1. **INTRODUCTION**

According to 2011 census around 70% of people are from villages in India and they depend upon agriculture. Agriculture in Indian villages has been the foremost profession for the people since the ancient period, as they earn their livelihoods from agriculture. Many farmers reduced cultivating due to migration of people from rural to urban, lack of interest, scarcity of agriculture fields and water. One of the major challenges in agriculture is the proper monitoring of Soil health, the air temperature and humidity, proper irrigation at right time, protecting crops from birds and animals.

Measuring soil moisture is important in agriculture to help farmers manage their irrigation systems more efficiently. Not only are farmers able to generally use less water to grow a crop, they are able to increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages. Embedded system for automatic irrigation of an agriculture field offers a potential solution to support site-specific irrigation management that allows producers to maximize their productivity while saving the water.

**1.1 OVERVIEW OF THE PROJECT**

As the talk, the number of companies to help enable their IoT (Internet of Things) ideas. And as a result, we hear about new ideas and solutions that are already solving business challenges with M2M (Machine to Machine) communication. In one of our recent posts, we discussed some of our favourite industrial IoT applications. And today, we want to highlight some of the most compelling IoT applications in another industry agriculture. Agriculture IoT is becoming one of the fastest growing fields (pun intended) within the IoT. Today, more than ever, farmers have to more effectively utilize and conserve their resources. That’s where the need for data comes in, and M2M communication has made the ongoing collection of that info easy. These five wireless sensors in agriculture and farming are making it possible to obtain the meaningful data they’ve been missing out on.

* 1. **NEEDS FOR THE PROJECT**
* To provide precision agriculture and irrigation, to increase the agricultural production and to use resources at the fullest extends so as to give efficient system.
* To make use of mobile application to monitor the condition of the harvest.
* Maintaining a database to collect up-to date information of the cultivation.

**1.3 OBJECTIVE OF THE PROJECT**

The main objective of the project is to use Internet of Things (IoT) as a means that all the collected data will send to Arduino Uno board and it sends to Web portal (Online view) through Wi-Fi. This monitoring can be done through any devices like Mobile, Tab, Laptops and PCs.

**1.4 SCOPE OF THE PROJECT**

The water facility for the irrigation purpose is major issue nowadays and this could be sorted out by using the water level sensor and automatically switching ON and OFF, thus reducing the man work in these areas. The next big issue is the usage of fertilizer levels for different crop types and soil conditions. For this, the pH level sensor comes into the play where if there is any lack of content in soil, then the system alerts us to make use of more urea for their purpose.

**2. LITERATURE SURVEY**

**2.1 A System for precision irrigation using sensor network**

**N. G. Shah**

**Description:** This paper is mainly aimed for monitoring soil moisture and estimating evapotranspiration by considering soil moisture, soil temperature and relative humidity as parameters for measurement. The objectives of the system were to provide precision agriculture and irrigation, to increase the agricultural production, to provide precise monitoring system and to use resources at the fullest extends so as to give efficient system. The system was analyzed for 3-4 months for calculating evapotranspiration rate. For more precise results, the system should be analyzed for 3-4 seasons.

# 2.2 A remote sensing and control irrigation system using distributed wireless sensor network

**Y. Kim**

**Description:** The paper was aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to maximize the productivity with minimal use of water. The system described details about the design and instrumentation of variable rate irrigation, wireless sensor network and real time in field sensing and control by using appropriate software. The whole system was developed using five in field sensor stations which collects the data and send it to the base station using global positioning system (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. The system provides a promising low cost wireless solution as well as remote controlling for precision irrigation. In one of the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity. Sensors were placed below the soil which communicates with relay nodes by the use of effective communication protocol providing very low duty cycle and hence increasing the life time of soil monitoring system. The system was developed using microcontroller, universal asynchronous receiver transmitter (UART) interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency (RF) signals. Some of the researchers developed a remote monitoring system in agricultural greenhouse using wireless sensor and short message service (SMS). The system was applied to strawberry farm and has capability to measure different levels of temperature and thus providing the necessary information to the farmers so that early precaution steps can be taken. System was divided into four parts namely data acquisition, data communication, data presentation and alert notification which also allowed the reverse communication i.e. from farmer side to the base station. The system was cost effective and reliable. The system can be made more effective by considering other environmental parameters and by using recent technologies such as artificial intelligence, neural network, etc.

# 2.3 A Wi-Fi based smart sensor network for agricultural environment

**G. Mendez**

**Description:** This paper considers temperature, humidity, light intensity, air pressure and soil moisture as main parameters. The objectives of the system were to develop a smart sensing wireless network for agriculture, to reduce cost and effort of incorporating wiring, to enhance flexibility and mobility for the system. The system was useful for transferring and logging the data from various nodes. The work can be done for interchangeability of nodes and for self powering from solar panels.

**2.4 A ZigBee based smart sensing platform for monitoring environmental parameters**

**M. Haefke**

**Description:** This model monitors several environmental parameters such as temperature, relative humidity, pressure and sunlight with the use of microcontroller which serve as a smart weather station. The research was based on characteristics such as use of low cost equipment, accurate sensors and flexibility in data handling. Use of XBee module provided the wider range and reduced the current consumption of the circuit. The analysis was done by fabricating six prototype weather stations tasting for more than 24 hours. For better results and analysis system has to be reviewed for more time period. In one of the studies, researchers developed a drip irrigation automated system using wireless technology. The objectives of the system were to develop a low cost wireless controlled irrigation system, to monitor water content of soil in real time, to remove the need for workmanship for flooding irrigation. The designed system has three unit namely base station unit, valve unit and sensing unit which were applied for controlling drip irrigation of 1000 dwarf cherry trees. Sensors were placed 20cm deep and 50cm away from the trees. The analysis of the system produced the circa linear graph between volumetric water content and time for which system was analyzed. It was a low cost and reliable system having advantages such as preventing moisture stress of trees, minimizing excessive use of water and ensuring of rapid growing weeds. System may be more effective by considering other environmental factors. Some of the researchers narrated a FPGA based real time monitoring system for agricultural field by considering temperature (wet and dry both), humidity and light intensity as their main parameters. The proposed system was an embedded based which monitors and control microclimatic parameters on regular basis so as to maximize the production of crop with reducing human intervention. The system was low cost, automated and can be made effective by considering other environmental parameters and real time fault detection. Some researchers developed a monitoring system to measure the water level in agriculture using sensor network which offers precision irrigation. They developed a routing algorithm which provides information related to water level as well as useful in computing threshold values based on transmission range. The algorithm was based on distances of wireless information from source to sink node as well as on minimum angle between source and destination. The proposed system can be optimized by the use of algorithms based on genetics and neural network.

**2.5 FEASIBILITY STUDY**

A Feasibility study is a test of system proposal regarding to its work ability, impact on organization, ability to meet the user needs and effective use of resources. Thus when a new applications is proposed, it normally goes through a feasibility study before it is approved for development. Thus during feasibility analysis for this project, primary areas of interest are considered. This is done by investigating existing system in the area under investigation and generating ideas about the new system. However there are constraints possessed by many factors.

**Economic Feasibility:**

“Economic justification is generally ‘bottom line’ consideration for most system”. Economic feasibility is measured in such a way that the proposed system has sufficient benefits in the economic point of view. Economical analysis is most frequently used for evaluating the effectiveness of a proposed system. More commonly known as cost benefits and saving that is expected from a proposed system is beneficial to organization. The present project is economically feasible because it makes use of easy available sensors and components and every other economic resources.

**Technical Feasibility:**

Technical feasibility is centre around the existing system for communication and to what extent it can suppose the proposed system. According to the feasibility of the proposed system is analyzed and the technical requirements such as software and hardware facilities, input and output devices are identified. It is also one of the important phases of the system development activities. Current equipment, Existing software and hardware technologies are sufficient to develop the proposed system. The smart agriculture monitoring system is purely feasible based on Internet of Things (IoT) as lot of module used correlate with each other.

**Resource Feasibility:**

Based on all the collective items, this project is resource feasible since fully functional system and agricultural and natural feedback are the main aspects of this project.

**Social Feasible:**

The system is very useful to the current generation farmers to enhance themselves in all the aspects of cultivation and sticking to the valuable resources provided to them.

**3. SYSTEM DESIGN**

**3.1 PROPOSED SYSTEM ARCHITECTURE DESIGN**

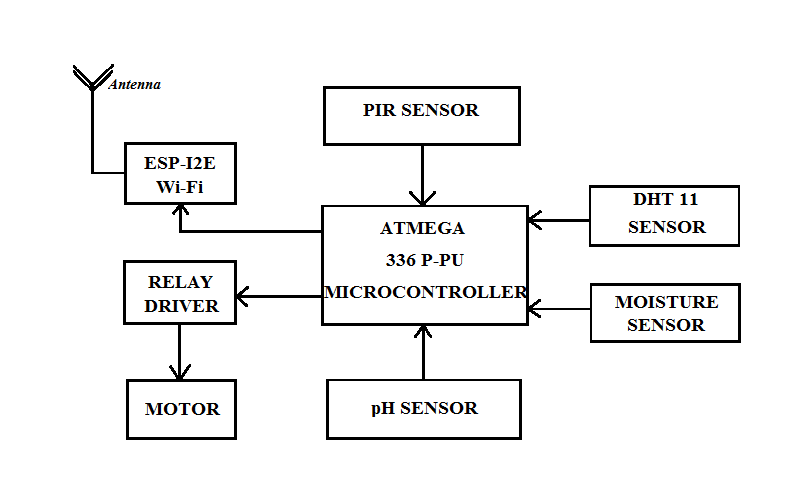
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Figure3.1 Proposed System Architecture

The architecture of the system consists of several sensors and microcontrollers, each performing individual operations on its own. The Kit operates on +5V current supply with two separate power connections for the motor and the Microcontroller.

Every component except motor is a digital component, whereas pH sensor is a sole analog component on its working. An external circuit is attached to relay its digital readings to the microcontroller.

Wi-Fi module helps to transfer the readings to the user system and the database storage is maintained in a private cloud storage network. Every individual sensor component contributes individually and they are all correlated by the centre of the system called the ATMEGA 336 P-PU microcontroller.

**3.1.2 COMPONENTS USED:**

* + AT mega 328 (microcontroller)
  + PIR(passive infrared sensor)
  + pH sensor
  + Water level sensor
  + Humidity sensor

1. **AT mega 328:**

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family.

**Specifications:**

The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

**Pin diagram:**

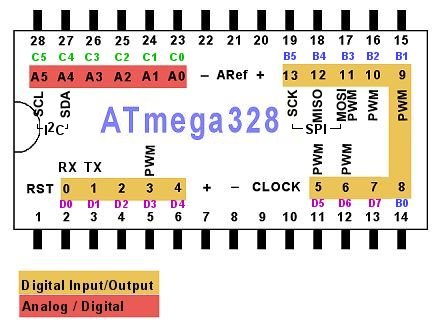
****

Fig 3.2 ATmega328 microcontroller

**Key parameters:**

|  |  |
| --- | --- |
|  | **Value** |
| CPU type | 8-bit AVR |
| Performance | 20 [MIPS](https://en.wikipedia.org/wiki/Instructions_per_second) at 20 MHz[[2]](https://en.wikipedia.org/wiki/ATmega328#cite_note-m8271ds-2) |
| [Flash memory](https://en.wikipedia.org/wiki/Flash_memory) | 32 kB |
| [SRAM](https://en.wikipedia.org/wiki/Static_random-access_memory) | 2 kB |
| [EEPROM](https://en.wikipedia.org/wiki/EEPROM) | 1 kB |
| Pin count | 28-pin [PDIP](https://en.wikipedia.org/wiki/Dual_in-line_package), [MLF](https://en.wikipedia.org/wiki/Quad_Flat_No-leads_package#Variants), 32-pin [TQFP](https://en.wikipedia.org/wiki/Quad_Flat_Package), MLF[[2]](https://en.wikipedia.org/wiki/ATmega328#cite_note-m8271ds-2) |
| Maximum operating frequency | 20 MHz |
| Number of touch channels | 16 |
| Hardware QTouch Acquisition | No |
| Maximum I/O pins | 23 |
| External interrupts | 2 |
| [USB](https://en.wikipedia.org/wiki/USB) Interface | No |
| USB Speed | – |

Table 3.1 Key parameters of ATmega328 microcontroller

**Serial alternative:**

A common alternative to the ATmega328 is the "PicoPower" ATmega328P. A comprehensive list of all other members of the megaAVR series can be found on the Atmel website.

