# IRRIGATION CONTROL SYSTEM IN LEMON FARMING BASED ON INTERNET OF THINGS USING HETEROGENEOUS SENSORS

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***Abstract***

Water scarcity is a major problem and makes farmers utilize resources of water optimally through IOT technology. Internet of Things (IoT) provides better solutions through application-specific heterogeneous sensors for data acquisition and intelligent subsystem. IoT-based irrigation control System helps to achieve a range of minimum water usage in the agricultural farming. This research work can be categorized into three phases. They are:

First stage focuses on predicting and identifying the irrigation condition by using heterogeneous sensors to know soil moisture, atmospheric temperature and humidity around the environment of crop area.

The second aims at making agriculture smart using automation and IoT technologies based on intelligent decision making.

The final phase includes temperature maintenance, humidity and soil maintenance, and controlling of all these operations will be done through WIFI modules and arduino processor.

## 1 INTRODUCTION

The aim of this research work is to manage water scarcity in Tamil Nadu, particularly in Namakkal area, because most people are involved in agriculture and need knowledge in precision agriculture for augmented yield to maximize the benefits. Here water scarcity is a major problem, due to failure of monsoon. t method farming minimizes utilization of the resources and maximizes yield by deploying a multi-factor dimension-reduction-oriented expert system including the irrigation management.

Thermal imaging and temperature measurements of atmospheric air, infrared canopy and atmospheric vapor deficiency have been considered by all researches previously in their studies. The proposed system follows different stages by choosing heterogeneous sensors that measure various parameters of the operation scenario with different paradigm approaches for the irrigation-optimization system. Heterogeneous sensors help to monitor the farming environmental parameters of lemon fields in various stages but random locations to measure the moisture content of the soil, humidity inside the trees and temperature the tree is facing. Using low cost and low power components help us to acquire undistributed data for a long time, which enables power management to optimize battery life.

## 1. METHODS AND METERIALS

### 1.1 Design of Embedded based Experimental setup:

**i) Temperature sensor**

LM35 is a precision centigrade temperature sensing device. It senses the variations in temperature and measures temperature across the surrounding environment. The output voltage of LM35 is linearly proportional to Celsius (in °C) and calibrated in Kelvin (in K). It measures the temperature more accurately than thermistor does. The LM35 is a low cost, small size sensor, and its operating temperature ranges from -55 °C to +150°C.

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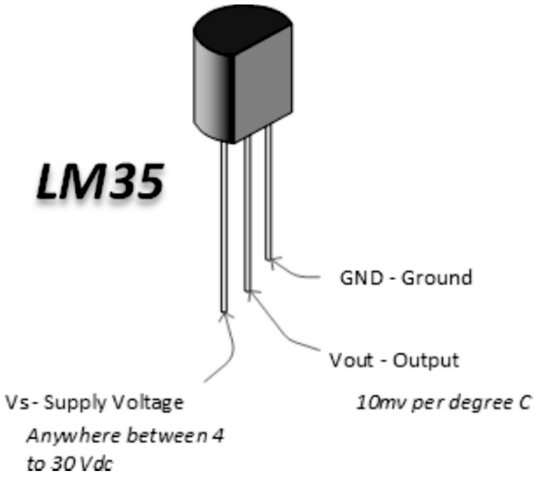


*Fig 1: LM 35 - Temperature / Heat Sensor*

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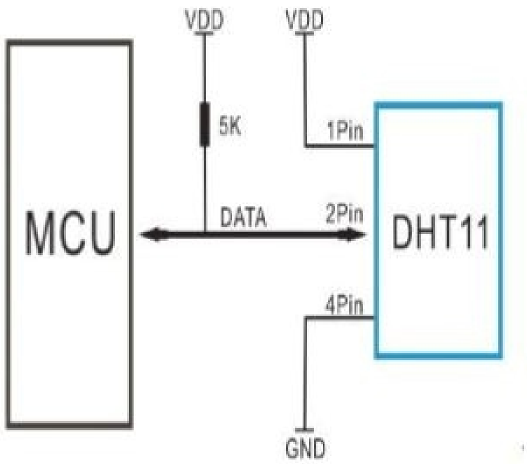


*Fig 2 : Circuit diagram of DHT 11 sensor device.*


*Fig 2 : Humidity Sensor*

**ii) ARDUINO UNO**

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*Fig 5: Arduino UNO processor with IC ATmega-328*

Arduino Uno is a microcontroller designed based on the ATmega328P IC. This device has 14 digital i/o pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, USB connection, power jack, ICSP header and a reset button. This board supports the microcontroller make a simple connection into a computer with the help of a USB cable.

**2.2 DATA AQUSITION SCHEDULE**

We recorded the data for ten days on a schedule of one month with an interval of one or two days. The sampling rate per hour was 12. The process continued from 6 am to 6 pm, since the natural way of irrigation is only during day time. There are 144 data received in a day of 12 hours and the data are recorded for every 5 minutes.

The data samples were recorded during 2019 and the maximum minimum temperature, humidity and soil moisture levels (along with natural irrigation) were identified to low, medium and high based on the recoded value, and they are tabulated in Table 1.

