IoT Enabled Plant Monitoring System
Internet Of Things
CSE3009
Final Project Review

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1 Abstract

Nurturing plants, gardening and farming are all very tedious tasks, and one must make sure that these plants and shrubs are always kept in the optimum conditions without any reduction in basic necessities like – water ,sunlight ,pleasant temperature and other such things. Due to this there is always a requirement of human presence, this won't be possible all the time because sometimes people need to go on vacation or leave their house for a period of time, as a result these plants would be neglected . There is a new concept of farming where crops are grown vertically rather than horizontally to save space, in this type of farming human intervention is a very tedious task, without automation or remote controlling nothing can be done at the greater heights, our project finds itself as a solution for that. Providing an Internet of things solution wherein we use the internet and a series of internal mechanisms to control or know the status of a plant and activate certain mechanisms to meet the optimum conditions thus ensuring the growth of the plant without hindrance. The internet is available throughout the globe, which makes it easier for people to connect to it from anywhere and use it to automatically take care of the status of these plants without much interaction or human intervention.

2 Literature Survey

General Plant Monitoring systems include RFID identification for each plant, and triggers developed for every parameter breach occurred. All of them are mostly machine based curation, where the machine itself decides when to power what. But we here, considering that machines in itself can default and damage the plant, have purely kept user based curation. Many plant monitoring systems have been for large spans of agriculture, using IR sensors for object detection. Our larger aim was usage of this technology to implement on Vertical Farming, the upcoming trend to stack up plants so as to save space and increase gain per unit area. Checking up on all the research papers written on the topic of vertical farming, most of them talk about to what extent they can go on increasing the height of the stack, so as to gain maximum benefit from minimum space coverage. Attaining that height is achievable, but to monitor that height manually is laboring. Hence we made this prototype to facilitate the extending heights of vertical farming.

Research Papers that we studied:

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VERTICAL FARMING CONCEPTIN THAILAND: IMPORTANT DECISION VARIABLES

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Abstract: This study conducts an exploratory study related to a systematic model of decision variables for the vertical farming concept found in Thailand. Utilizing the model of decision variables found in three paradigms, the different available sources of data were synthesized to understand the concept as a phenomenon and to find a valid model for a new construction and product development strategy using the vertical farming concept for Thailand in the future.

Keywords: vertical farming, urban agriculture, soil-less culture, bioclimatic design, decision variables

Smart Plant Monitoring System

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Abstract

Plant monitoring is seen as one of the most important tasks in any farming or agriculture based environment. With the inception of Ambient Intelligent systems, there have been a rise in ambient intelligent based devices - Smart Homes[1] and other similar technologies involving RFID has evolved over the past few years[2]. Integration of such an ambient intelligent system with plant monitoring makes farming easier. In this paper, we discuss about the implementation of a smart plant monitoring system which makes use of the concept ambient intelligence with the use of .Net Gadgeteer which, proactively handles the plant monitoring system. The given implementation works along with a cloud based server and a mobile based device (ideally
along with a cloud based server and a mobile based device (ideally
Android/iOS device) which helps the user to control and see the status of the plant which is being monitored by the hardware device. The given circuitry detects changes in the moisture, temperature and light conditions in and around the plant, and performs a machine based curation on the plant by providing necessary irrigation and illumination for the plant. Machine curation is also integrated with active weather forecasting systems which are deployed in the cloud based server using which advanced machine curation is performed. For user based curation, the Android device provides user an option to override a machine curated operation.

Motivation

The most important factors for the quality and productivity of plant growth are temperature, humidity, light and the level of the carbon dioxide. Continuous monitoring of these environmental variables gives information to the grower to better understand, how each factor affects growth and how to manage maximal growth of plants. Climate control and monitoring of the plant is one of important aspects in agriculture. The aspects we are presenting resembles the concept of precision agriculture, this is the trend of farming presented in recent years for commercial and research agriculture[5]. In the precision agriculture framework the focus is mainly on understanding the environment through the interpretation of a wide variety of data coming from GPS systems, satellite imaging, and in-field sensors.Cypress is one of top semiconductor company in the world. Currently they have envisioned the scope by moving towards Internet of Things,with the major focus on "Internet of plants". The main motivation of the project is for the user to monitor the plants or cultivation to get enough resources such as light and water without the user need to be present at the plants or cultivation area, and also could manipulate the resources provided to the plants depending on the climate of the plant's location(Example : if there is enough rain or moisture for the day, the sensor in the soil would detect accordingly for the operation to begin and intimate the user). This could help user not only to give the resources to the plants everyday without much manual effort also helps the constant and healthy growth of a plant.