**Applications:**

As of 2018 the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models.

1. **PIR sensor (passive infrared sensor):**



Fig 3.3 PIR sensor

A **passive infrared sensor** (**PIR sensor**) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.  
**Operating principal:**

All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose.

The term *passive* in this instance refers to the fact that PIR devices do not generate or radiate energy for detection purposes. They work entirely by detecting infrared radiation emitted by or reflected from objects. They do not detect or measure "heat".

**Pin diagram:**

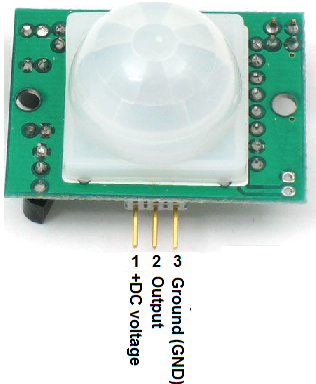


Fig 3.4 PIR sensor PIN diagram

**Applications (PIR based motion detector):**

A PIR-based motion detector is used to sense movement of people, animals, or other objects. They are commonly used in burglar alarms and automatically-activated lighting systems. They are commonly called simply "PIR", or sometimes "PID", for "passive infrared detector".

1. **pH level sensor:**

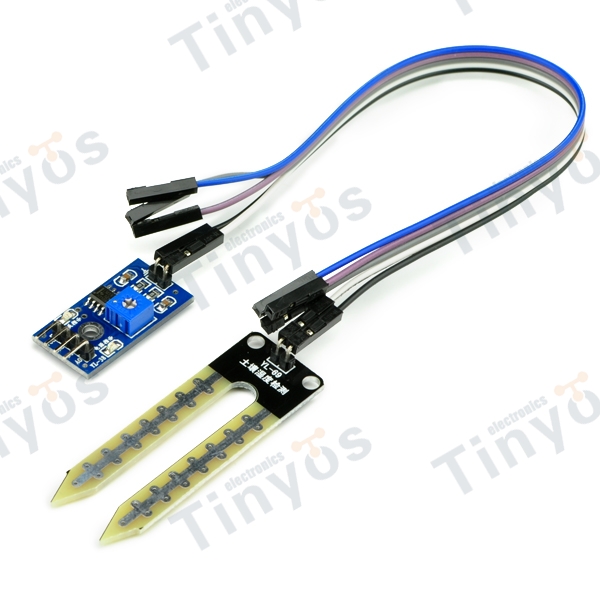
****

Fig 3.5 pH level sensor

pH level sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

**Pin diagram:**

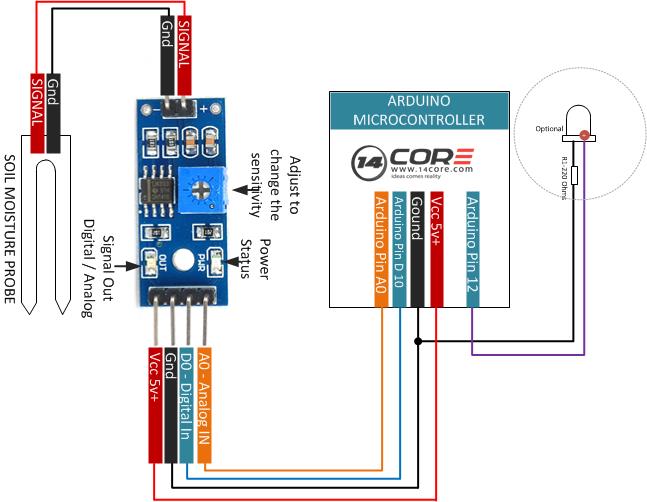
****

Fig 3.6 pH level sensor PIN diagram

**Applications:**

* **Agriculture**:

Measuring soil moisture is important for agricultural applications to help farmers manage their irrigation systems more efficiently. Knowing the exact soil moisture conditions on their fields, not only are farmers able to generally use less water to grow a crop, they are also able to increase yields and the quality of the crop by improved management of soil moisture during critical plant growth stages.

* **Landscape irrigation**:

In urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a "smart" irrigation controller that prevents irrigation cycles when the soil is already wet, e.g. following a recent rainfall event. Golf courses are using soil moisture sensors to increase the efficiency of their irrigation systems to prevent over-watering and leaching of fertilizers and other chemicals into the ground.

* **Research:**

pH level sensors are used in numerous research applications, e.g. in agricultural science  and horticulture including irrigation planning, climate research, or environmental science including solute transport studies and as auxiliary sensors for soil respiration measurements.

* **Simple sensors for gardeners**:

Relatively cheap and simple devices that do not require a power source are available for checking whether plants have sufficient moisture to thrive. After inserting a probe into the soil for approximately 60 seconds, a meter indicates if the soil is too dry, moist or wet for plants.

1. **Water level sensor:**

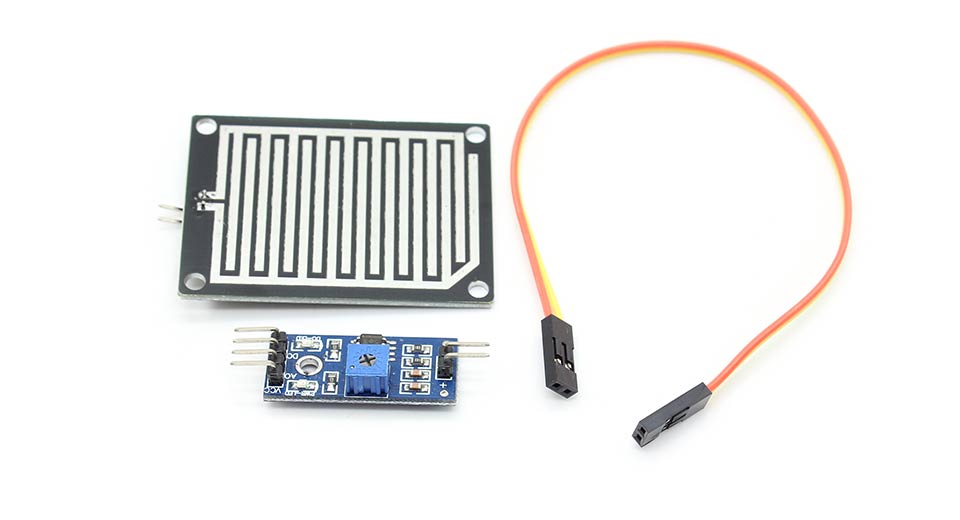


Fig 3.7 Water level sensor

A **Water level** or *rain switch* is a switching device activated by rainfall. There are two main applications for rain sensors. The first is a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall. The second is a device used to protect the interior of an automobile from rain and to support the automatic mode of windscreen wipers. An additional application in professional satellite communications antennas is to trigger a rain blower on the aperture of the antenna feed, to remove water droplets from the Mylar cover that keeps pressurized and dry air inside the wave-guides.

**Humidity sensor:**

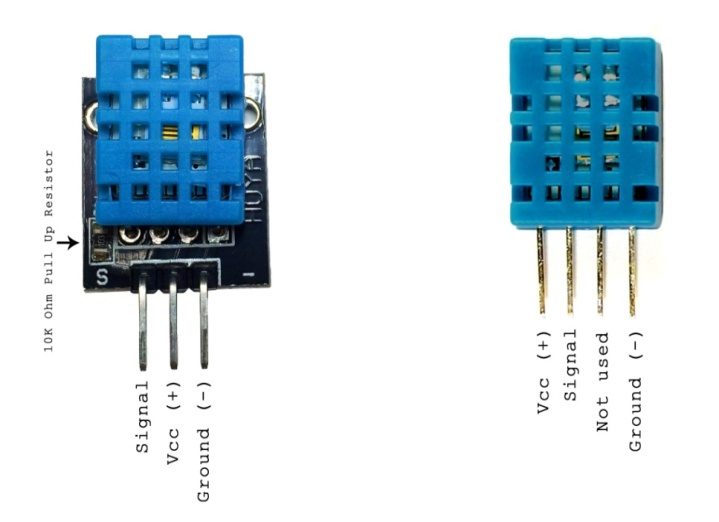


Fig 3.8 Humidity sensor

This DFRobot DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC

Temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor’s internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users’ request.

**3.2 DATA FLOW DIAGRAM FOR PROPOSED SYSTEM**

**LEVEL 0**

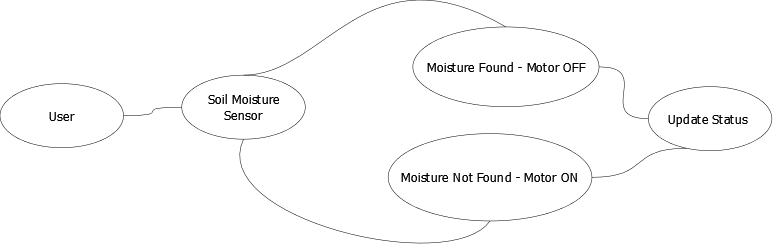
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Fig 3.9 Level 0 - Soil Moisture sensing and updating

**LEVEL 1**

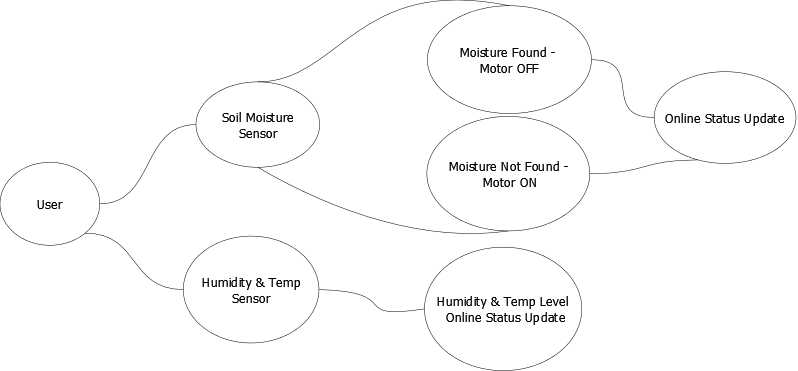
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Fig 3.10 Level 1 - Soil moisture and Humidity level updating

**LEVEL 2**

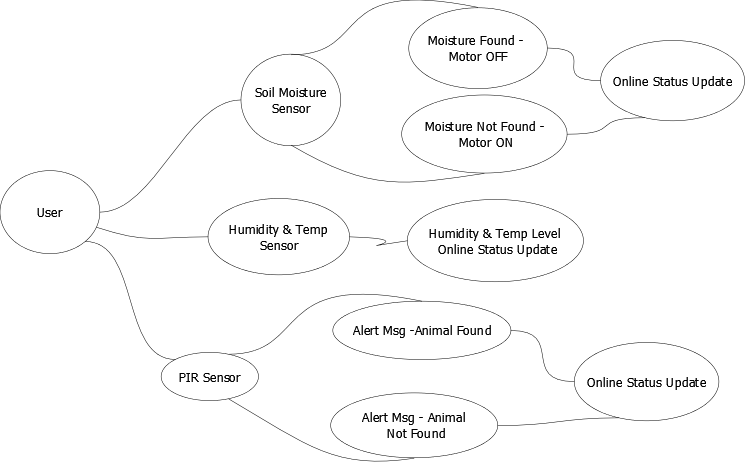
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Fig 3.11 Level 2 - PIR Sensor Updating

