Agricultural Monitoring System with Real Time Data

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***Abstract*- The field of electronics continues to change and evolve rapidly. Electronics are tremendously being used to collect and process all types of data, transfer information, make decisions, and provide automation and control functions. Agriculture is most important sector of Indian Economy. Indian agriculture sector accounts 18% of India's GDP and provide employment to 50% of the countries workplace. Electronics in agriculture provides International coverage of advances in development and application of computer hardware, software and electronic instrumentation and control system for solving problems in agriculture and related industries. Electronics components are increasing in their capabilities, while becoming easier to use, smaller in size and cheaper to buy. This paper is all about development of a smart system which helps farmers to monitor their field through android application and they could also know the essential parameter and control them (if necessary). The system has a controller (Arduino) and a sensors network; also the system behaves like Robot, moving around the field, monitoring the soil and controlling them when they go beyond the threshold. The sensors used up here are fast and accurate and they are connected through Wi-Fi to the server (through the controller). An android application is also developed for viewing the parameters, with the control of motor.**

Keywords- Electronics, Smart system, Beagle-bone-black, Wi-Fi, sensors and Server.

I. INTRODUCTION

Electronics components are increasing in their capabilities are easy to use, smaller in size and cheaper to buy. This paper is all about development of a smart system which helps farmers to monitor their field through android application and they could also know the essential parameter and control them (if necessary). The system has a controller (Arduino) and a sensors network; also the system behaves like Robot, moving around the field, monitoring the soil and controlling them when they go beyond the threshold. The sensors used up here are fast and accurate and they are connected through Wi-Fi to the server (through the controller).

The camera used up here is with greater pixel, i.e., camera with high resolution and the sensors are more precise and accurate.

The control part is done using a relay network; the motor is switched through relay. An android application is also developed for viewing the parameters, with the control of motor.

II. PROBLEM IDENTIFIED

1. Lack of proper irrigation system.
2. Excess flow of water in the soil.
3. Nature of soil could be determined by taking the soil to the lab, and waiting for the results for more than a day.
4. Movement of birds and animals in the field.
5. Testing of nitrogen in the content in the soil.

III. PROPOSED SYSTEM

The system uses up two controller boards, one is Raspberry pi and other is Arduino. The sensors are connected with Arduino, where as Raspberry pi acts like a server and Robot. Raspberry pi communicates to the user, through the android application.

