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Available online at: www.jrrset.com

ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105
JIR IF : 2.54
SJIF IF : 4.334
Cosmos: 5.395

Volume 4, Issue 10 - October 2016 - Pages 85-93

Internet of Things and Cloud Computing for Agriculture

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ABSTRACT

Agriculture is the major source for the largest population in India to earn money and carry out their livelihood. Precision agriculture is already adopted in other countries, but we still need to involve IoT and cloud computing technologies for better production of crops. IoT will be beneficial to connect the devices collect and distribute the information. Cloud adoption is expected to increase significantly in near future due to improved cloud hosting facilities and faster internet speeds. Together they will be able to give required information along with the consideration of reduction in cost which will be beneficial to farmers. In this system, an automatic Smart Irrigation Decision Support System, SIDSS, is proposed to manage irrigation in agriculture. Our system estimates the weekly irrigations needs of a plantation, on the basis of both soil measurements and climatic variables gathered by several autonomous nodes deployed in field. This enables a closed loop control scheme to adapt the decision support system to local perturbations and estimation errors.

KEY WORDS: Internet of things, radio frequency identification, ANFIS, PLSR.

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1. INTRODUCTION

The Food and Agricultural Organization of the United Nation (FAO) predicts that the global population will reach 8 billion people by 2025 and 9.6 billion people by 2050. In order to keep pace, food production must increase by 70 percent by 2050 globally. India is a large agricultural country, and agricultural production has an important impact on national food security also. Compared with developed countries in the world, the area of farmland per capita is far lower than the average level in the world and the production value per capita and land yield per unit are also on a lower level in case of India. Thus, to face challenges of food production, we need to develop methods to produce more output with the limited available natural resources.

The resurfacing of global recession has caused ripples across both the developed and the developing economies. Agriculture sector will have to be much more efficient and resilient to ensure global food security. Indian farmers are at great disadvantage in terms of size of farms, technology, trade, government policies, etc. Information and Communication Technology (ICT) can mitigate some of the problems of farmers. After the World Wide Web (of the 1990s) and the mobile Internet (of the 2000s), we are now heading to the third and potentially most "disruptive" phase of the Internet revolution—the "Internet of Things" (IOT) which is also known as "Ubiquitous Computing. IOT applications encompass diverse areas including agriculture, healthcare, retail, transport, environment, supply chain management, infrastructure monitoring etc.

Concept of IOT:

The term "Internet of Things" (IoT) was first used in 1999 by British technology pioneer Kevin Ashton to describe a system in which objects in the physical world could be connected to the Internet by sensors. Ashton coined the term to illustrate the power of connecting Radio-Frequency Identification (RFID) tags used in corporate supply chains to the Internet in order to count and track goods without the need for human intervention. Today, the Internet of Things has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items. While the term "Internet of Things" is relatively new, the concept of combining computers and networks to monitor and control devices has been around for decades. By the late 1970s, for example, systems for remotely monitoring meters on the electrical grid via telephone lines were already in commercial use. In the 1990s, advances in wireless technology allowed "machine–to–machine" (M2M) enterprise and industrial solutions for equipment monitoring and operation to become widespread. Many of these early M2M solutions, however, were based on closed purpose–built networks and proprietary or industry–specific standards, rather than on Internet Protocol (IP)–based networks and Internet standards.

Cloud Computing:

Cloud computing is the buzzword today in the IT world. The most appropriate definition of cloud computing is provided by BarcoFurth of Florida Atlantic University, who defines it as "a new style of computing in which dynamically scalable and often

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virtualized resources are provided as a service over the Internet." The integration of IOT and cloud computing is of great significance. Cloud computing powerful storage, processing and service ability, combined with the IOT's ability of information collection, composes a real network between people and items and the items themselves. Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced environment. The idea of cloud computing is based on a very fundamental principal of reusability of IT capabilities'. The difference that cloud computing brings compared to traditional concepts of "grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organizational boundaries.