**LEVEL 3**

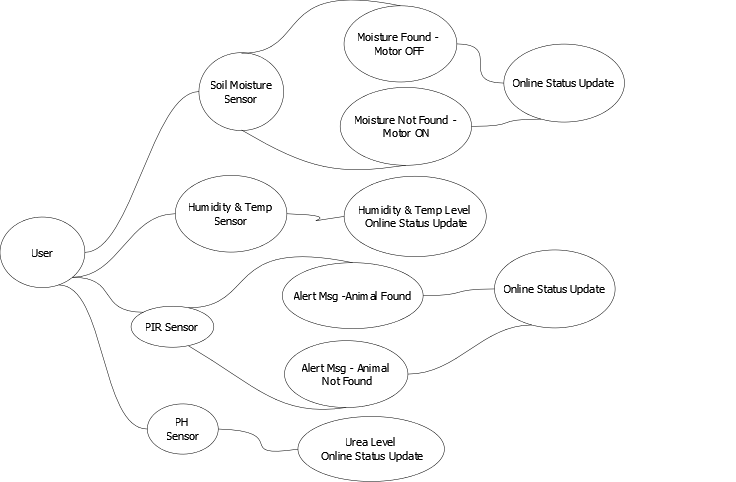


Fig 3.12 Level 3 - pH level updating

**3.3 UML DIAGRAM FOR PROPOSED SYSTEM**

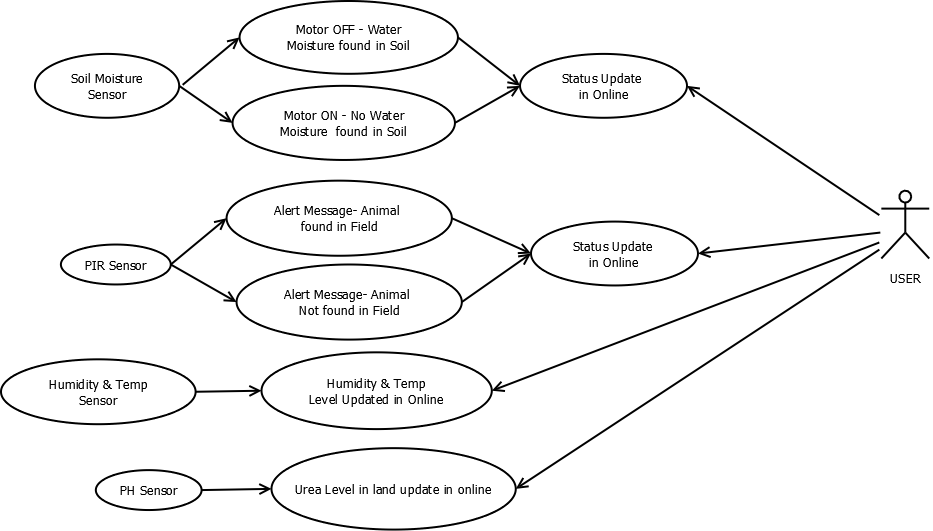


Figure3.13 UML Use Case Diagram

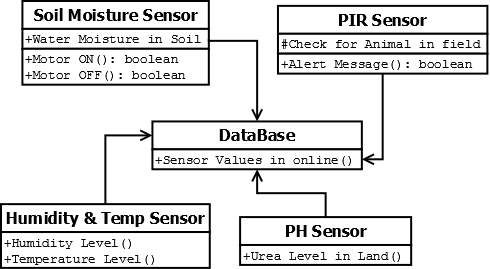


Figure 3.14 UML Class Diagram

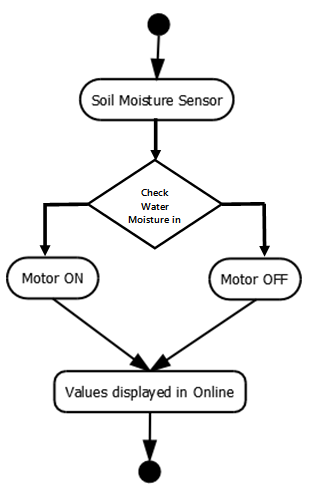


Figure 3.15 UML Activity Diagram 1

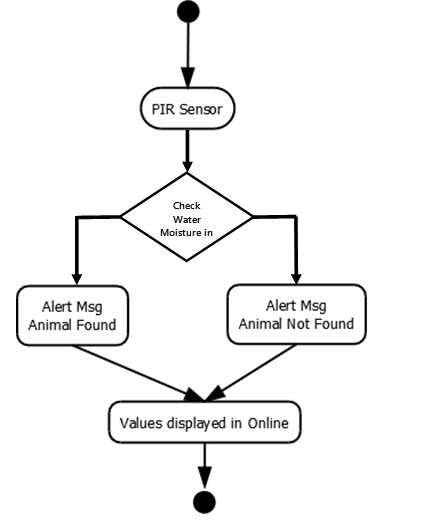


Fig 3.16 UML Activity Diagram 2

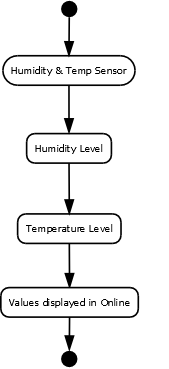


Fig 3.17 UML Activity Diagram 3

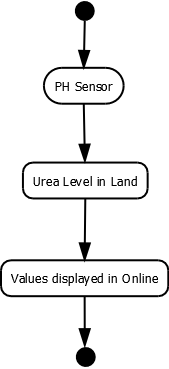


Fig 3.18 UML Activity Diagram 4

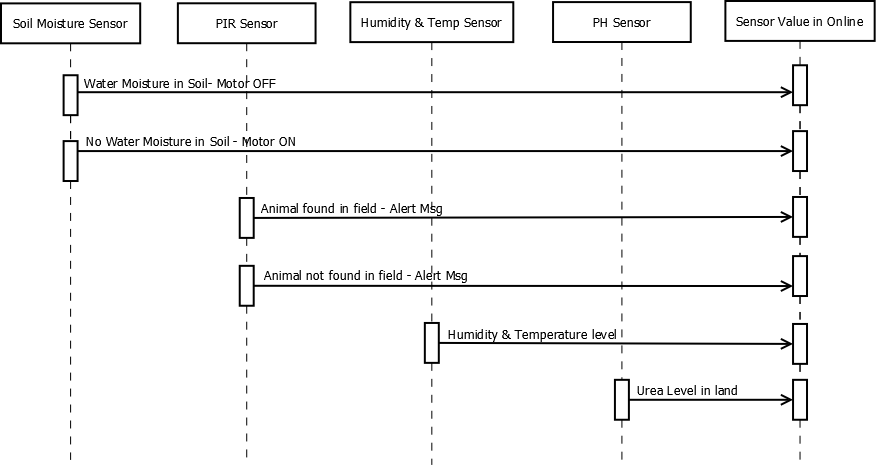


Figure3.19 UML Sequence Diagram

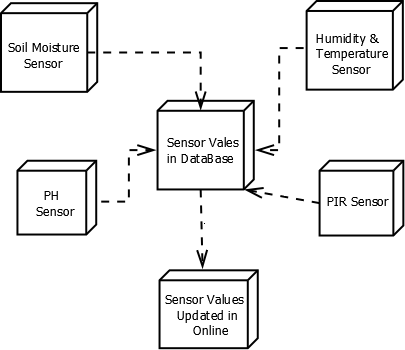


Fig 3.20 UML Deployment Diagram

* 1. **MODULE DESCRIPTION**

**3.4.1 Wi-Fi Module**

**3.4.2 Digital Sensing components**

**3.4.3 Analog Sensing component**

**3.4.4 Microcontroller**

**3.4.5 Data Reception and alert processing**

**3.4.6 Cloud Storage**

**3.4.1 Wi-Fi Module**

The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications.

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controller based design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated WiFi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. Espressif Systems’ Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

**Features:**

• 802.11 b/g/n

• Integrated low power 32-bit MCU

• Integrated 10-bit ADC

• Integrated TCP/IP protocol stack

• Integrated TR switch, balun, LNA, power amplifier and matching network

• Integrated PLL, regulators, and power management units

• Supports antenna diversity

**Memory Organization:**

ESP8266EX Wi-Fi SoC is embedded with memory controller, including SRAM and ROM. MCU can visit the memory units through iBus, dBus, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor. According to our current version of SDK provided, SRAM space that is available to users is assigned as below:

▪RAM size < 36kB, that is to say, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap and data section is around 36kB.)

▪There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

****

Table 3.2 Recommended operating conditions

**3.4.2 Digital Sensing components**

Since the project is mainly based on 3 different types of sensors, a brief description of them are required. Each one performs their own individual operations; the three different types of sensors used are **PIR Sensor, Humidity and Temperature level Sensor and Water level sensor.**

**A) PIR Sensor:**

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.  
 PIRs are basically made of a pyroelectric sensor (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

For many basic projects or products that need to detect when a person has left or entered the area, or has approached, PIR sensors are great. They are low power and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Note that PIRs won't tell you how many people are around or how close they are to the sensor, the lens is often fixed to a certain sweep and distance (although it can be hacked somewhere) and they are also sometimes set off by house pets. PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram  
 The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.  
  
**B) Humidity and Temperature level Sensor:**

This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor complex. Its technology ensures the high reliability and excellent long-term stability. A high-performance 8-bit microcontroller is connected. This sensor includes a resistive element and a sense of wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high cost performance advantages.  
 Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the OTP program memory, internal sensors detect signals in the process, we should call these calibration coefficients. The single-wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters, making it a variety of applications and even the most demanding applications. The product is 4-pin single row pin package. Convenient connection, special packages can be provided according to users need.

**Specification**-  
 Supply Voltage: +5 V  
 Temperature range: 0-50 °C error of ± 2 °C  
 Humidity: 20-90% RH ± 5% RH error  
 Interface: Digital

**C) Water level Sensor:**

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity though a potentiometer.

The analog output is used in detection of drops in the amount of rainfall. Connected to 5V power supply, the LED will turn on when induction board has no rain drop, and DO output is high. When dropping a little amount water, DO output is low, the switch indicator will turn on. Brush off the water droplets, and when restored to the initial state, outputs high level.

**Specifications**

 Adopts high quality of RF-04 double sided material.

 Area: 5cm x 4cm nickel plate on side,

 Anti-oxidation, anti-conductivity, with long use time;

 Comparator output signal with clean waveform, driving ability, over 15mA;

 Potentiometer adjust the sensitivity;

 Working voltage 5V;

 Output format: Digital switching output (0 and 1) and analog voltage output;

 With bolt holes for easy installation;

 Small board PCB size: 3.2cm x 1.4cm;

 Uses a wide voltage LM393 comparator.

**3.4.3 Analog Sensing component**

The only analog component to be used here is the pH level sensor. Since it is the sole analog component, an A/D convertor is used along with it. This sensor notes the pH level of the soil and then its data is converted from analog to digital using the A/D convertor.

The pH sensor regulates values from 0-7 from its scale of acidic to neutral levels.

**3.4.4 Microcontroller**

ATmega-328 is basically an Advanced Virtual RISC (AVR) micro-controller. It supports the data up to eight (8) bits. ATmega-328 has 32KB internal built in memory. This micro-controller has a lot of other characteristics.  
 ATmega-328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega-328 has 2KB Static Random Access Memory (SRAM).

ATmega-328 has several different features which make it the most popular device in today’s market. These features consist of advanced RISC architecture, good performance, low power consumption, real timer counter having separate oscillator, 6 PWM pins, programmable serial USART, programming lock for software security, throughput up to 20 MIPS etc. ATmega-328 is mostly used in Arduino. ATmega-328 is an AVR micro-controller having twenty eight (28) pins.

**Description:-**

Functions associated with the pins must be known in order to use the device appropriately. ATmega328 pins are divided into different ports which are given in detail

* VCC is a digital voltage supply.
* AVCC is a supply voltage pin for analog to digital converter.
* GND denotes Ground and it has a 0V.
* Port A consists of the pins from PA0 to PA7. These pins serve as analog input to analog to digital converters. If analog to digital converter is not used, port A acts as an eight (8) bit bidirectional input/output port.
* Port B consists of the pins from PB0 to PB7. This port is an 8 bit bidirectional port having an internal pull-up resistor.
* Port C consists of the pins from PC0 to PC7. The output buffers of port C has symmetrical drive characteristics with source capability as well high sink.
* Port D consists of the pins from PD0 to PD7. It is also an 8 bit input/output port having an internal pull-up resistor.

AREF is an analog reference pin for analog to digital converter. ATmega 328 has three types of memories e.g. EEPROM, SRAM etc. Flash Memory has 32KB capacity. It has an address of 15 bits. It is a Programmable Read Only Memory (ROM). It is non volatile memory.

SRAM stands for Static Random Access Memory. It is a volatile memory i.e. data will be removed after removing the power supply.

EEPROM stands for Electrically Erasable Programmable Read Only Memory. It has a long term data.

ATmega-328 has thirty two (32) General Purpose (GP) registers.  
These all of the registers are the part of Static Random Access Memory (SRAM).  
ATmega328 is the most micro-controller that is used while designing.  
ATmega328 is the most important part of Arduino. The program is uploaded on the AVR micro-controller attached on Arduino.