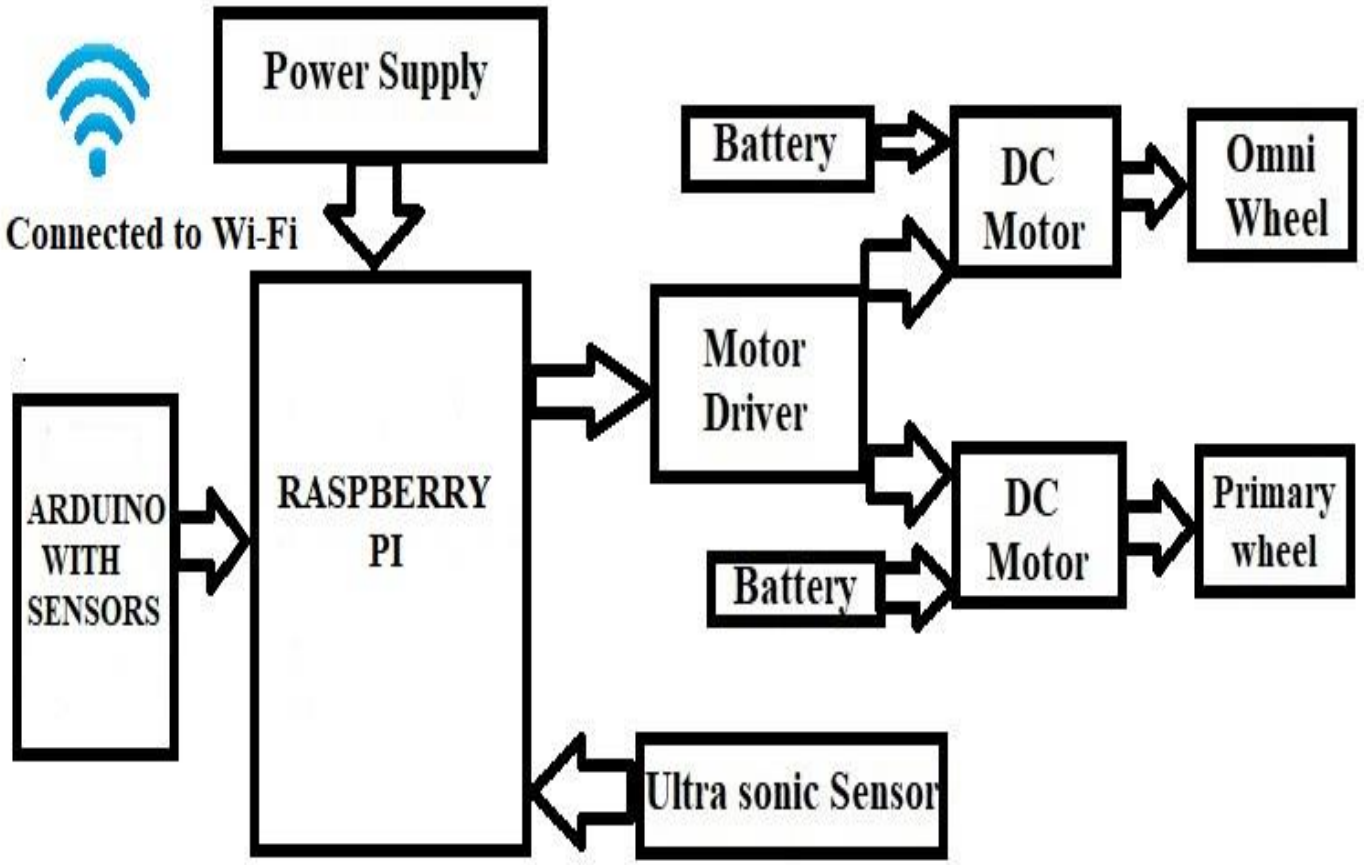

Fig 1: Block diagram of proposed System

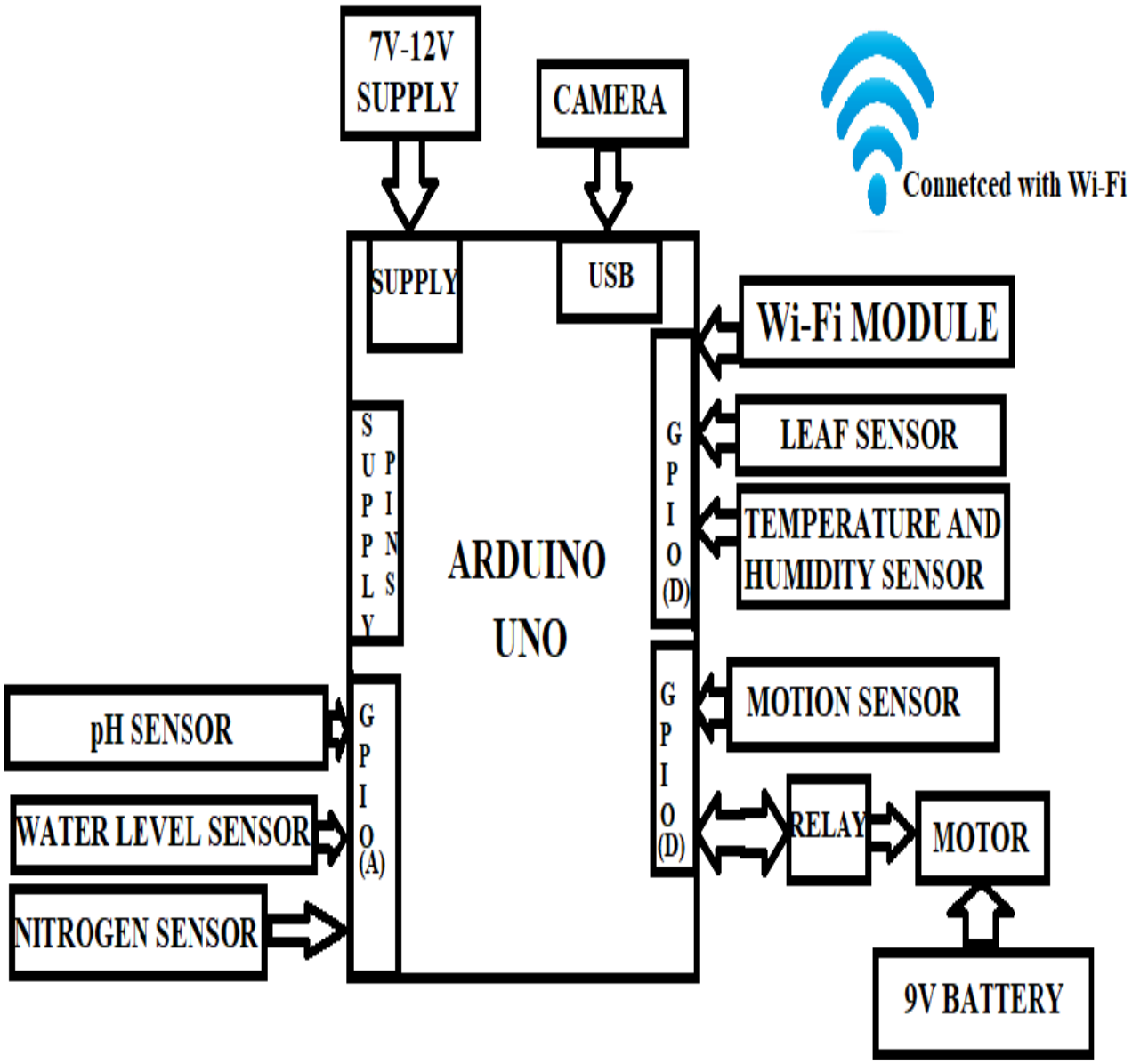

Fig 2: Block Diagram of sensor Network

Since the system uses up 2 controller unit, the execution is much faster. Raspberry Pi can be accessed either through VNC Server (or) PuTTy. Similarly Arduino uses Arduino Web Editor. Programs are done with Python and application is developed using MQTT. Arduino doesn't require any OS, but Raspberry Pi requires an OS, which is Raspbian.

Sensors like leaf sensor, water level sensor and temperature and humidity sensors are inter linked to each other, i.e., when the leaf sensor detects that the crop needs water, immediately water level sensor is being instructed to check the water level in the tank, mean while the temperature