Design

The proposed system consists of two curation systems. The first one being the *machine based curation* and other being the *user based curation*. These curative systems are in place to provide a smart and involuntary feedback to the given environment. The former is more of predictive system devised on a hardware whereas, the latter is for the user to actively handle the response provided by hardware. The curation handled by the device are based on the sensor information it receives from its end points(*sensory hardware units*), such a curation is called as *"Direct Machine Based Curation"*. There is also a hybrid machine based curation provided by the device and the cloud server which relies on the Weather Forecast information with the collects sensor values from the endpoints, such a curation can be called as *"Advanced Machine Based Curation"*. If the user wants to take over the system then, it becomes more of a *"User Based Curation"*. On top of all, the proposed system design is a pub-sub system. The Monitoring hardware is the publisher and Mobile based devices are subscribers. The cloud based server act as *"brokers"*.

Basic Interaction

Primarily the interaction between the monitoring device and the user enabled mobile device happens as a publisher-subscriber system. This interaction is brokered by the cloud based server with monitoring hardware and the mobile device as the publisher and subscriber respectively. The Cloud Based server - "Parse" [1] provides core functionalities. This server not only gives a hand for machine based curation but also, in providing various push based services to the Mobile Device(Android/iOS/Windows). The monitoring hardware used for this system is .Net Gadgeteer [2]. Before any curation to work the device must initially register to the cloud server by their respective device tokens thereby, the broker service can later on perform push services. For handling the registration operation, the server have provided two different registration APIs — one for the Android/iOS/Windows device using which mobile device can register itself and also subscribe to a particular monitoring device. And the other for the Monitoring hardware device in order for registering to server with its Geo-Location. Once the registration is successful the device and user can perform curations. The mobile application deployed in the mobile device informs the user about the device status and weather status in the location of subscribed monitoring

Development Of A Temperature Monitoring And Control System Using Temperature Sensor

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Sayan Samanta, "corresponding author"

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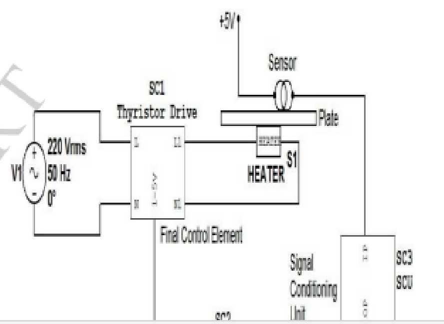
Srismrita Basu , *Assistant* professor Greater Kolkata College Of Engg & Mgmt, Baruipur,

i) Abstract: This project aims at controlling the temperature of an aluminum plate which is being heated by a 50 watt heating element. For controlling the temperature of the metal plate the current through the heating element is controlled. The thermal energy produced by the heater is directly proportional to the square of the current passing through the heater coil. Hence, by controlling the current through the heater coil ,the heat produced by the heater is controlled. The target is to control the temperature of the plate between room temperature and 100 °C with

ii) Proposed design:



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3 Methodology

• We use a soil moisture detector , which is a sensor based on varying levels of resistance to check whether the soil has enough moisture.

content or not .It has two leads which will be inserted into the soil. It almost acts as a hygrometer for the soil , we would use a DHT11 module.
• We use a temperature sensor for measuring the ambient temperature of the plant , using a DHT11 module which is an embedded module for both temperature and humidity.
• We use a basic LDR for sensing the ambient light in the room for the plant .
• To make this an "Internet of things" related project we could use many of the different IOT dashboards but we are using Cayenne as a cloud MQTT service , which even works through an app on the phone , this turns out to be the most convenient option.
• Our basic implementation idea, is to get the plant's status , or current data on to the internet so that the user can see the data and take action as per his intention.
• We connect all the sensors above to the Arduino and then we connect the Arduino to the internet using a serial USB.
• We establish a dashboard on the website having all the widgets , graphs, guages and actuators we need.