**3.4.5 Data Reception and alert processing**

**A) Data Reception:**

Once all the sensors are correlated, then these sensors collect the respective data and show them to the project link which comes by the address, [www.smartagroids-iot.science](http://www.smartagroids-iot.science) . All the necessary information is shown in the main page for every automatic refresh period of 20 seconds.

The data can be retrieved from the cloud storage with the access of the server administrator.

**B) Alert Processing:**

Alert system only acts for two processes. One is for the reduction of the water level and the other is for the intrusion detection. If any of the following occurs, then an alert is passed and a pop-up will be shown.

**3.4.6 Cloud Storage**

Cluster storage is the format of maintaining the data set of the sensors, different levels of them and related sorts of data as a table in the data base.

**4. REQUIREMENT SPECIFICATION**

* 1. **HARDWARE REQUIREMENTS**
* Atmega328 microcontroller
* Soil moisture sensor
* Humidity sensor
* Temperature sensor
* Urea level sensor
* Wi-Fi module
* Power supply

**4.2 SOFTWARE REQUIREMENTS**

* + 1. **Arduino IDE - Features:**

1. Arduino boards are relatively inexpensive compared to other microcontroller platforms.

2. The Arduino software runs on Windows, Macintosh OSX and Linux operating system.

3. Simple – Clear programming environment and flexible enough for beginners and more advanced users as well.

* + 1. **Proteus Simulation – Features:**

1. Ability to integrate information both horizontally and vertically.

2. Organize data by user role and content and allow access to that data in accordance with position.

3. Integrates data from desperate systems into a consolidated view that can be aggregated at all levels for all stakeholders.

**4.2.3 MySql - Features:**

1. Relational Database Management System (RDBMS).

2. Easy to use.

3. It is secure.

4. Client/ Server Architecture.

5. Free to download.

6. It is scalable.

**4.3.4 Dreamweaver – Features:**

1. Syntax highlighting.

## 2. Easy code completion.

## 3. Real-time syntax checking.

## 4. Visualization of web content.

**4.3.5 Wamp – Features:**

1. Centralized GUI for all important features.

2. Focus on a light weight and fast system.

3. Preconfigured WAMP System with Apache, PHP, MySQL, etc.

**5. IMPLEMENTATION**

**5.1 SAMPLE CODE**

1. **Sensors co-ordination & control:**

#include <dht.h>

dht DHT;

#define DHT11\_PIN 8

static int moistpin = 12;//Digital input

static int pirpin =11;//Digital input

//int motor = 13;

int Soilmoisture(void);

float Phsensor (void);

int PIRsensor(void);

void setup()

{

Serial.begin(115200);

pinMode(moistpin,INPUT\_PULLUP);

pinMode(pirpin,INPUT\_PULLUP);

pinMode(motor,OUTPUT);

}

void loop()

{

int moi = Soilmoisture();

int pir = PIRsensor();

int chk = DHT.read11(DHT11\_PIN);

int temp= DHT.temperature;

int hum = DHT.humidity;

float ph = Phsensor();

//delay(2000);

String data ="moisture="+String(moi)+ "&pir=" + String(pir)+ "&temp=" + String(temp)+ "&hum=" + String(hum)+ "&ph=" + String(ph);

Serial.println(data);

}

float Phsensor (void)

{

float ph=analogRead(A0);

ph=(ph\*5)/1024;

return(ph);

}

int Soilmoisture(void)

{

int moisture=digitalRead(moistpin);

return(moisture);

}

int PIRsensor(void)

{

int pir=digitalRead(pirpin);

return(pir);

}

1. **Wi-Fi module:**

#include <ESP8266WiFi.h>

const char\* ssid = "smartagroids";

const char\* password = "12345678";

WiFiServer server(80);

String data;

void setup() {

Serial.begin(115200);

// Connect to WiFi network

Serial.println();

Serial.println();

Serial.print("Connecting to ");

Serial.println(ssid);

WiFi.begin(ssid, password);

while (WiFi.status() != WL\_CONNECTED) {

delay(500);

Serial.print(".");

}

Serial.println("");

Serial.println("WiFi connected");

// Start the server

server.begin();

Serial.println("Server started");

// Print the IP address

Serial.println(WiFi.localIP());

}

void loop() {

WiFiClient client = server.available();

//data ="moisture="+String(moisture)+ "&pir=" + String(pir)+ "&temp=" + String(temp)+ "&hum=" + String(hum)+ "&ph=" + String(ph);

if (client.connect("www.smartagroids-iot.science",80))

{

// REPLACE WITH YOUR SERVER ADDRESS

client.println("POST /add.php HTTP/1.1");

client.println("Host:www.smartagroids-iot.science"); // SERVER ADDRESS HERE TOO

client.println("Content-Type: application/x-www-form-urlencoded");

client.print("Content-Length: ");

if(Serial.available() >0)

{

data=Serial.readString();

}

client.println(data.length());

client.println();

client.print(data);

Serial.println(data);