and humidity sensors, checks for the moisture content of the soil. If the humidity is more and leaf sensor value goes down, then the submersible pump is switched ON automatically, the water level is monitored continuously, when the water level goes below the threshold, the motor goes OFF automatically. Each and every activity of the sensor is automatically updated in the Android application through the MQTT server.

IV. TOOLS/COMPONENTS DESCRIPTION

1. *Hardware description*

a) Arduino UNO

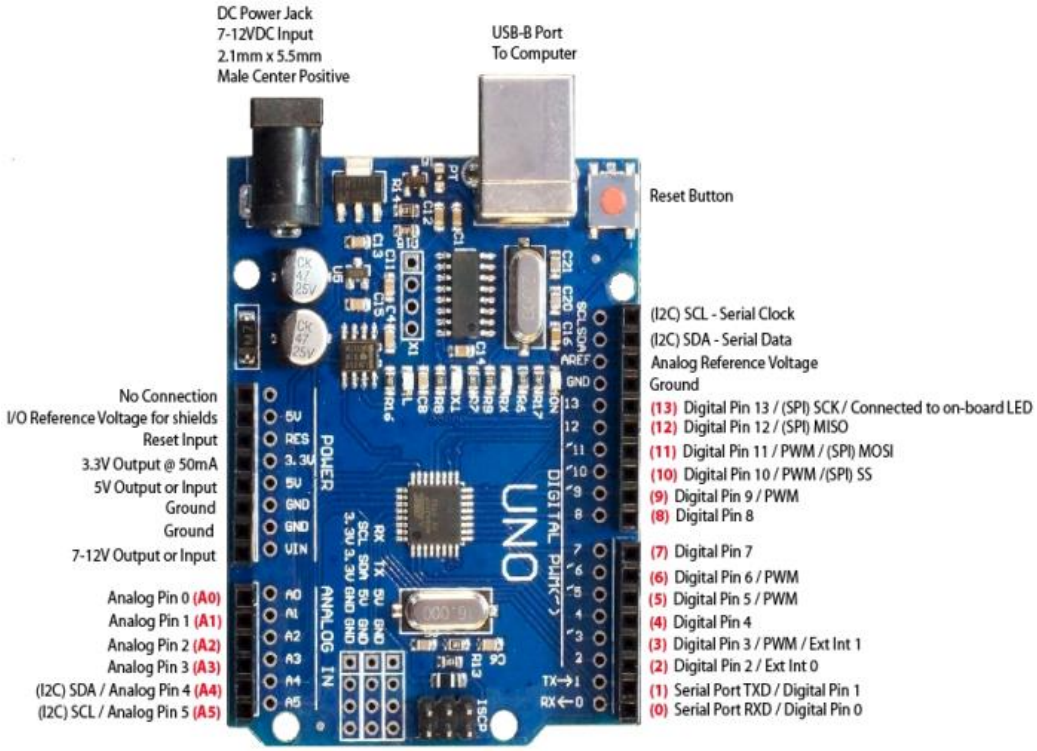

Fig 3: Arduino UNO

Arduino boards designs use a variety of microprocessors and controllers. The board are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion board (or) breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs for personal computing.