2. PROPOSED SYSTEM

The Intel 8051 microcontroller is one of the most popular general purpose microcontrollers in use today. The success of the Intel 8051 spawned a number of clones which are collectively referred to as the MCS-51 family of microcontrollers, which includes chips from vendors such as Atmel, Philips, Infineon, and Texas Instruments. The Intel 8051 is an 8-bit microcontroller which means that most available operations are limited to 8 bits. There are 3 basic "sizes" of the 8051: Short, Standard, and Extended. The Short and Standard chips are often available in DIP (dual in-line package) form, but the Extended 8051 models often have a different form factor, and are not "drop-in compatible". All these things are called 8051 because they can all be programmed using 8051 assembly language, and they all share certain features (although the different models all have their own special features).

The 8051 microcontroller is employed and the program is down loaded in the ROM, the 8051 receives the signal from the input port and executes the instructions stored in the ROM an sends the signal through the output port to the driver IC's to control the different o/PS such as buzzer, motor control and the appliance control and the status of load is displayed on the LCD.

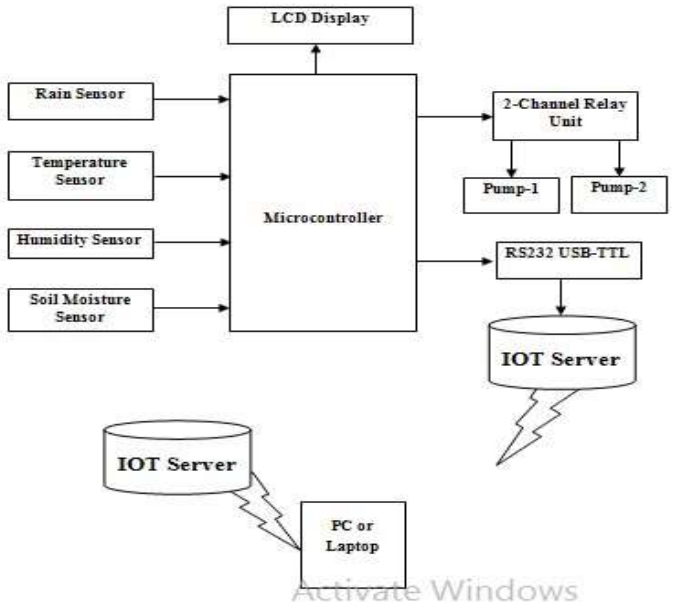

Fig 1: Block diagram description

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3. HARDWARE DESCRIPTION

3.1.Temperature & Humidity (DHT11)

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digitalsignal-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.

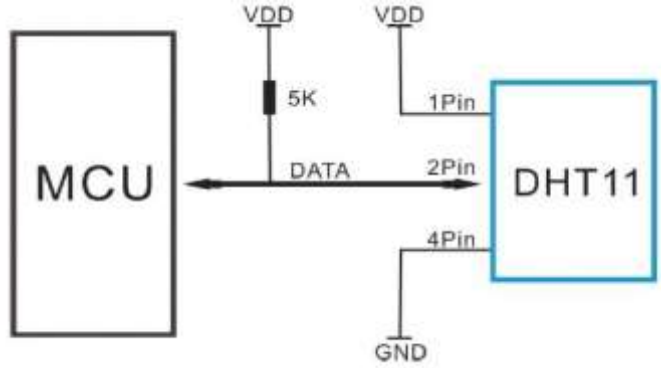

Fig 2: DHT11 Connectivity

3.2 Power and Pin

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

3.3 Overall Communication Process

When MCU sends a start signal, DHT11 changes from the low-power-consumption mode to the running-mode, waiting for MCU completing the start signal. Once it is completed, DHT11 sends a response signal of 40-bit data that include the relative humidity and temperature information to MCU. Users can choose to collect (read) some data. Without the start signal from MCU, DHT11 will not give the response signal to MCU. Once data is collected, DHT11 will change to the low-powerconsumption mode until it receives a start signal from MCU again.

3.4 MCU Sends out Start Signal to DHT

Data Single-bus free status is at high voltage level. When the communication between MCU and DHT11 begins, the programme of MCU will set Data Single-bus voltage level from high to low and this process must take at least 18ms to ensure DHT's detection of MCU's signal, then MCU will pull up voltage and wait 20-40us for DHT's response.