*Table 1: Data recoded on lemon farming*

| Date and Time | temp 1 | temp 2 | temp 3 | Humidity sensor | soil sensor |
|---|---|---|---|---|---|
| 7/21/19 & 9:03:00 AM | 26 | 25 | 25 | 32 | 79 |
| | 24 | 24 | 25 | 31 | 73 |
| | 24 | 25 | 25 | 31 | 72 |
| | 26 | 25 | 25 | 31 | 69 |
| | 25 | 26 | 26 | 31 | 63 |
| | 25 | 26 | 26 | 30 | 37 |
| | 25 | 26 | 27 | 06 | 24 |
| | 24 | 25 | 25 | 31 | 69 |
| | 26 | 25 | 25 | 31 | 71 |
| | 25 | 26 | 26 | 31 | 14 |
| | 25 | 26 | 26 | 30 | 40 |
| | 26 | 27 | 28 | 79 | 03 |

The data set was generated using our circuit of transmitter by attaching the sensor on and around lemon trees aged 2 years and pomegranate aged 2 years. We repeated the experiment for 10 days by choosing a single tree in each variety. Three temperature sensor t1, t2, t3 humidity sensor h1,h2,h3 and soil moisture sensor m1, m2, m3 were fixed on different parts of the tree so that it represented the average temperature, humidity and soil moisture of the trees. The WIFI module that controls the data acquisition by the attached transmitter and required sub modules is given in Figure 2.

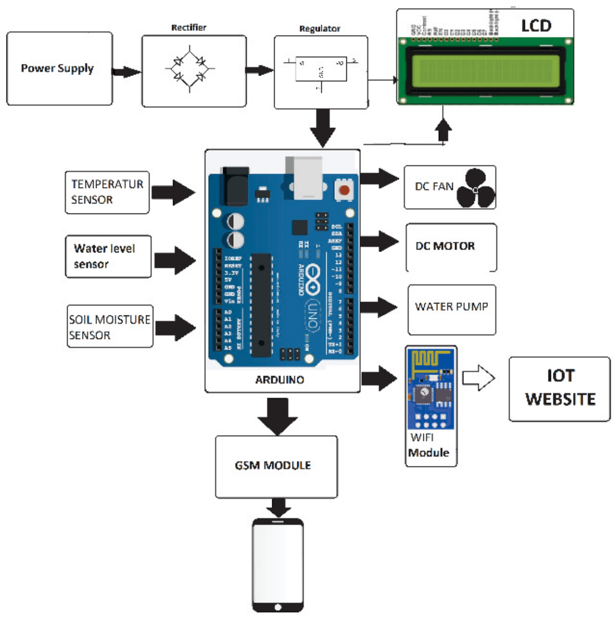


*Fig 6: Block diagram of proposed system*

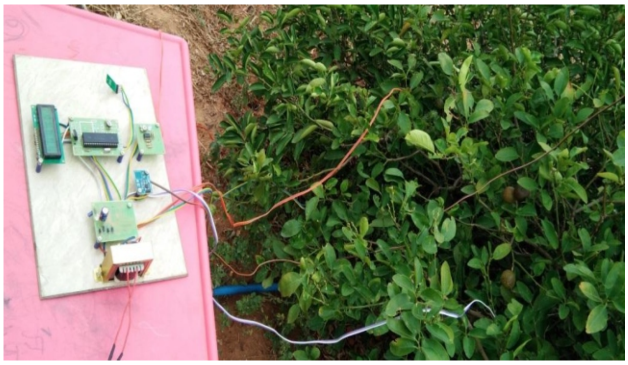

*Fig 7: Experimental set up in lemon farming*

IOT plays a vital role in this research. IOT sensors are capable of sensing and providing information about agriculture farming condition systematically. Here we proposed a system of IOT and smart agriculture by using automation technology. This system makes use of WSN that collects all data from various heterogenous sensors at various nodes and sends them through the wireless protocol.

The system is powered by Arduino uno processor, and contains temperature sensor, moisture sensor, water level sensor, DC motor and GPRS module. When the IOT based agriculture monitoring system starts it checks the water level, humidity and moisture level. It sends SMS alerts on the phone about the levels. Sensors sense the level of water if it goes down, and the system automatically starts the water pump. If the temperature goes above the level, fan starts. This all is displayed on the LCD display module. This is also seen in IOT where it shows information of humidity, moisture and water level with date and time, based on per minute.

## 2.3 SOFTWARE IMPLEMENTATION

The software part is programmed through Arduino Uno software (IDE). It is a code easy to write and upload on to the board. C and C++ languages are used for programming.