4 Innovative Ideas

• We implemented a water pump to control a water source for water to enter the potted plant when the soil moisture levels are too down, this feature could be user activated through the app or the website of the same.
•We implemented a light using relay circuits to switch on when the light levels become low for the plant. Light levels are very important for the continued growth of the plant.
• We use a relay to power a small fan to keep the temperature within the controlled parameters.
•We made an app, to show how M2M differs from IOT , we made this to communicate only with each other with a fixed end simplex communication.
•Our prototype can be extrapolated from a small house plant to several plants, as it is very flexible.

5 Circuit Layout

6 Sample Code

include ¡DHT.h¿
include ¡DHT$_{U}.h >$

/* Cayenne Generic Analog Input Example

This sketch shows how to automatically send data to a Generic Analog Input Sensor in the Cayenne Dashboard.

The Cayenne Library is required to run this sketch. If you have not already done so you can install it from the Arduino IDE Library Manager.

Steps:
1. In the Cayenne Dashboard add a new Generic Analog Input widget.
2. Set the widget to Value Display.
3. Select the Integrated ADC and a pin number.
4. Attach an analog input device (e.g. a potentiometer) to the analog pin on your Arduino matching the selected pin.
Make sure to use an analog pin, not a digital pin.
5. Set the token variable to match the Arduino token from the Dashboard.
6. Compile and upload this sketch.
7. Once the Arduino connects to the Dashboard it should automatically update the Generic Analog Input widget with data.

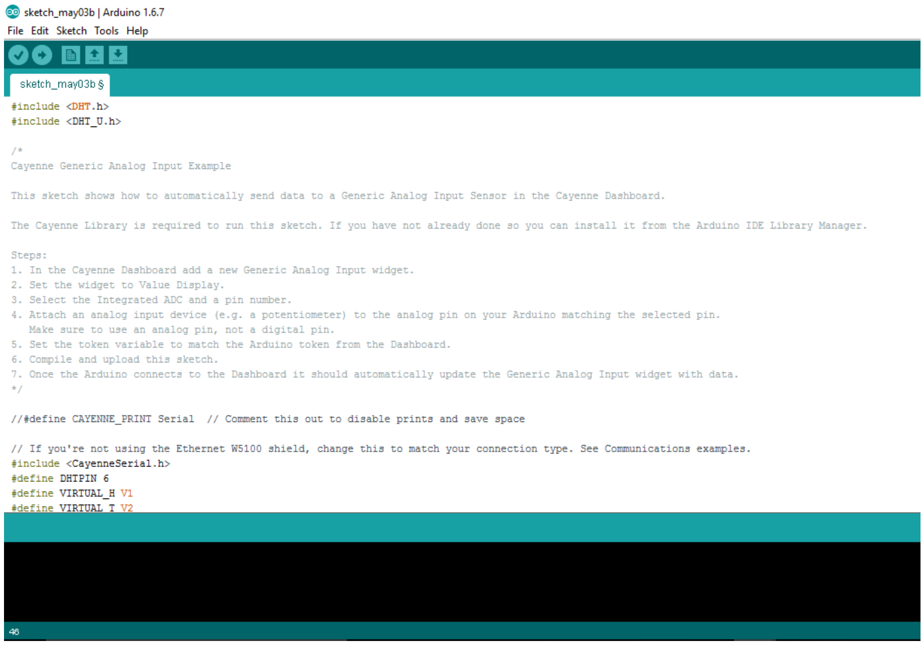
include ¡CayenneSerial.h¿
define DHTPIN 6
define VIRTUAL$_H V1$
$defineVIRTUAL_T V2$
$defineVIRTUAL_M V3$
$defineVIRTUAL_L V4$
$defineDHTTYPEDHT11$
$definemois_s ensorA0$
$defineldrA1$
$DHTdht(DHTPIN, DHTTYPE);$

char token[] = ”kptuju3ec7”;

void setup()