3.5 DHT Responses to MCU

Once DHT detects the start signal, it will send out a low-voltage-level response signal, which lasts 80us. Then the programme of DHT sets Data Single-bus voltage level from low to high and keeps it for 80us for DHT's preparation for sending data. When DATA Single-Bus is at the low voltage level, this means that DHT is sending the response signal. Once DHT sent out the response signal, it pulls up voltage and keeps it for 80us and prepares for data transmission.

When DHT is sending data to MCU, every bit of data begins with the 50us lowvoltage-level and the length of the following high-voltage-level signal determines whether data bit is "0" or "1".

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3.6 LCD Display

Fig 3: LCD display

Liquid Crystal Display which is commonly known as Alphanumeric Display can display Alphabets, Numbers as well as special symbols thus alphabets. Graphic display has embedded controller for controlling different modes. Controller accepts commands and data bytes from micro controller.

3.7 USB-TTL

Fig 4: USB TTL

Single-chip USB to Serial (RS232/RS422/RS485) asynchronous serial data transfer interface With Fully Compliant with USB Specification v2.0 (Full-Speed) Integrated USB 1.1 Transceiver and 5V to 3.3V Regulator. Integrated 96MHz clock generator (No external crystal required).Integrated OTPROM (One-Time Programming ROM) – no external EEPROM required. For writing and storing customer USB VID/PID, Serial Number, Product String, and other device startup configurations. (uses default settings if OTPROM is empty) Supports USB to RS232 Serial UART Interface. Full-duplex transmitter and receiver (TXD and RXD) Six MODEM control pins (RTS, CTS, DTR, DSR, DCD, and RI) 5, 6, 7 or 8 data bits Odd, Even, Mark, Space, or None parity mode. One, one and a half, or two stop bits, Parity error, frame error, and serial break detection, Programmable baud rate from 75 bps to 12M bps.

3.8 DC Water Pump 12v

DC 12V 1A Powerful Micro Brushless Magnetic Amphibious Appliance Water Pump Pump motor DC brushless motor, no spark of work. Pump starting current, high efficiency, stable and reliable operation, low power. Consumption, energy saving, environmental protection. Pump motor shaft with high degree of wear-resistant ceramic shaft, continuous service life of 20,000 hours or more. Pumps can be amphibious. Specification : Rated voltage : DC12V. Current : 1.05A. Flow : 550L / h. Noise : 35dB (0.5 meters). Fluid temperature range of 0 to 65°C. Size : 8cm x 5cm Diameter of Outlet : 10mm Package Includes : 1 x DC 12V Powerful Water Pump.

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Fig 5: DC water pump

3.9 Soil Moisture Sensor

This sensor can be used to test the moisture of soil, when the soil is having water shortage, the module output is at high level, else the output is at low level. By using this sensor one can automatically water the flower plant, or any other plants requiring automatic watering technique. Module triple output mode, digital output is simple, analog output more accurate, serial output with exact readings.

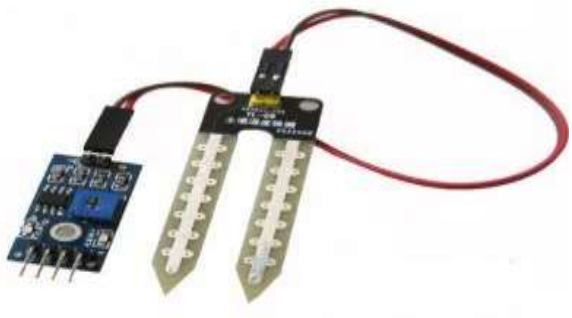

Fig 6: soil sensor

3.10 Rain Sensor

Fig 7: Rain 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.

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4. SOFTWARE DESCRIPTION

SQL is a language to operate databases; it includes database creation, deletion, fetching rows, modifying rows, etc. SQL is an ANSI (American National Standards Institute) standard language, but there are many different versions of the SQL language.