}

if (client.connected()) {

client.stop(); // DISCONNECT FROM THE SERVER

}

delay(20000); // WAIT 30 seconds BEFORE SENDING AGAIN

}

**5.2 SAMPLE SCREENSHOTS**

**A) HUMIDITY SENSING**

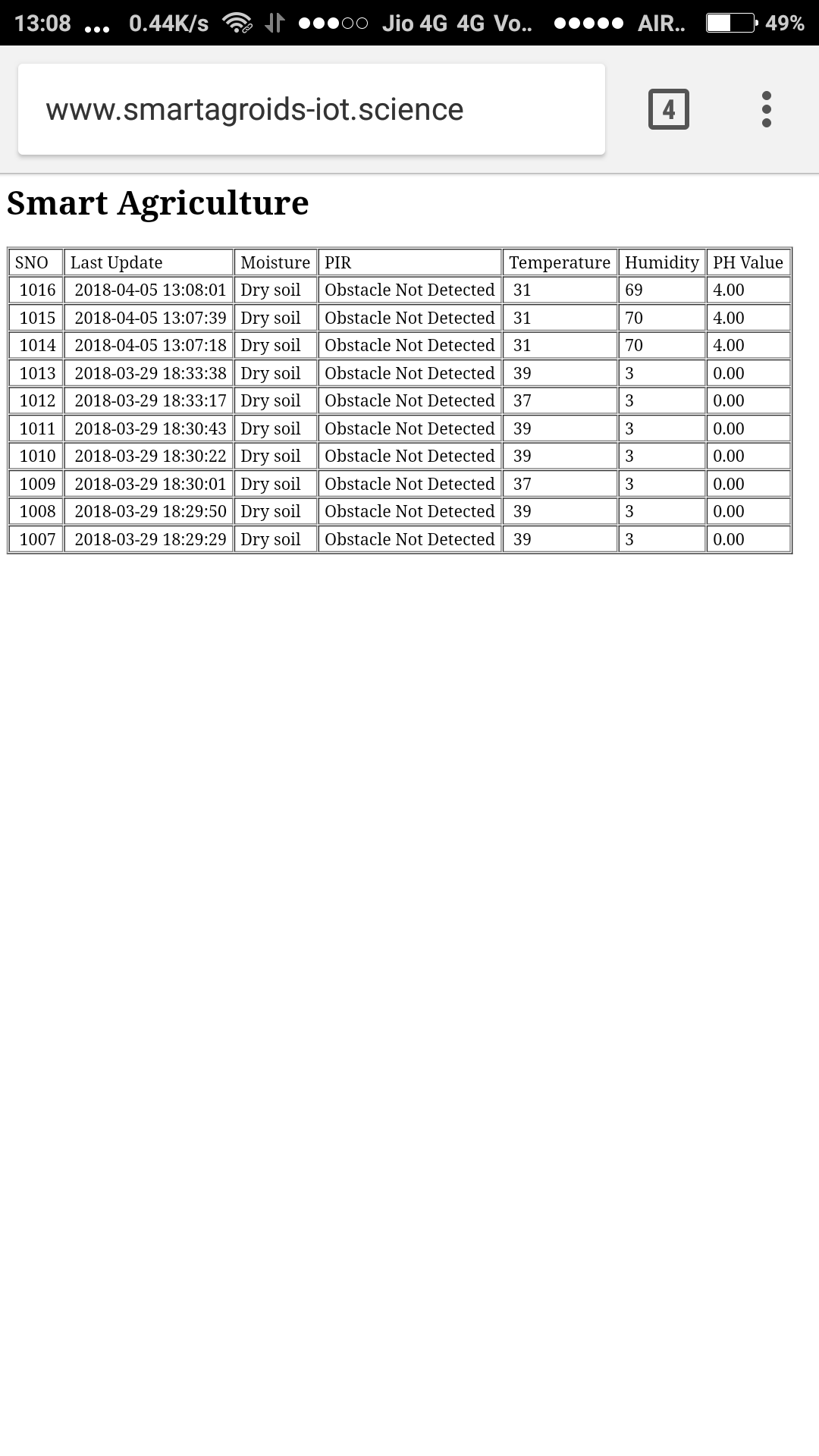
****

Fig 5.1 Humidity at normal level

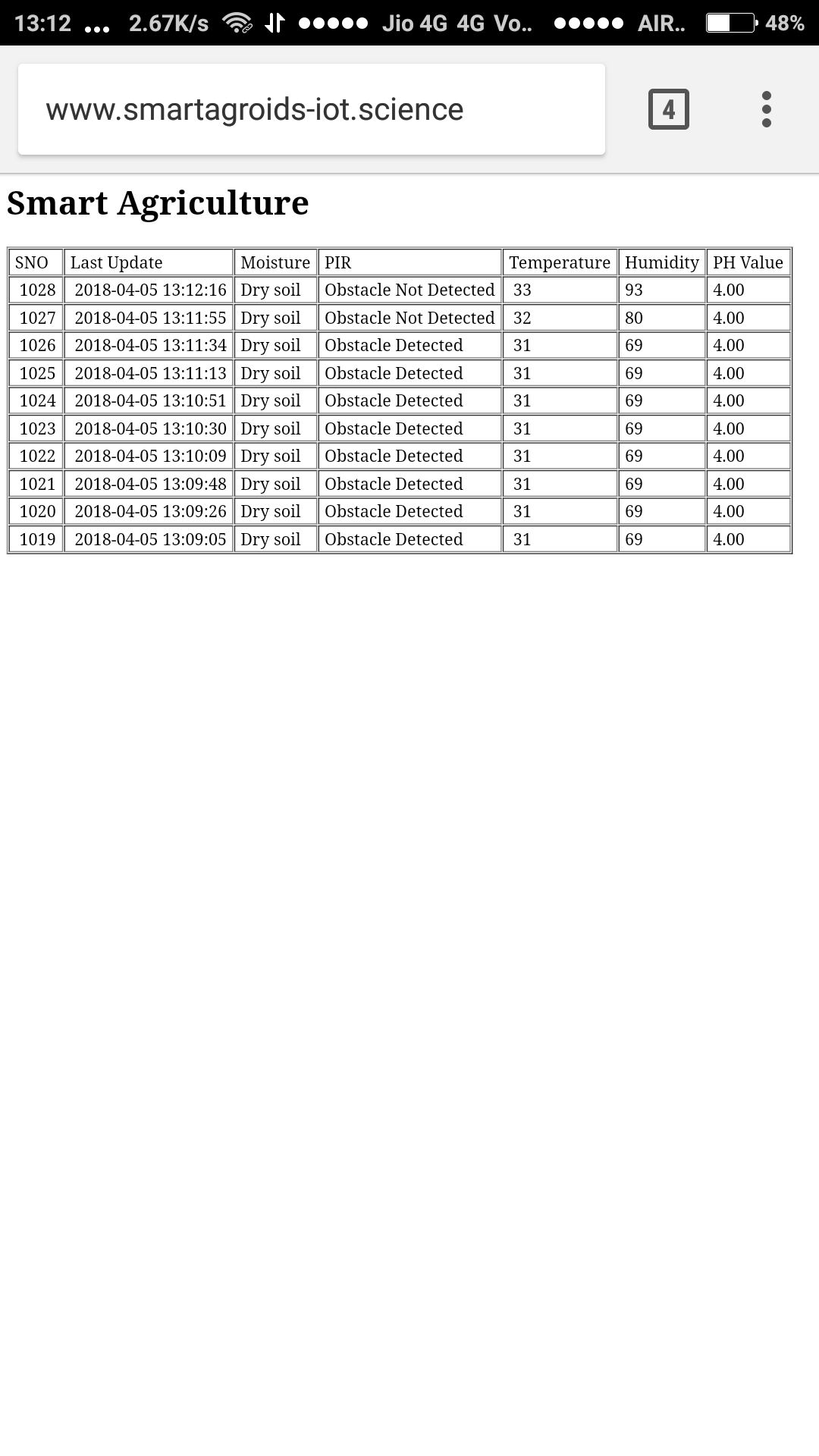


Fig 5.2 Humidity level when changed

1. **TEMPERATURE LEVEL SENSING**

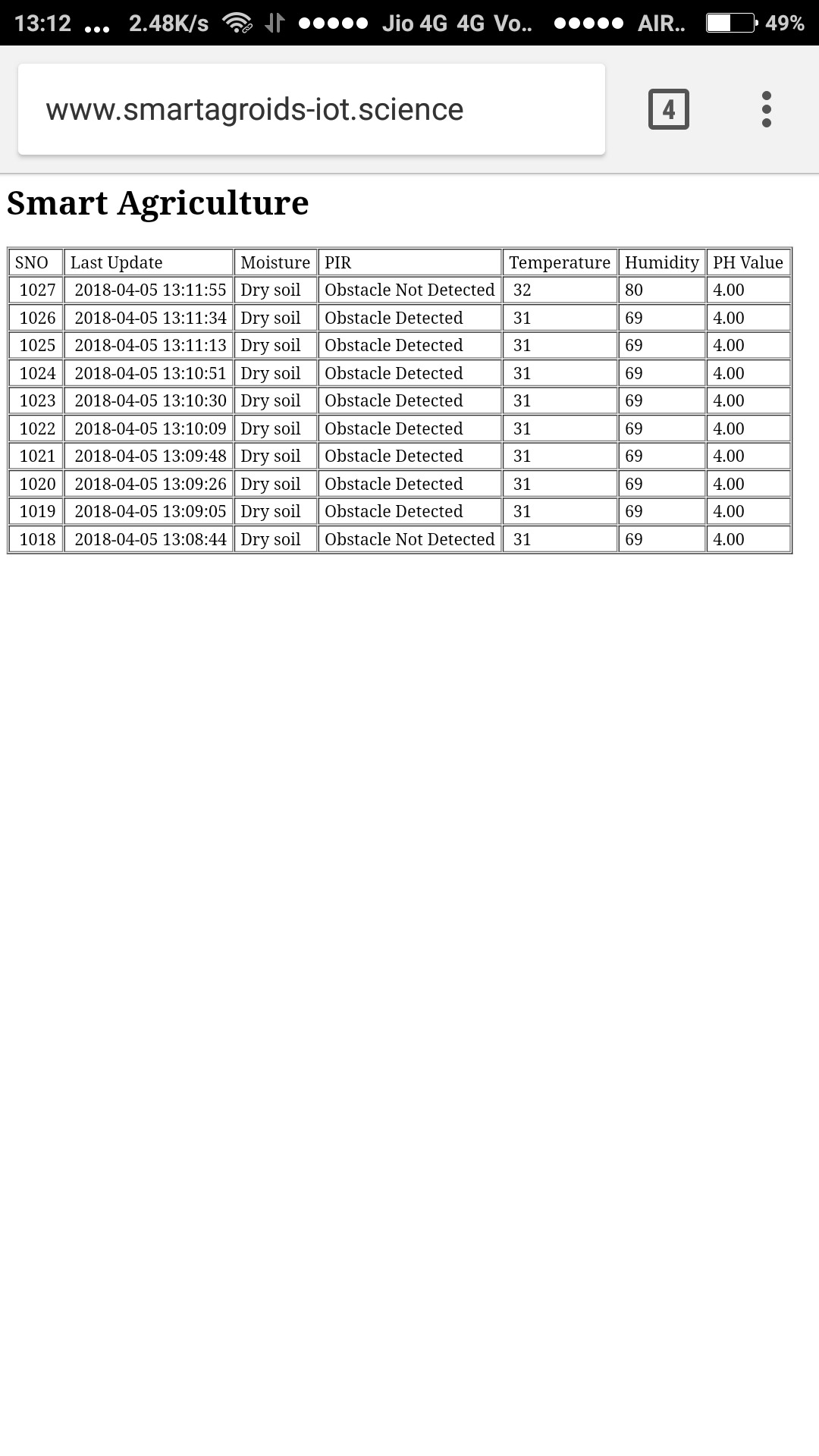
****

Fig 5.3 Reading before Temperature Change

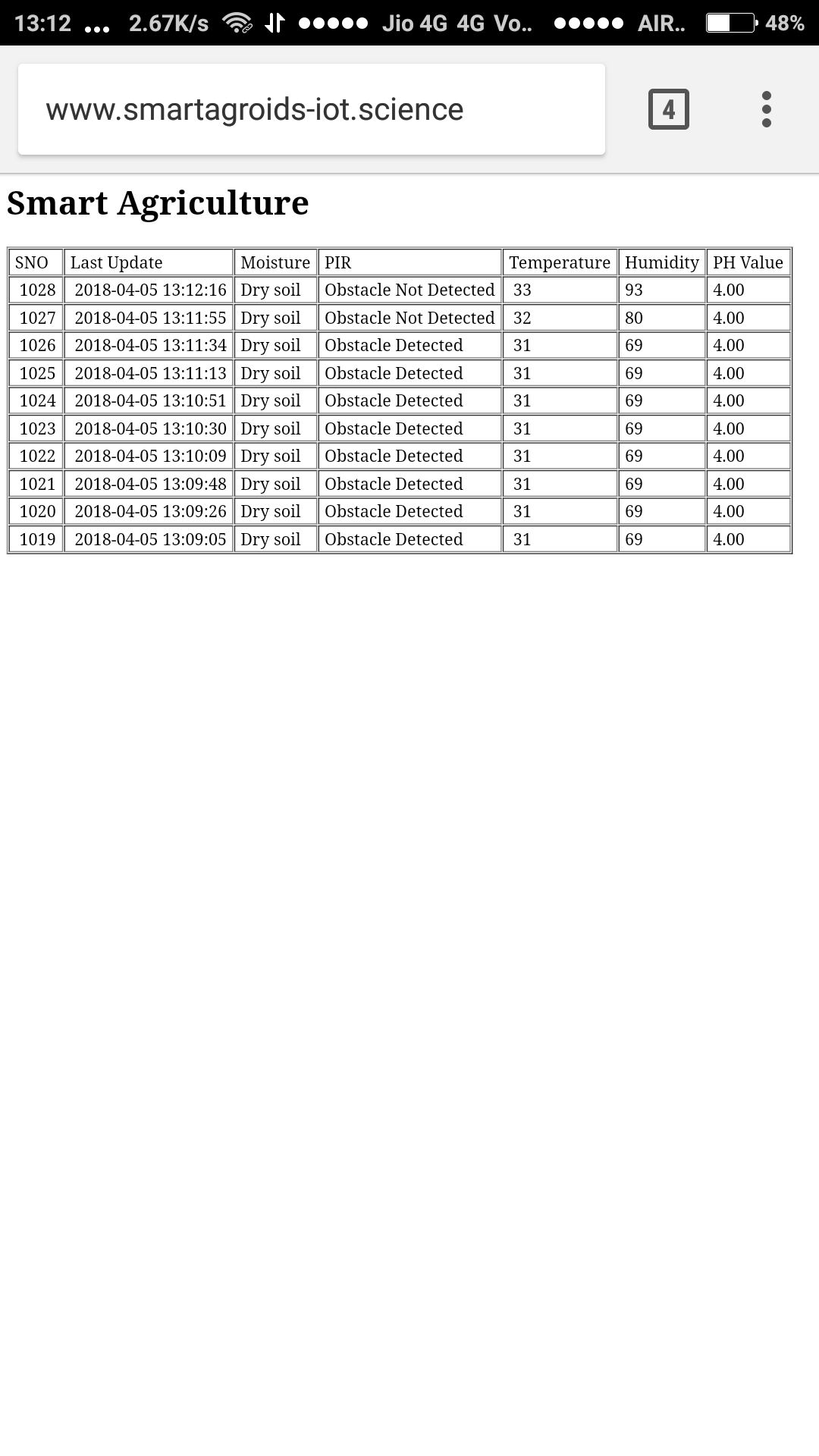


Fig 5.4 Increase in Level of Temperature

**C) INTRUSION DETECTION**

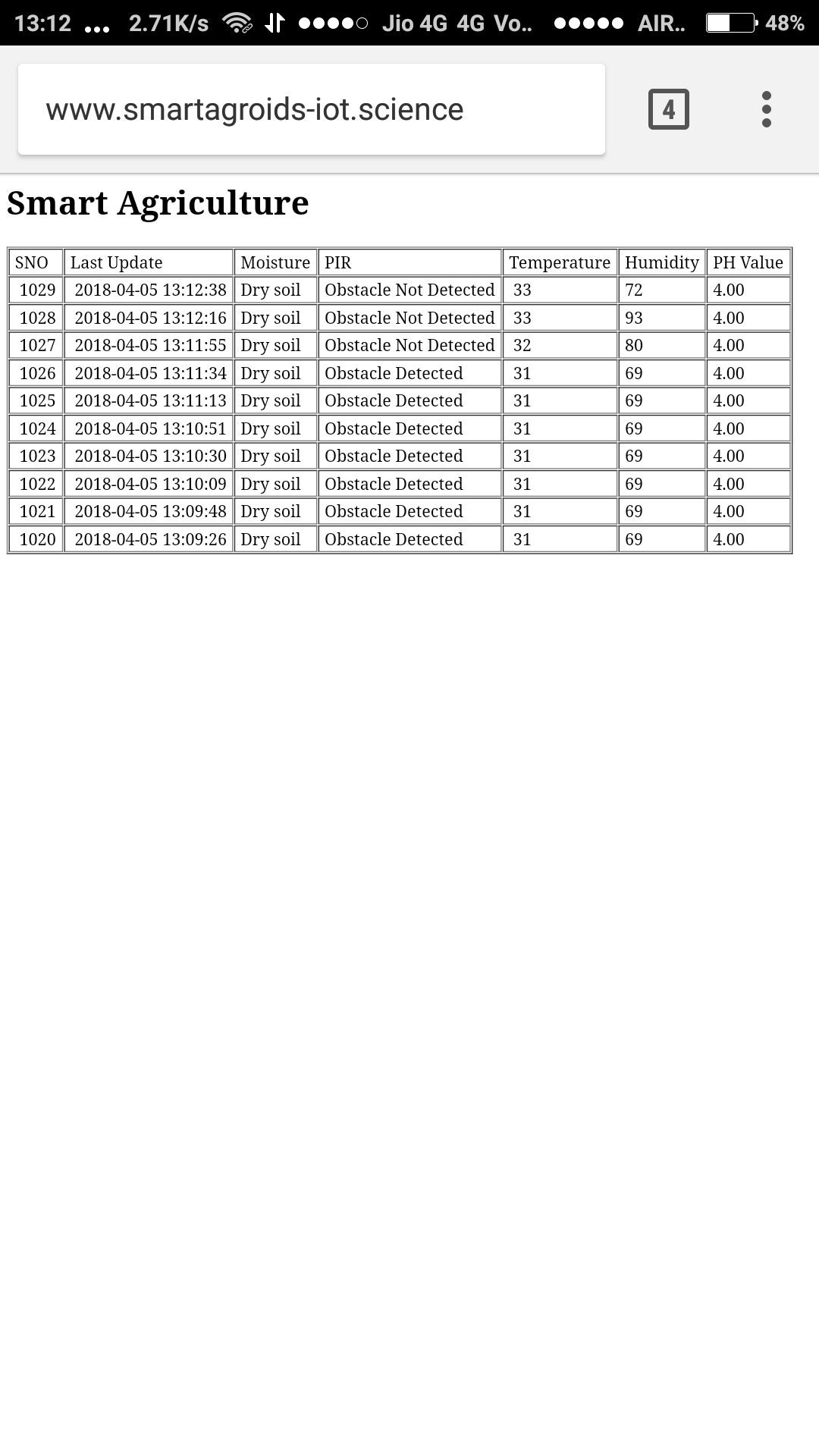
****

Fig 5.5 No detection in Obstacle

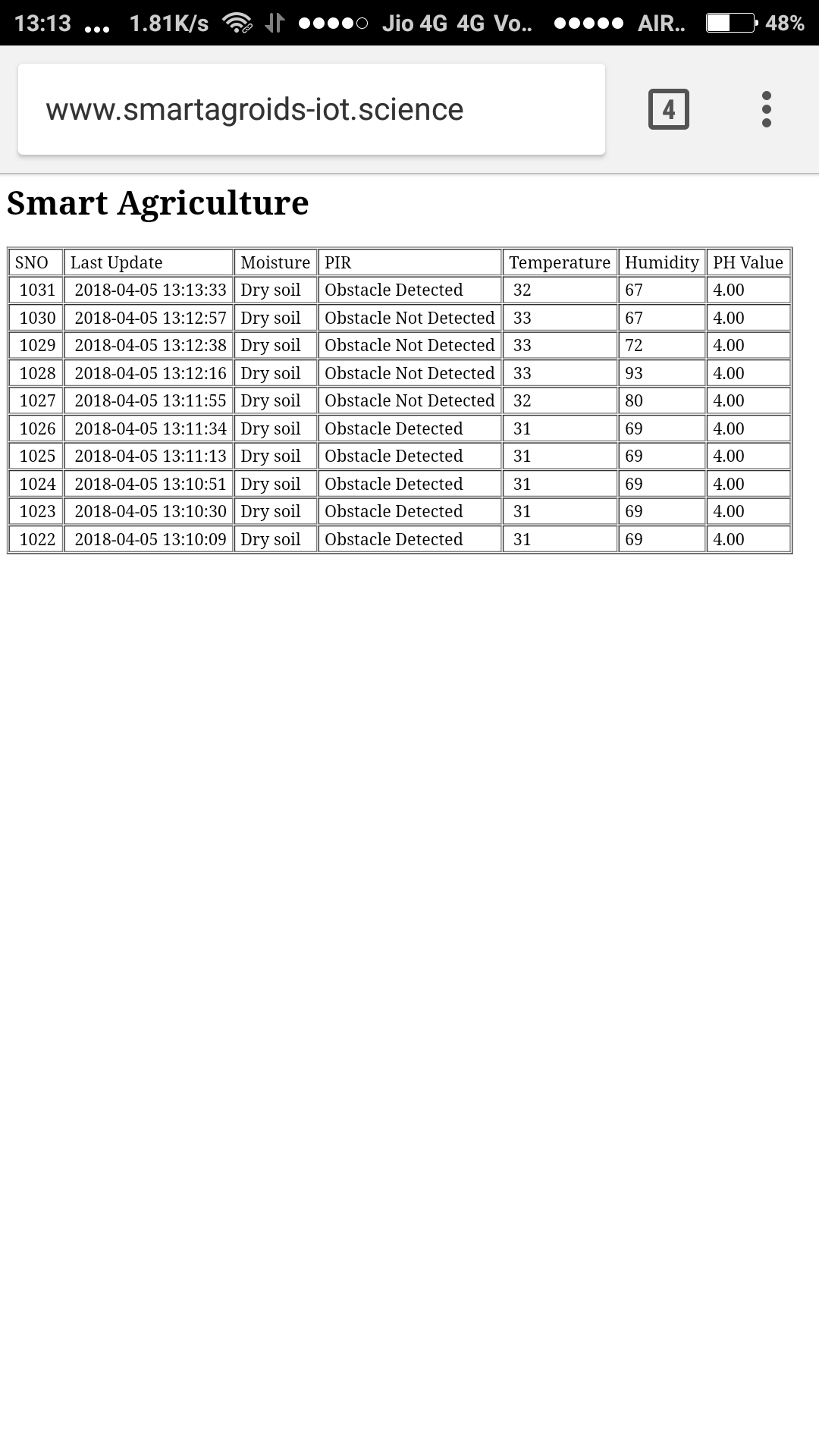


Fig 5.6 Detection of an obstacle

**D) pH LEVEL SENSING**

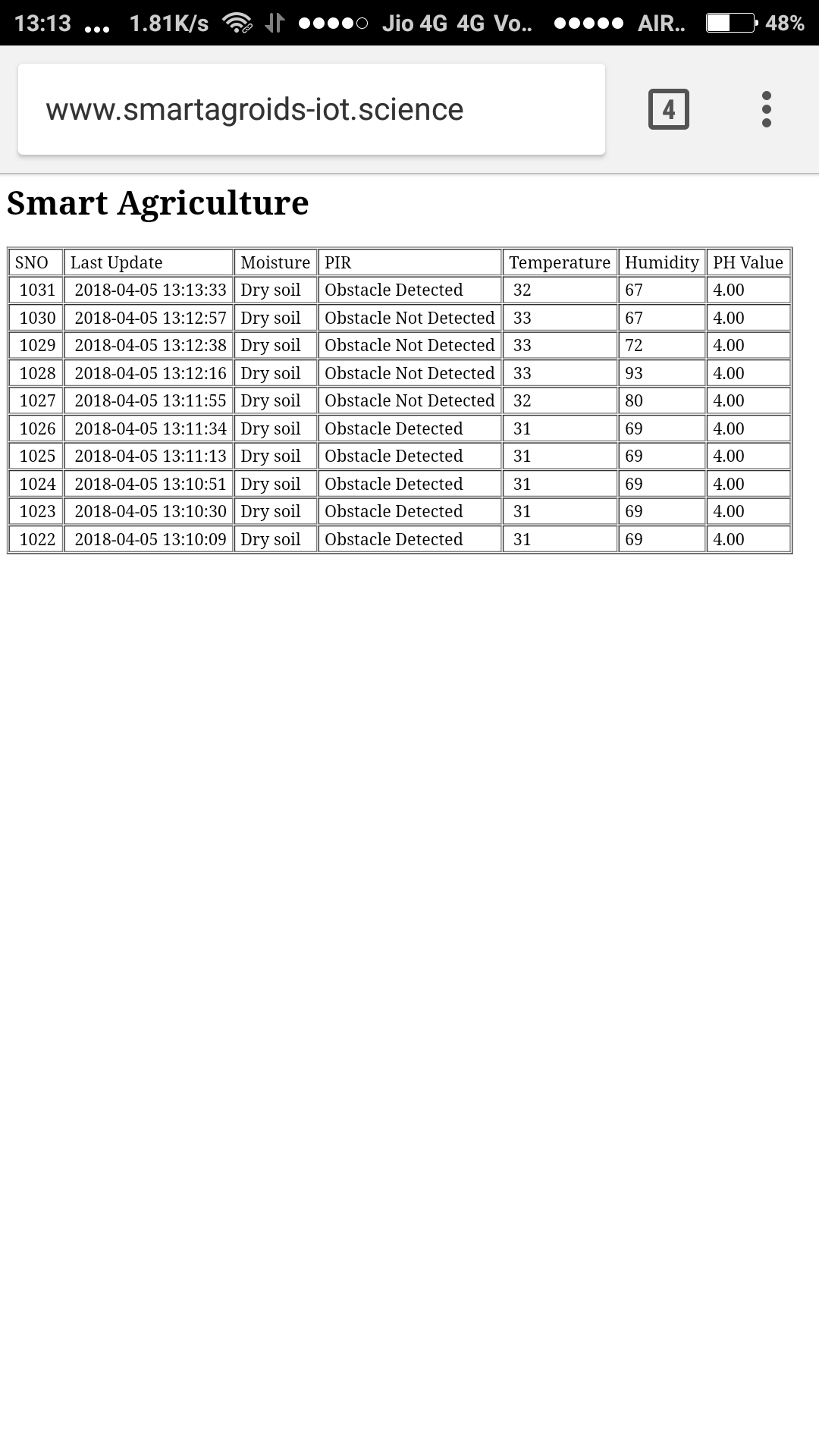
****

Fig 5.7 pH at normal level

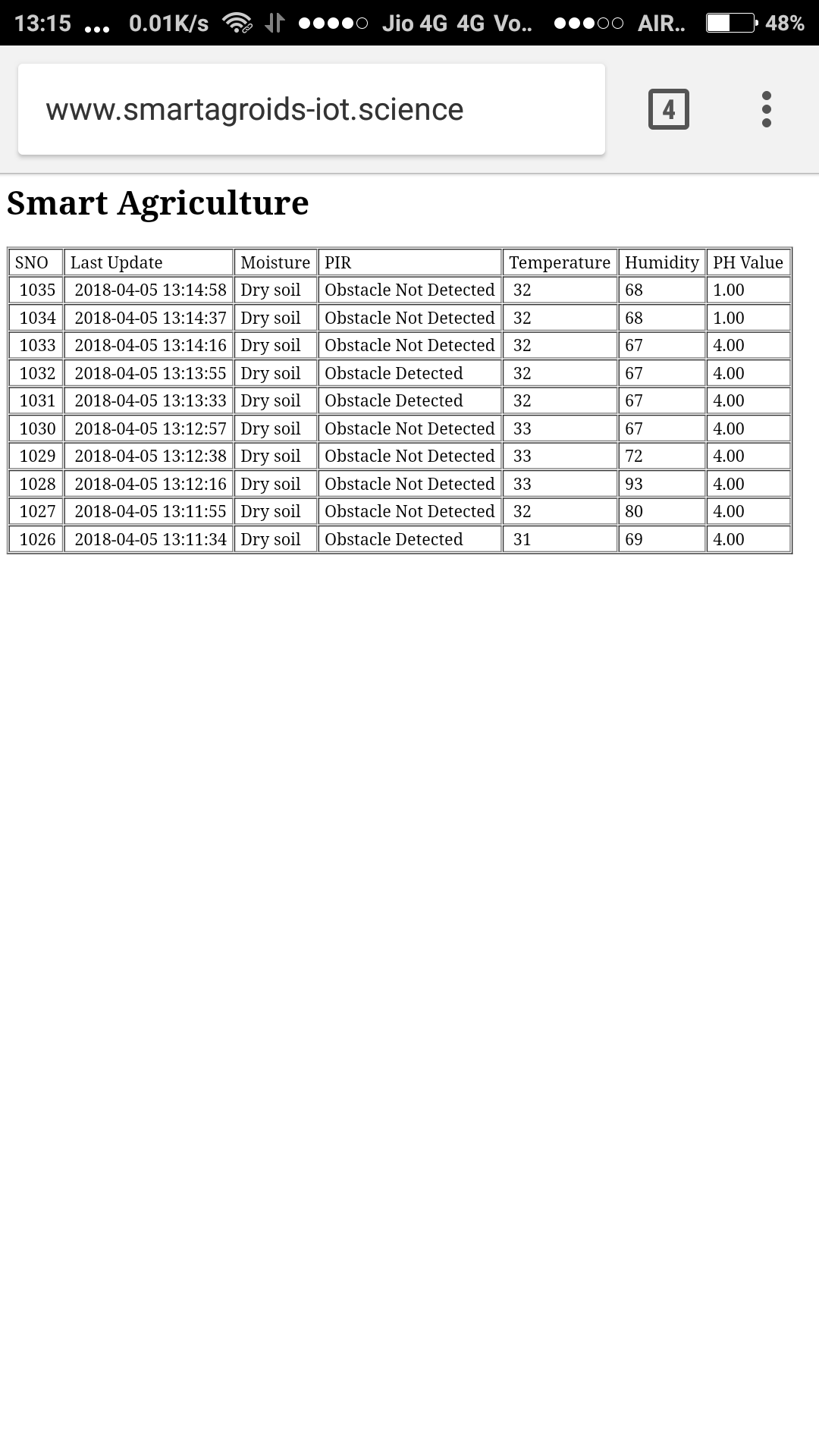


Fig 5.8 pH at “1” when urea is low

**E) WATER LEVEL SENSING**

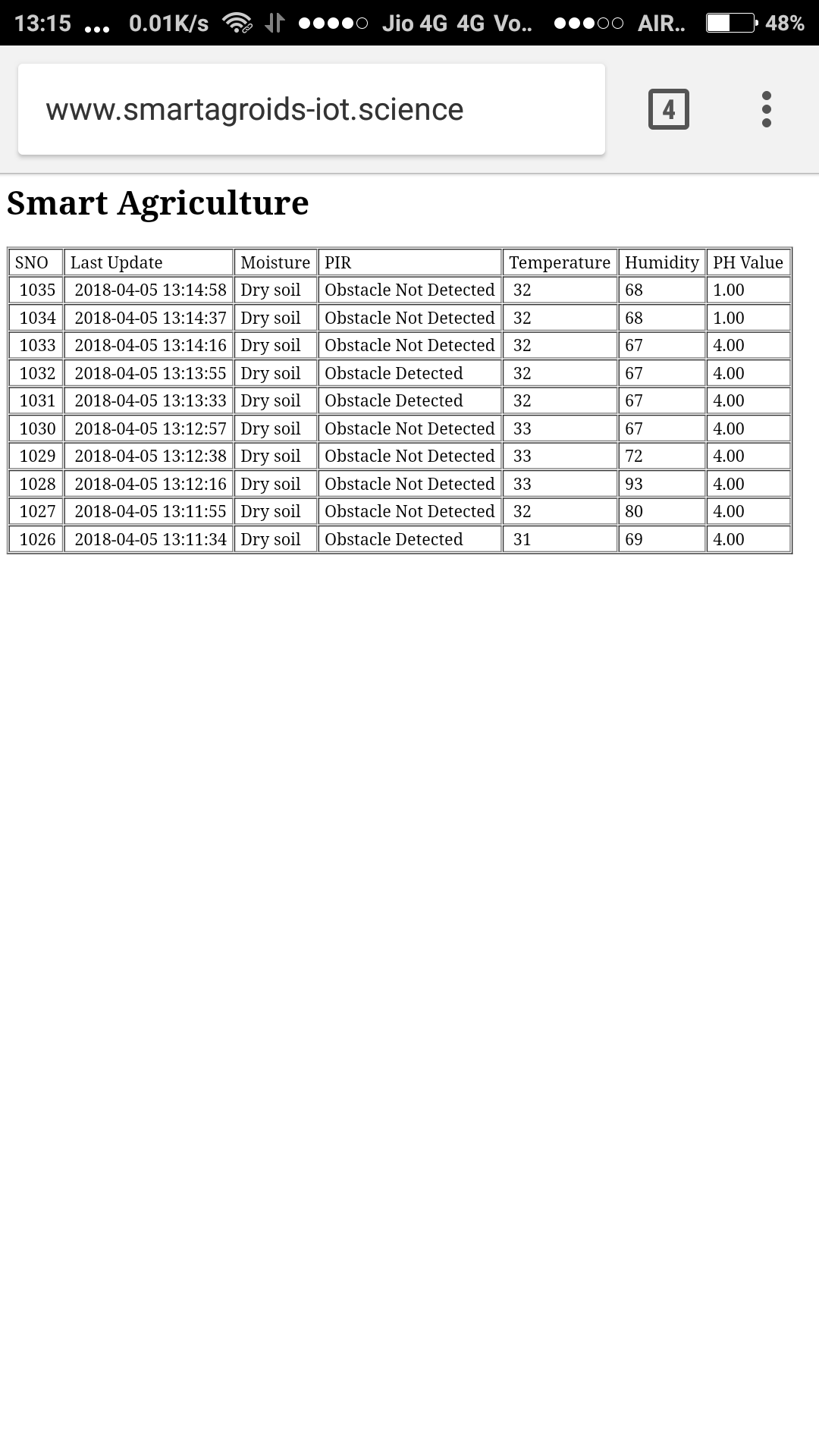
****

Fig 5.9 Water not present in the soil

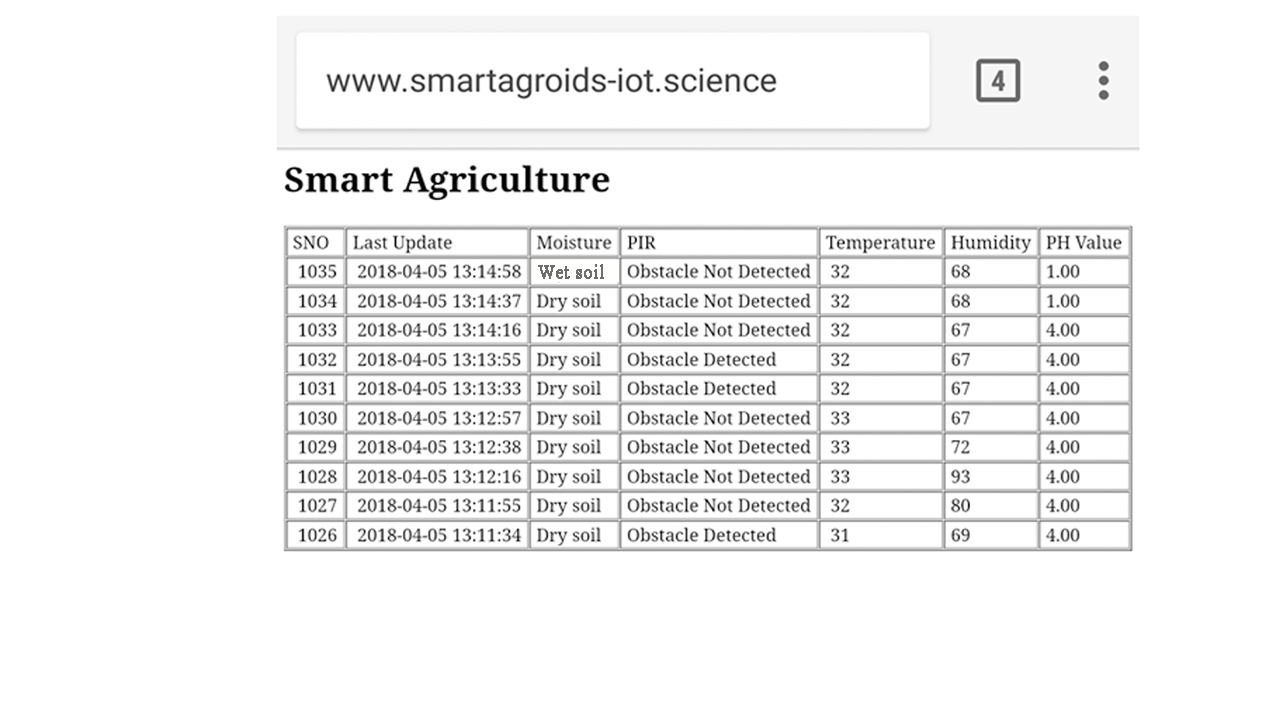


Fig 5.10 Water present in soil

**F) REAL-TIME WORKING COMPONENTS**

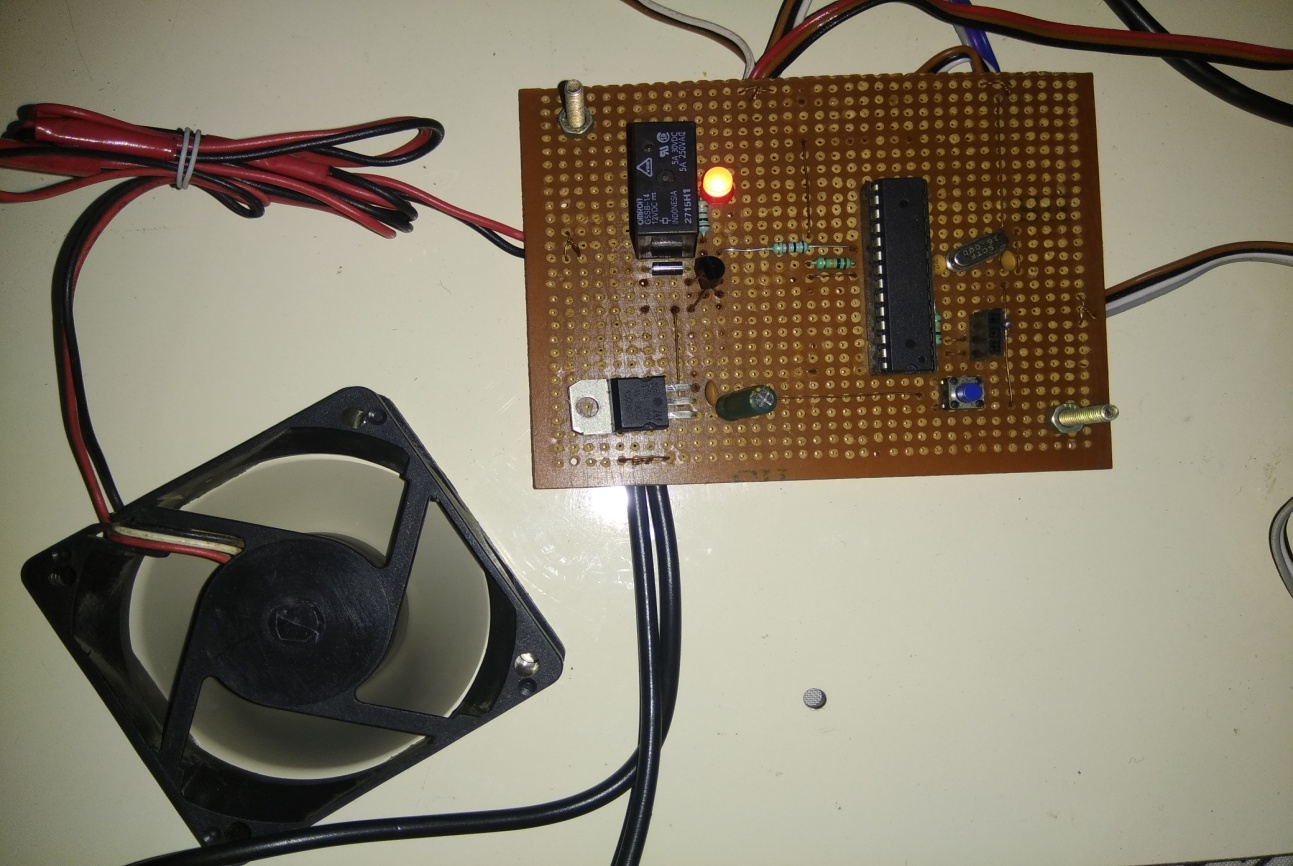
****

Fig 5.11 Working of Motor and alert system

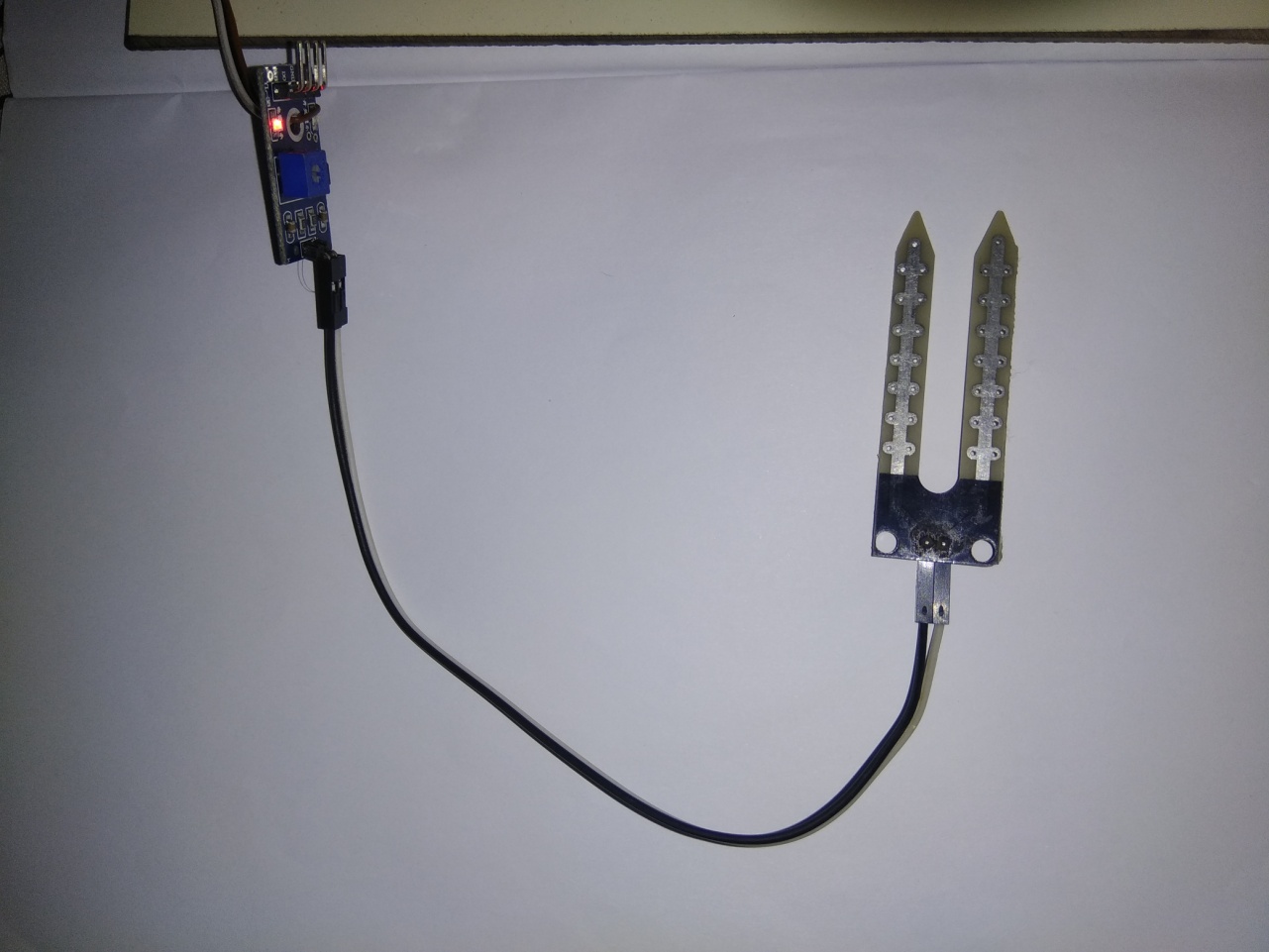


Fig 5.12 pH Sensor and its A/D convertor

****

Fig 5.13 Working of Water Level sensor



Fig 5.14 Working of Wi-Fi module

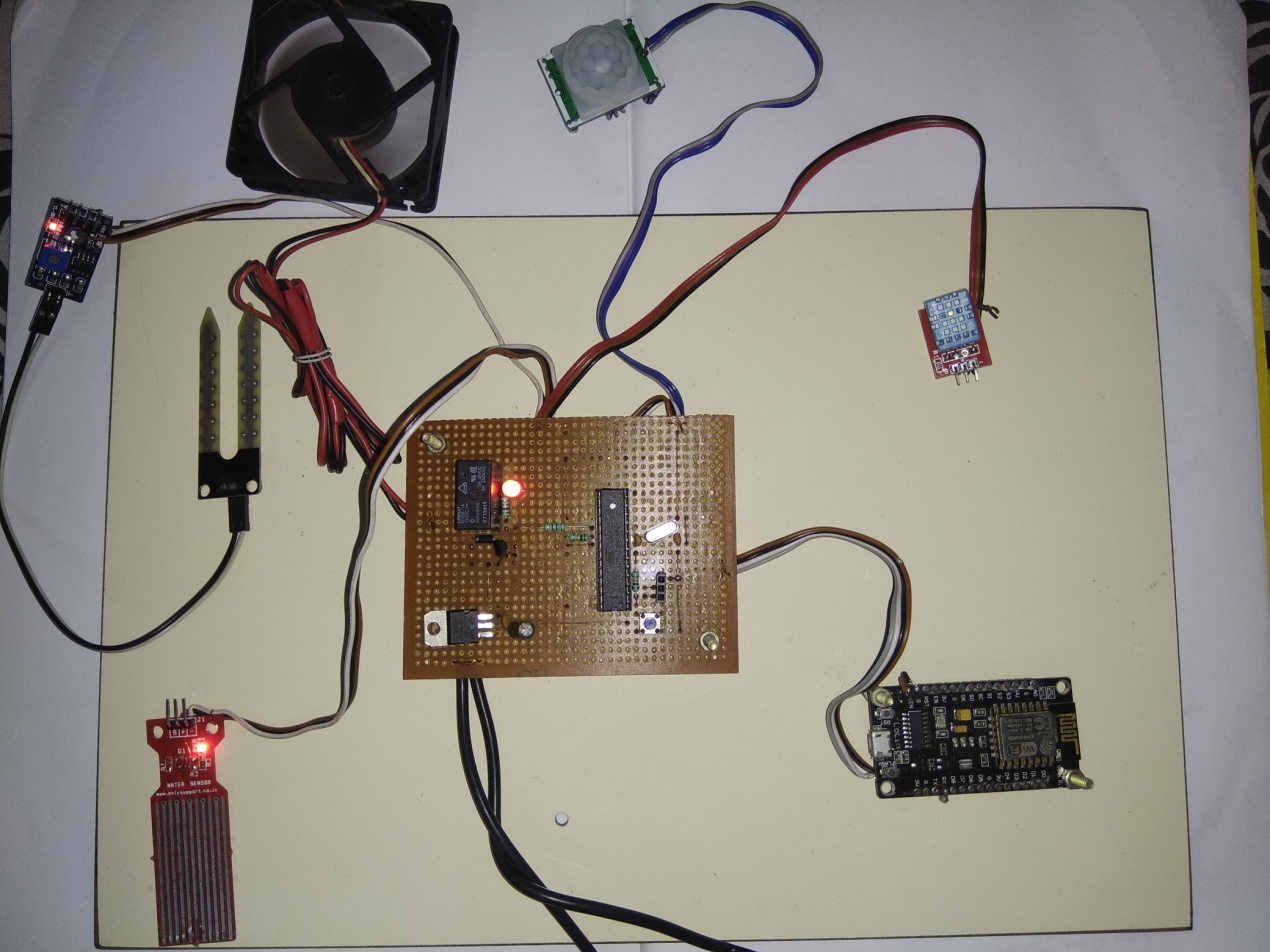


Fig 5.15 Correlation of ATmema328 microcontroller

**6. TESTING AND MAINTENANCE**

Testing is an important step in software development life cycle. The process of testing takes place at various stages of development in programming. This is a vital step in development life cycle because the process of testing helps to identify the mistakes and sends the program for correction.

This process gets repeated at various stages until the final unit or program is found to be complete thus giving a total quality to the development process. The various levels and types of testing found in a software development life cycle are as follows:

6.1. White Box Testing

6.2. Black Box Testing

6.3. Unit Testing

6.4. Regression Testing

6.5. Integration Testing

6.6. Smoke Testing

6.7. Alpha Testing

6.8. Beta Testing

**6.1 WHITE BOX TESTING**

For doing this testing process the person have to access to the source code of the product to be tested. So it is essential that the person doing this white box testing have some knowledge of the program being tested. Though not necessary it would be more worth if the programmer itself does this white box testing process since this testing process requires the handling of source code.