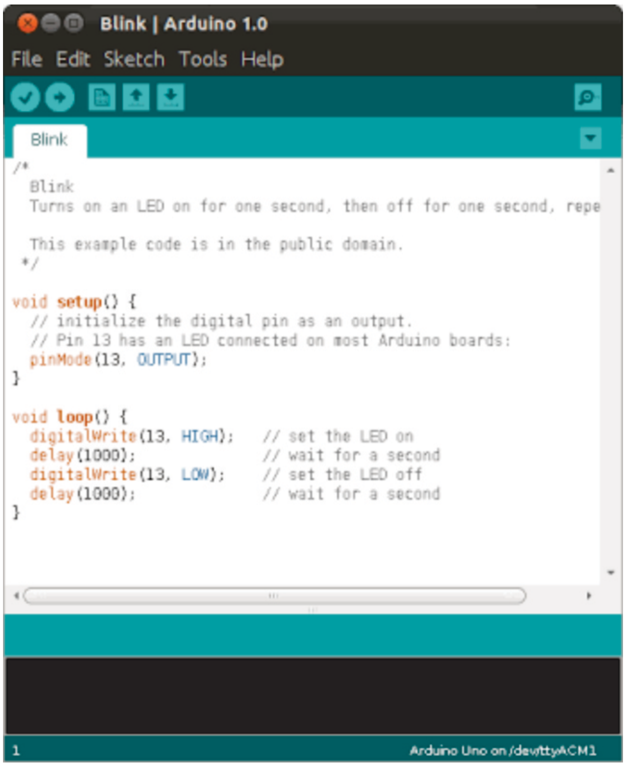


*Fig 8: Software application development part using Arduino 1.0*

## 3. RESULT AND DISCUSSION

### 3.1 Independent Component Analysis

The independent component analysis technique is followed by data reduction, which reduces the noise of the given input and works as a good feature extraction technique. Here assume Suppose that monitor n linear mixtures to ( x1,...,xn of n) independent components. We recorded the heterogeneous sensors' data in agricultural farming area and, using this technique, measured the data reduction. Using this technique they do not get more significant action and decision making to solve the irrigation problem.

*Table 2: Quantification and data reduction using ICA*

| | | | | | |
|---|---|---|---|---|---|
| 1 hour | 1.2981 | 1.2981 | -0.7431 | -0.7431 | -0.7431 |
| | 0.1341 | 2.3702 | 0.7773 | 2.5292 | 0.45 |
| | -1.9442 | 0.2891 | -0.4371 | -2.0899 | 0.0444 |
| | -3.8993 | -3.7888 | -2.1249 | -4.174 | -5.2332 |

### 3.2 Power of Matrices

The power of matrix technique was followed for the resultant ICA values of 4X5 and 4X4 matrices for the sensor reading inputs of size 12X3. The purpose of calculating power of matrix is to try a method to quantify the differences between the occurrences of incidence that happens to the sensor readings.

For example, Experiment 1: from this example it is found that there is no significant difference reflected in the power of matrix calculate from the ICA values resulting from change in sensor readings.

So, this technique was not followed in the quantification of ica values for different sensor readings with respect to time.

*Table 3: Quantification and data reduction using Power of Matrix*

| | | | | | |
|---|---|---|---|---|---|
| Set 2 | -1.7875 | 0.2538 | 0.2538 | 0.2538 | -1.7874 |
| | -0.7207 | -0.5989 | -2.1466 | -2.7705 | -2.9567 |
| | -0.9574 | 1.3764 | -0.0723 | -0.8253 | 1.2767 |
| | -2.4385 | -3.0481 | -0.7017 | -3.709 | -3.709 |

**Equals**

| $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | |
|---|---|---|---|---|---|
| 1 | 2.15036 | -1.0299 | -1.1949 | -2.3076 | 1.82725 |
| 2 | 10.5309 | 5.66595 | 3.20194 | 13.5237 | 10.5942 |
| 3 | 2.8011 | 1.34877 | -2.6132 | -0.9356 | 0.61039 |
| 4 | 16.2718 | 11.5462 | 8.5775 | 22.1617 | 26.2317 |
| 5 | 0 | 0 | 0 | 0 | 0 |

### 3.3 Multifactor Dimensionality Reduction (MDR)

Multifactor dimensionality reduction (MDR) is used to combine the sensor data for the purpose of taking swift decisions with an idea of reducing the voluminous data by applying various combinations of sensors used in this experiment. This statistical approach highly contributes to machine learning and process automation to quantify the inputs received. This approach is helpful in detecting the available attributes from the sensor data using multiple combinations that will help in protecting the information without affecting features hidden in the continuous data. MDR was designed to identify the hidden component of the entire data by reducing data size. This is considered as one of the non-parametric techniques, which is a model-free alternative to the statistical data processing techniques like the traditional logistic regression.

| Binary combinations | Combinations | | | Action |
|---|---|---|---|---|
| | Temperature and Humidity | Temperature and moisture | Humidity and moisture | |
| 000 | HtHh | HtHm | HmHh | Drip |
| 001 | HtHh | HtHm | HmLh | Fan |
| 010 | HtHh | LtHm | HmHh | No Action |
| 011 | HtHh | LtHm | HmLh | No Action |
| 100 | LtHh | HtHm | HmHh | No Action |
| 101 | LtHh | HtHm | HmLh | Spray |
| 110 | LtHh | LtHm | HmHh | No Action |
| 111 | LtHh | LtHm | HmLh | No Action |

## 4. CONCLUSION AND FUTURE WORK

Here, proposed design is implemented with Arduino uno platform for plant-monitoring, controlling temperature and soil moisture with the help of Web server using IOT.

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