b) 7V-12V power supply

Fig 4: 7V-12V Power Supply

c) Raspberry Pi

Fig 5: Raspberry pi

- The Raspberry Pi uses the ARM processor architecture, which is also used by most modern mobile phones.
- The Raspberry Pi can use Linux Operating System, (or) RISC OS, instead of Microsoft Windows (or) Mac OS X like most computers.
- The Raspberry Pi operating system can be installed using NOOBS, (or) directly installing an operating system.

d) 5V-2A Power supply

Fig 6: 5V-2.5mA Power Supply

e) Wi-Fi Module

Fig 7: ESP8266 Wi-Fi Serial Module

- Build on ESP8266 SDK

- Lua core based on eLua project.
- Easy to access wireless router.
- Based on Lua 5.1.4.
- Event-Drive programming preferred.
- Build-in json, file, timer, pwm, i2c, SPI, 1-wire, net, MQTT, COAP, GPIO, Wi-Fi, ADC, UART and system API.
- GPIO pin re-mapped, use the index to access GPIO, i2c and PWM.
- Both integer and float version firmware re provided.

f) Wi-Fi Modem

- Input type is RJ-11 (Telephone Line) supported by ISP's such as MTNL, BSNL and Tata Indicom.
- It has ADSL2+ Modem, NAT Router, 4-port switch and wireless N Access Point.
- Wireless N speed up to 300Mbps, makes it ideal for heavy bandwidth consuming (or) interruption sensitive applications like online gaming, internet calls and even the HD video streaming.
- Easy setup Assistant with multi-language support provides quick and hassle-free installation.
- Backward compatible with 802.11b/g products.

Fig 8: Wi-Fi Modem

g) Camera

Fig 9: Camera

- Maximum Resolution: 720p/30fps
- Focus type: fixed Focus
- Lens Technology: standard
- Built-in Mick: Momo
- FoV : 60℃

h) Leaf sensor

This sensor is particularly used for measurement water loss of the water deficit stress in plants by real time monitoring the moisture level in plant leaves.

Fig 9: Leaf sensor

i) Temperature and humidity sensor

Pin Configuration

1. Output: Digital GPIO of Arduino
2. VCC: Power supply pins of Arduino
3. Ground: Power supply pins of Arduino

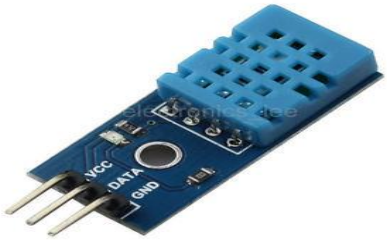

Fig 10: Temperature and Humidity Sensor

j) Motion sensor

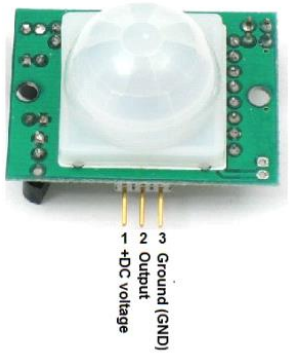

Fig 11: Motion Sensor

Pin Configuration

1. Output: Digital GPIO of Arduino
2. VCC: Power supply pins of Arduino
3. Ground: Power supply pins of Arduino

k) pH Sensor

Analog pH sensor, specially designed for Arduino controllers is easy to use and can be used as a plug and solution to measure pH value of a solution without any additional circuit required.