**6.2 BLACK BOX TESTING (Functional Testing)**

This is otherwise called as functional testing. In contrary to white box testing here the person who is doing the black box testing need not have the programming knowledge. This is because the person doing the black box testing would access the output or outcomes as the end user would access and would perform thorough functionality testing to check whether the developed module or product behaves in functionality in the way it has to be.

**6.3 UNIT TESTING**

This testing is done for each module of the program to ensure the validity of each module. This type of testing is done usually by developers by writing test cases for each scenarios of the module and writing the results occurring in each step for each module.

**6.4 REGRESSION TESTING**

We all know that development life cycle is subjected to continuous changes as per the requirements of user. Suppose if there is a change in the existing system which has already been tested it is essential that one has to make sure that this new changes made to the existing system do not affect the existing functionality. For ensuring this regression testing is done.

**6.5 INTEGRATION TESTING**

By making unit testing for each module as explained above the process of integrated testing as a whole becomes simpler. This is because by correcting mistakes or bugs in each module the integration of all units as a system and testing process becomes easier. So one might think why the integration is testing needed. The answer is simple. It is needed because unit testing ad explained test and assures correctness of only each module. But it does not cover the aspects of how the system would behave or what error would be reported when modules are integrated. This is done in the level of integration Testing.

**6.6 SMOKE TESTING**

This is also called as sanity testing. This is mainly used to identify environmental related problems and is performed mostly by test manager. For any application it is always necessary to have the environment first checked for smooth running of the application. So in this testing process the application is run in the environment technically called as dry run and checked to find that the application could run without any problem or abend in between.

**6.7 ALPHA TESTING**

The above different testing process described takes place in different stages of development as per the requirement and needs. But a final testing is always made after a full finished product that is before it released to end users and this is called as alpha testing. The alpha testing involves both the white box testing and black box testing thus making alpha testing to be carried out in two phases.