Serial.begin(9600);
pinMode(mois$_s ensor, INPUT);$
$pinMode(ldr, INPUT);$
$Cayenne.begin(token);$
$dht.begin();$

$voidloop()$
$delay(2000); Cayenne.run(); intmoisture = anlogRead(mois_s ensor); moisture = map(moisture, 0, 1023, 100,$


sketch_may03b | Arduino 1.6.7
File Edit Sketch Tools Help
sketch_may03b §
#include <DHT.h>
#include <DHT_U.h>
/*
Cayenne Generic Analog Input Example
This sketch shows how to automatically send data to a Generic Analog Input Sensor in the Cayenne Dashboard.
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Make sure to use an analog pin, not a digital pin.
5. Set the token variable to match the Arduino token from the Dashboard.
6. Compile and upload this sketch.
7. Once the Arduino connects to the Dashboard it should automatically update the Generic Analog Input widget with data.
*/
//#define CAYENNE_PRINT Serial // Comment this out to disable prints and save space
// If you're not using the Ethernet W5100 shield, change this to match your connection type. See Communications examples.
#include <CayenneSerial.h>
#define DHTPIN 6
#define VIRTUAL_H V1
#define VIRTUAL_T V2
46


```
7. Once the Arduino connects to the Dashboard it should automatically update the Generic /
*/

//#define CAYENNE_PRINT Serial  // Comment this out to disable prints and save space

// If you're not using the Ethernet W5100 shield, change this to match your connection ty
#include <CayenneSerial.h>
#define DHTPIN 6
#define VIRTUAL_H V1
#define VIRTUAL_T V2
#define VIRTUAL_M V3
#define VIRTUAL_L V4
#define DHTTYPE DHT11
#define mois_sensor A0
#define ldr A1
DHT dht(DHTPIN,DHTTYPE);

// Cayenne authentication token. This should be obtained from the Cayenne Dashboard.
char token[] = "kptuju3ec7";

void setup()
{
  Serial.begin(9600);
  pinMode(mois_sensor , INPUT);
  pinMode(ldr , INPUT);
  Cayenne.begin(token);
  dht.begin();
}
```