Pin configuration

1. TO: Temperature
2. DO: Signal the limit of pH
3. PO: pH value in V
4. G: Mass of the analog circuit
5. G: Mass power
6. V+: Power Supply (5V)

Fig 12: pH Sensor

l) Water level sensor

Fig 13: Water level Sensor

- Operating Voltage: DC 3-5V
- Operating current: Less than 20mA
- Sensor type: Analog
- Operating temperature: 10°C to 30°C
- Humidity: 10% to 90% non-condensing

m) Nitrogen Sensor

Item	Parameter	Min	Typical	Max	Unit
VCC	Working Voltage	4.9	5	5.1	V
PH	Heating consumption	0.5	-	800	mW
RL	Load resistance		adjustable		
RH	Heater resistance	-	33	-	Ω
Rs	Sensing Resistance	3	-	30	kΩ

Table 1: Nitrogen Sensor

Fig 14: Nitrogen Sensor

n) Relay

- Max Current: 20mA
- Relay contact current capacity at AC250V: 10A
- Relay contact current capacity at DC30V: 10A
- One normally closed contact and one normally open contact
- Triode drive, increasing relay coil
- High impedance controller pin

Fig 15: Relay

o) Submersible pump (Motor)

Fig 16: Submersible Pump

p) Motor driver

Dual VNH2SP30 motor driver carrier MD03A model DC motor card is used to run the motor so that control card can operate the robot. The motor card has two channels, and it can operate and control two motors at same time.

In order for Tractacus to move, two Dc motors with 75:1 drive wheel is used. The robot has a front wheel drive. Each front wheel is controlled separately and this makes it possible to drive the robot.

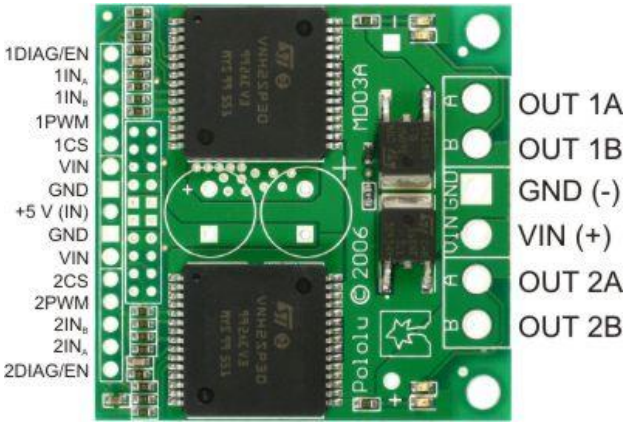

Fig 17: Motor Driver

q) Ultra Sonic Sensor

Ultrasonic ranging module HC-SR04 provides 2cm-400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle is:

i. Using IO trigger for at least 10us high level signal
ii. The module automatically sends eight 40kHz and detect whether there is a pulse signal back
iii. If the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.
iv. Test distance = (high level time*Velocity of sound (340M/S))/2

Fig 18: Ultra Sonic Sensor

r) 5V-DC Motor

Technical features of DC motors are

- 6V operating voltage
- 130 RPM maximum turn speed
- 120 oz-in torque
- Maximum load capacity 6A voltage
- 450mA current

s) Wheel

Tractacus has a front-drive wheel. Each wheel is about 5inch diameter. Because of cogwheel surface, and the quality of the material, it can move on different grounds. DC engines are directly embedded in wheels.

4. Software description

a) Python

Python syntax is very clean, with an emphasis on readability and uses Standard English keywords. Python could be easily understood using IDLE (Integrated Development and Learning Environment)

Features of IDLE:

i. Coded in 100% pure python, using **TKINTER** GUI toolkit
ii. Cross-Platform: Works with Windows, UNIX and MAC OS.
iii. Python shell window with colorizing of code input, output and error messages.
iv. Debugger with any window, replace within editor window and search through multiple file.

Python features a dynamic type system and Automatic memory management. It supports multiple programming paradigms, including Object-Oriented, imperative, functional and procedural, it also has a comprehensive standard library.

Python is open source software and has a community-based development model. It is meant to be an easily readable language.

b) Raspbian OS

Raspbian is a Debian-based computer operating system for Raspberry pi. There re several versions namely, Raspbian Stretch and Raspbian Jessie. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

c) MQTT

Message Queuing Telemetry Transport is an ISO Standard (ISO/IEC PRF 20922) publish-subscribe-based messaging protocol. It works on top of TCP/IP protocol. It is designed for connections with remote locations where a "small code footprint" is required (or) the network bandwidth is limited. Publish-subscribe messaging pattern requires a message broker.