**6.8 BETA TESTING**

This process of testing is carried out to have more validity of the software developed. This takes place after the alpha testing. After the alpha phase also the generally the release is not made fully to all end users. The product is released to a set of people and feedback is got from them to ensure the validity of the product. So here normally the testing is being done by group of end users and therefore this beta testing phase covers black box testing or functionality testing only.

**6.9 TESTCASES AND RESULTS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test Case ID** | **Test Item** | **Input Specifications** | **Output Specifications** | **Pass/Fail** |
| **TC\_01** | Humidity sensor | The humidity value in the field is recorded. | Once the value of humidity alters, the reading changes. | Pass |
| **TC\_02** | Temperature sensor | The temperature value of the soil and the corps is recorded. | If the value of the temperature seems to be changing, then the new temperature is displayed. | Pass |
| **TC\_03** | Intrusion Detection | The obstacle on the field is observed with the help of motion capture and temperature detection. | “Obstacle detected” message will be passed. | Pass |
| **TC\_04** | Water Level sensor | The presence of water in the field is determined, and the motor will be automatically switchedON/OFF | If water is not present, “Dry Soil” message is passed and the motor is switched ON. If “Wet Soil” is displayed then the switched OFF. | Pass |
| **TC\_05** | Wi-Fi module | The Wi-Fi module connects with the network and passes the messages to the website and the server. | Once a change in the system is recorded, then the module sends the data for every 20 seconds automatically. | Pass |
| **TC\_06** | pH level sensor | The pH sensor will note the exact pH value of the urea and alerts if the urea level decreases in the soil | If the pH value is normal at 4, then no problem. If the pH value comes to 1, The alert is passed to add extra Urea | Pass |

Table 6.1 Testing conditions

**7. CONCLUSION AND FUTURE ENHANCEMENTS**

**7.1 CONCLUSION**

Thus, this system avoids over irrigation, under irrigation, top soil erosion and reduce the wastage of water. The main advantage is that the system’s action can be changed according to the situation (crops, weather conditions, soil etc.). By implementing this system, agricultural, horticultural lands, parks, gardens, golf courses can be irrigated. Thus, this system is cheaper and efficient when compared to other type of automation system. In large scale applications, high sensitivity sensors can be implemented for large areas of agricultural lands**.**