sketch_may03b | Arduino 1.6.7

File Edit Sketch Tools Help

sketch_may03b §

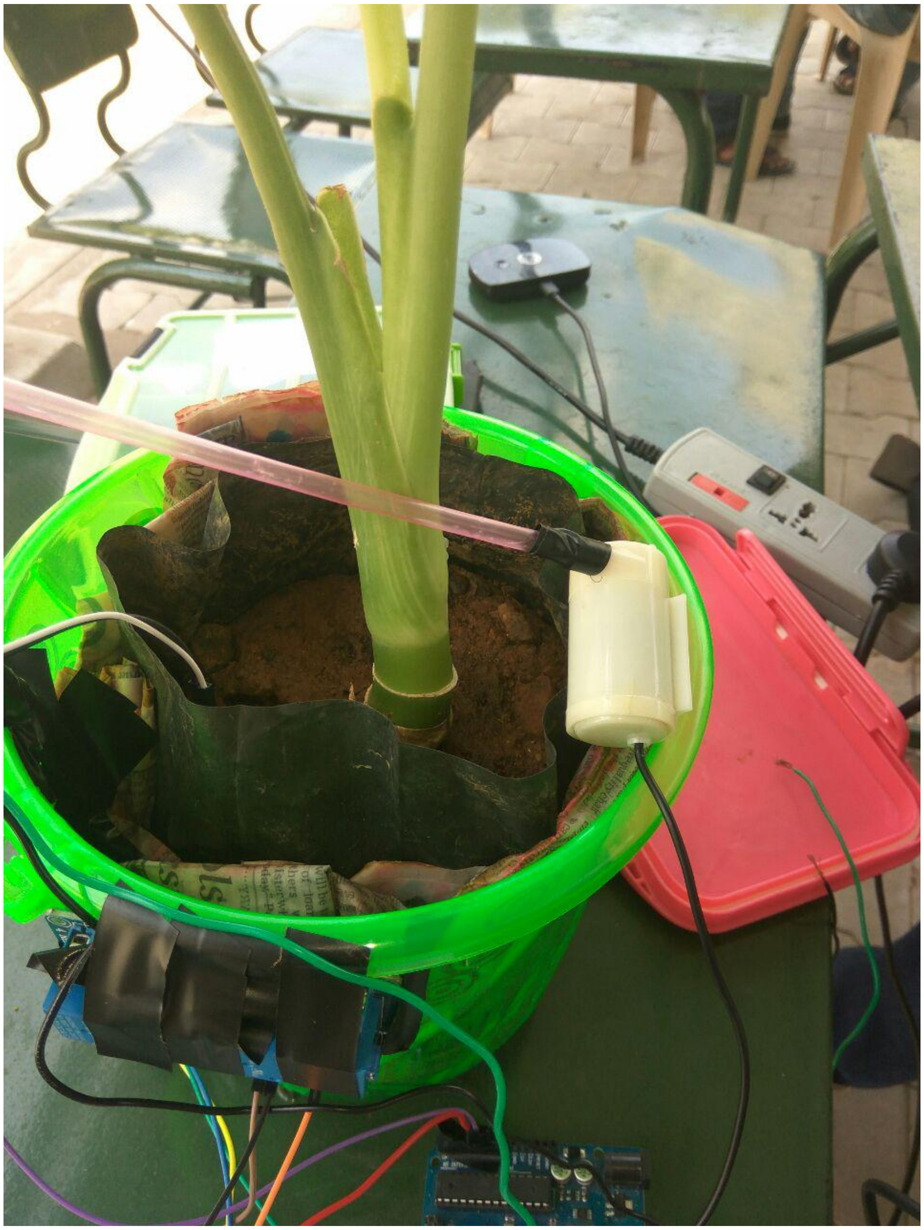
```
void setup()
{
  Serial.begin(9600);
  pinMode(mois_sensor , INPUT);
  pinMode(ldr , INPUT);
  Cayenne.begin(token);
  dht.begin();
}

void loop()
{
  delay(2000);
  Cayenne.run();
  int moisture = analogRead(mois_sensor);
  moisture = map(moisture,0,1023,100,0);
  int light = analogRead(ldr);
   light = map(light,0,1023,100,0);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
   if (isnan(h) || isnan(t)) {
    return;
   }
  Cayenne.virtualWrite(VIRTUAL_H,h);
  Cayenne.virtualWrite(VIRTUAL_T,t);
  Cayenne.virtualWrite(VIRTUAL_M,moisture);
  Cayenne.virtualWrite(VIRTUAL_L,light);

}
```