SQL is Structured Query Language, which is a computer language for storing, manipulating and retrieving data stored in a relational database. SQL is the standard language for Relational Database System. All the Relational Database Management Systems (RDMS) like MySQL, MS Access, Oracle, Sybase, Informix, Postgres and SQL Server use SQL as their standard database language.

Also, they are using different dialects, such as:

- MS SQL Server using T-SQL
- Oracle using PL/SQL
- MS Access version of SQL is called JET SQL (native format) etc.

SQL is widely popular because it offers the following advantages: Allows users to access data in the relational database management systems.

- Allows users to describe the data.
- Allows users to define the data in a database and manipulate that data.
- Allows to embed within other languages using SQL modules, libraries & precompilers.
- Allows users to create and drop databases and tables.
- Allows users to create view, stored procedure, functions in a database.
- Allows users to set permissions on tables, procedures and views.

SQL Process:

When you are executing an SQL command for any RDBMS, the system determines the best way to carry out your request and SQL engine figures out how to interpret the task. There are various components included in this process.

These components are

- Query Dispatcher
- Optimization Engines
- Classic Query Engine
- SQL Query Engine, etc.

A classic query engine handles all the non-SQI engine won't handle logical files.

Following is a simple diagram showing the SQL Architecture:

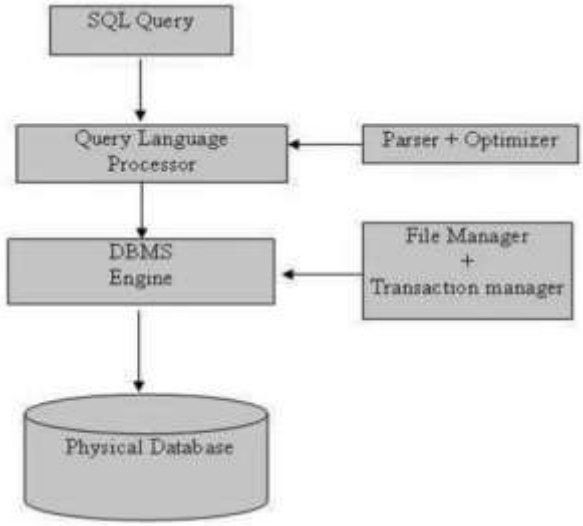

Fig 8: SQL Architecture

5. APPLICATIONS

Soil, medium, and water monitoring.

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I. Monitor soil/media for pH, conductivity, temperature, humidity etc. for the best growing conditions.

II. Monitor water quality including pH, conductivity, temperature, dissolved oxygen etc.

III. View historically stored data and produce graphs to view trends.

Microclimate monitoring.

I. Use sensors to monitor environmental aspects such as temperature, relative, humidity.

II. View historically stored data and produce graphs to view trends.

Rain monitoring.

I. Use sensor to pump water automatically.

6. BENEFITS OF IoT IN AGRICULTURE

The following are the benefits of IOT applications in agriculture:

1. Improvement in the use efficiency of inputs (Soil, Water, Fertilizers, Pesticides, etc)
2. Reduced cost of production
3. Increased profitability
4. Sustainability
5. Food safety
6. Protection of the environment.

FUTURE SCOPE

From the above information collected from various researches the work can be further extended in two broad ways.

(i) Few parameters such as reliability, scalability can be improved and the open source programming languages such as python could be used as a program. The data set can be still increased to improve the accuracy of the system In authentication scheme further complexities of the protocol are reduced without compromising security features. The entire work can be even merged with cloud computing environment.

From the previous work some of the new decisions can be made in crops. There are sensors which can do amazing things in the agriculture. The country lacks in good agriculture and it could be made still smart. The data set is maintained for every smart work in agriculture and can be used for further reference.

CONCLUSION

With the Internet of Things, single farmers may be able to deliver the crops directly to the consumers not only in a small region like in direct marketing or shops but in a wider area. This will change the whole supply chain which is mainly in the hand of large companies, now, but can change to a more direct, shorter chain between producers and consumers. Cloud Computing would enable corporate sector to provide all the necessary services at affordable cost to farmers in rural areas.

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