V. RESULTS AND OUTPUTS

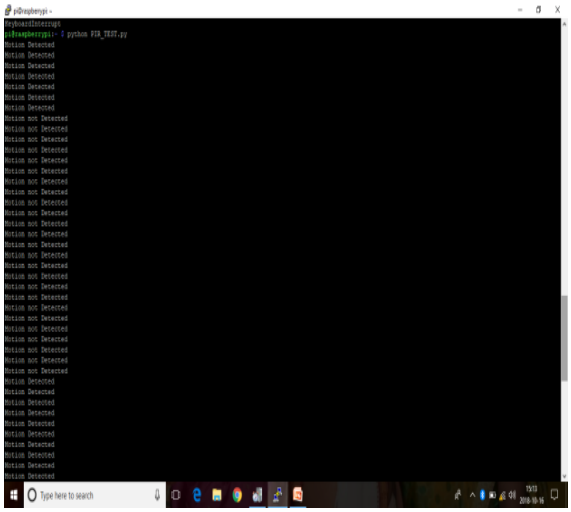

Fig 19: Motion Detection

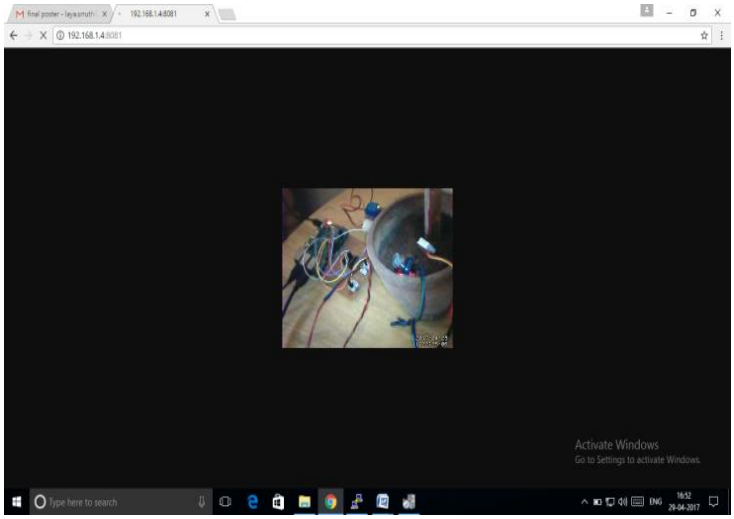

Fig 20: Live Video Streaming

```
pi@raspberrypi: ~
pi@raspberrypi:~ $ sudo su
root@raspberrypi:/home/pi# sudo service motion start
root@raspberrypi:/home/pi# sudo motion
[0] [NTC] [ALL] conf_load: Processing thread 0 - config file /etc/motion/motion.conf
[0] [ALR] [ALL] conf_cmdparse: Unknown config option "sdl_threadnr"
[0] [NTC] [ALL] motion_startup: Motion 3.2.12+git20140228 Started
[0] [NTC] [ALL] motion_startup: Logging to syslog
[0] [NTC] [ALL] motion_startup: Using log type (ALL) log level (NTC)
[0] [NTC] [ALL] become_daemon: Motion going to daemon mode
root@raspberrypi:/home/pi# python sensors.py 2302 2
Sensor Code Running!!!
Inside While Loop
Function returned : PH:00.00     W: 0    L:  62         T:  63

4
Room Temperature :  34.0
Humidity is  :  63.5
Inside While Loop
Function returned : PH:00.00     W: 0    L:  62         T:  63

4
Room Temperature :  33.7000007629
Humidity is  :  65.6999969482
Inside While Loop
Function returned : PH:00.00     W: 0    L:  62         T:  63

4
Room Temperature :  33.7000007629
Humidity is  :  65.6999969482
Inside While Loop
Function returned : PH:00.00     W: 0    L:  62         T:  63
```

Fig 21: Sensors Data

Fig 22: Motor Control and Status

VI. CONCLUSION

Agricultural sensors have been invented to meet the increasing worldwide demand for food. They are simple to use, cost effective and help collect and apply data, so that resources can be used most efficiently. The sensors are contributing to solutions that extend beyond farms, including pollution, global warming and conservation. With respect to research in IoT and smart concepts in India, one field that the smart technology needs application is agriculture and farming domain. Precision Agriculture system helps to improve economic returns and reduce environmental impact. It also includes decision support system for whole farm management. The management information system helps in collecting, processing, storing and disseminating data in the form needed to carry out a farmers operations and Function.

Future developments in precision agriculture will likely include increased autonomous farm vehicle use, as well as improved wireless data transmission and acquisition from smarter, smaller unmanned Aerial and Unmanned Ground vehicles. In addition to monitoring crop and soil conditions, these smaller vehicles can also monitor the status of farm equipment, allowing farmers to improve machine servicing and maintenance. Process improvements learned in the industrial manufacturing arena will continue to find their way into agriculture.

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