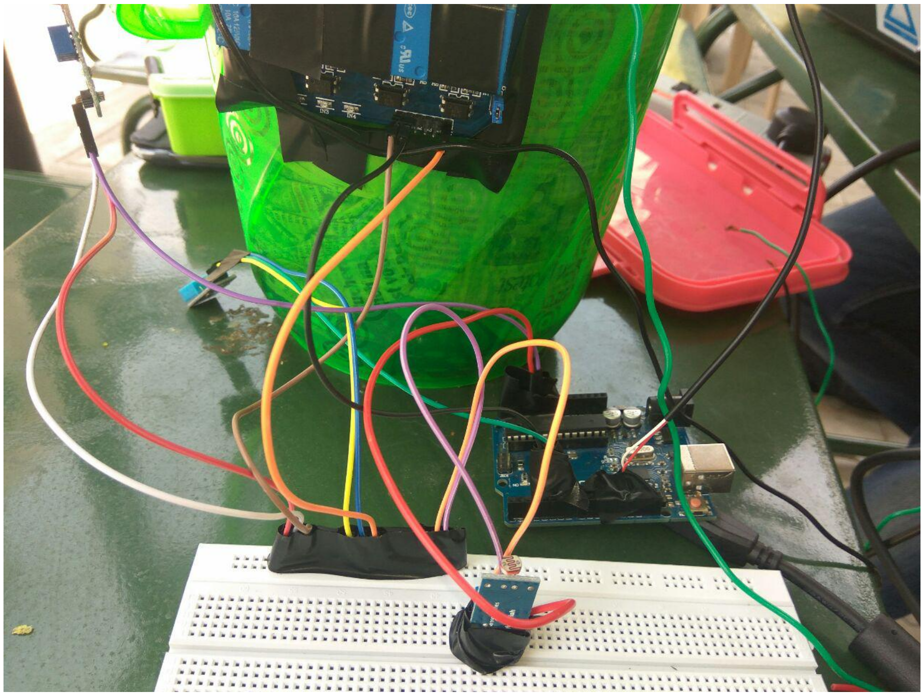
7 Components

Components to be used:

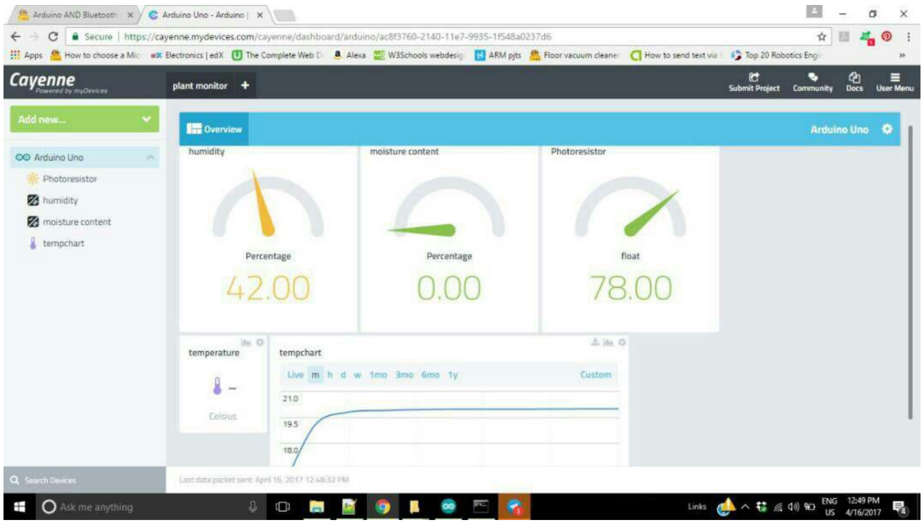
1. Microcontroller (ATMega 328)
2. DHT11 Temperature and Humidity Module
3. LDR Module
4. Soil Moisture Sensor Module
5. Bulb
6. L293D Motor Driver Module
7. DC Motor
8. Plant
9. Water Pump
10. Breadboards or PCB's

