) $X = Z \times \sin\emptyset$ (5) Fig.

Equivalent circuit diagram of interdigital sensor R and X are the real part and imaginary part of the total impedance of the circuit, as shown in Fig. 6. The actual resistive component of the sensor is given by equ. 6 $Rsensor = R - Rs$ (6) Finally, the resistive component is used to calculate the temperature and eventually, calculating the nitrate concentration. C. Control of Pump and Valve Sample water to be tested for nitrate concentration was pumped in to and out of the sample container, to avoid the sensor being continuously dipped in water. This is achieved using a pump and valve. The operation of the circuits has been explained in [21].

Control of water flow, pump and valve control D. IoT-based Smart System The IoT [30] offers promising solutions to transform the operation and role of existing industrial technologies. IoT is already having an impact in the areas of agriculture, food processing, environmental monitoring, security surveillance and others [31]. The proposed Arduino Yun has integrated WiFi which can provide instant connectivity to the Internet. WiFi offers high bandwidth, large coverage area, non-line-ofsight transmission, easy expansion, cost-effectiveness, robustness and small distribution of Links [32]. An external antenna (2.4 GHz) is added to increase the transmission signal strength. The collected data is transmitted to Thingspeak [33] which is the open data platform for the IoT. HTTP POST [34] protocol has been used to send data directly to the specified server. The final IoT-based smart sensing system with a smart sensor which has been used to measure nitrate and upload the data on the designated website.

V. RESULT:

Fig8: Kit based output result

VI. CONCLUSION

A temperature compensated interdigital capacitive sensor has been developed in the current study to measure nitrate at low concentrations. A portable, novel sensing system has been developed that could be used on-site as a stand-alone device, as well as IoT-based remote monitoring smart sensor node, to measure nitrate concentration in surface and ground water. Electrochemical Impedance Spectroscopy was employed to detect and display nitrate concentrations, by evaluating the impedance change read by the interdigital transducer immersed in the surface water samples. The test samples were evaluated by commercial equipment (LCR meter) and the designed system. These results were also validated using standard laboratory techniques to assess nitrate concentrations in water samples. The designed system showed a good linear relationship between the measured nitrate concentrations (ranged from 0.01 to 0.5 mg/L) to those measured by the commercial equipment in the collected water samples. However, the current system has the potential to be used to estimate nitrate concentrations in water samples, in real-time. The system can upload the measured nitrate data on a website based on IoT. This system could be used to integrate water quality monitoring sites within farms, or between streams, rivers, and lakes. For the in-situ installation, a robust box containing the whole system would need to be installed at the monitoring site.

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