**7.2 FUTURE ENHANCEMENT**

Smart farming is a concept quickly catching on in the agricultural business. Offering high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked farm has to offer.

The food production will increase by 70 percent in the year 2050 in order to meet our estimated world population of 9.6 billion people. It also happens to note growing concerns about farming in the future: climate change, limited arable land, and costs/availability of fossil fuels. So, the solution for these problems is Smart farming.

Of the many advantages IoT brings to the table, its ability to innovate the landscape of current farming methods is absolutely groundbreaking. IoT sensors capable of providing farmers with information about crop yields, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time. New hardware, like the corn-tending Robot, is making strides by pairing data-collecting software with robotics to fertilize the corn, apply seed cover-crops, and collect information in order to both maximize yields and minimize waste.

Another direction in which smart farming is headed involves intensively controlled indoor growing methods. The Open AG Initiative at MIT Media Lab uses "personal food computers" (small indoor farming environments that monitor/administrate specific growing environments) and an open source platform to collect and share data. The collected data is termed a "climate recipe" which can be downloaded to other personal food computers and used to reproduce climate variables such as carbon dioxide, air temperature, humidity, dissolved oxygen, potential hydrogen, electrical conductivity, and root-zone temperature. This allows users very precise control to document, share, or recreate a specific environment for growing and removes the element of poor weather conditions and human error. It could also potentially allow farmers to induce drought or other abnormal conditions producing desirable traits in specific crops that wouldn't typically occur in nature.

With a future of efficient, data-driven, highly-precise farming methods, it is definitely safe to call this type of farming smart. We can expect IoT will forever change the way we grow food.

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**APPENDIX**

**(PUBLICATION DETAILS)**

|  |  |
| --- | --- |
| **Paper title :**  **Authors :**  **Journal Name :**  **Edition :**  **MONTH & YEAR :** | SMART AGRICULTURE MONITORING SYSTEM BASED ON IOT  Mr. P.V. RAO M.E, (Ph.D.,), ANURAAG. K, ARAVINTH. V, ARUN DAVID. M, ARUN. E  INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY (IRJET)  VOLUME 5 ISSUE 3 SL. NO: 442  e-ISSN: 2395-0056, p-ISSN: 2395-0072  MARCH 2018 |