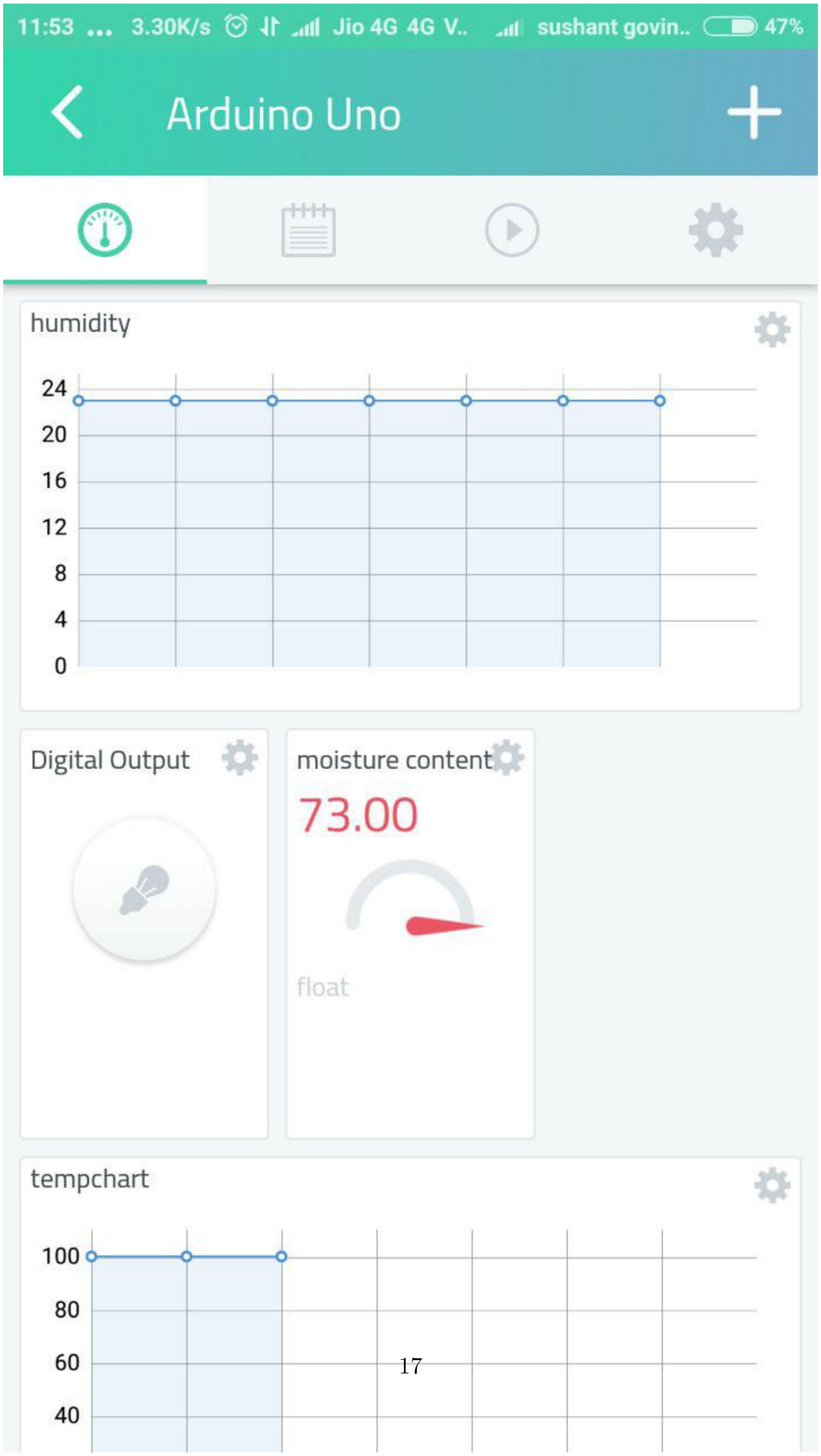
8 Structure





9 Dashboard


Cayenne
plant monitor
Add new...
Arduino Uno
Photoresistor
humidity
moisture content
tempchart
Overview
humidity
Percentage
42.00
moisture content
Percentage
0.00
Photoresistor
float
78.00
temperature
Celsius
tempchart
Live m h d w 1mo 3mo 6mo 1y Custom
21.0
19.5
18.0


11:53 ... 3.30K/s Jio 4G 4G V.. sushant govin.. 47%
Arduino Uno
humidity
24
20
16
12
8
4
0
Digital Output
moisture content
73.00
float
tempchart
100
80
60
40

10 Future Plans

We could expand the reaches of the product by making it more cheaper , so that its available for everyone,including farmers.
We could make a soil sensor using galvanized steel , solder and wires , which would not go beyond 10 rupees.
We could make use of an analog temperature sensor like LM35 or TM36 which is a lot cheapter than a DHT.
We could employ a WiFi module for communication which would cost around 200 rupees, so aggregate cost of everything would be less than 300.
We could use the data we get by spreading these nodes across various farms in India and use Big Data Analytics to integrate weather and climate conditions and synthesize data patterns which would be ideal for growing plants.
For a bigger budget we could enable a image sensor and detect damages on a plant or identify a plant from a database and automatically set the optimum parameters for the plant.
We could even use machine learning through cloud, which would make the applications must more vast.