

# Smart drip irrigation system using sensor networks

E. Soorya, M. Tejashree, P. Suganya

**Abstract**—A semi-automated irrigation system was developed in order to facilitate continuous and efficient irrigation under water and labour scarcity conditions. Due to reliability, robustness and limited resources, resistive sensors were chosen. A field with okra crops was prepared and divided into two equal areas. One half was non-automated drip irrigated and other area was drip irrigated and sensor operated. The volumetric data of water utilised and crop yield were collected and the results showed that the water consumption is reduced in the automated field as compared to the manually irrigated field.

**Index Terms** — Automation, Drip irrigation, Environmental monitoring, Sensor networks, Soil moisture, Water management.

## 1 INTRODUCTION

Being an agrarian nation, about 65% of the Indian population depends on agriculture and it accounts for around 22% of the India's GDP [8]. Water management is the most important issue on which the growth of agriculture sector largely depends. Indian agriculture sector is in dire need of investment to meet the expenses. To fuel the capital needs of the agricultural economy and also to ensure that the benefits of growth percolate to bottom of the socio-economic pyramid, farming has to be projected as an avenue of investment for the urban population. The scarcity of available water both in its quantity and quality and the migration of labour from agriculture for various reasons resulted in modernizing and automating farming practices that will pave way for revamping agriculture.

Recent scientific advancements have made possible the networking of a wide variety of sensors, independently from any pre-existing infrastructure. Whenever physical conditions change rapidly, these allow for real-time data processing at a minimal cost. **Sensor Networks (SNs) are increasingly considered by the scientific community as the future of Environmental Monitoring. Providing at a low cost, the possibility to gather and process all sorts of data with a space and time resolution which was inconceivable before, these networks are viewed as a critical element of the revolution of ubiquitous computing.**

A system that provides the necessary data granularity and sensors that works in an automated fashion, that comes at a reasonable price, and can be easily adapted to an existing system was designed and implemented.

- E. Soorya is currently pursuing under graduate degree program in electronics and communication engineering in Anna University, India, PH-919884623842. E-mail: soorya\_zeal@gmail.com
- M. Tejashree is currently pursuing under graduate degree program in electronics and communication engineering in Anna University, India, PH-919840381934. E-mail: teja92@gmail.com
- P. Suganya is currently pursuing under graduate degree program in agricultural and irrigation engineering in Anna University, India, PH-919840077036. E-mail: suganya\_pandian85@yahoo.co.in

## 2 STUDY AREA

### 2.1 Site Selection

The study area chosen for this project is the field lab in College of Engineering, Anna University, Guindy, Chennai, Tamil Nadu. An area of 5x5 m<sup>2</sup> was chosen for this study. The geographic location of the area is between 13.0121° N, 80.2356° E, and the average minimum temperature during the months July to September 2012 was 23.33°C and the average maximum temperature was 30.55°C. The soil type is sandy loam.

### 2.2 Drip Irrigation System

The field is divided into two halves for having automated drip system on one side and non-automated drip system on the other side. Water supply for both sides is from separate lines from separate sources and thus has two different designs for the drip system. Volume of water utilized for non-automated system was calculated from the time of operation of the system. The total ON time and the volume of water used to recoup the source every time gave the volume of water consumed by the automated system. All cultivation practices were followed in both the regions. The field layout is represented in the Fig. 1. Okra (*Abelmoschus esculentus*) was planted in this area.

## 3 SYSTEM DESIGN AND IMPLEMENTATION

In this model, data is generated locally but processed globally. Nodes do not analyze the data they collect; they transmit them to a central system, where they are stored and processed.

### 3.1 Data Generation Strategy

Data was generated as a response to an event, viz. when the parameter reaches or exceeds a threshold. We seek to generate as much data as possible, while not compromising the lifetime of the network, so that it remains operational throughout a full season at the minimum.

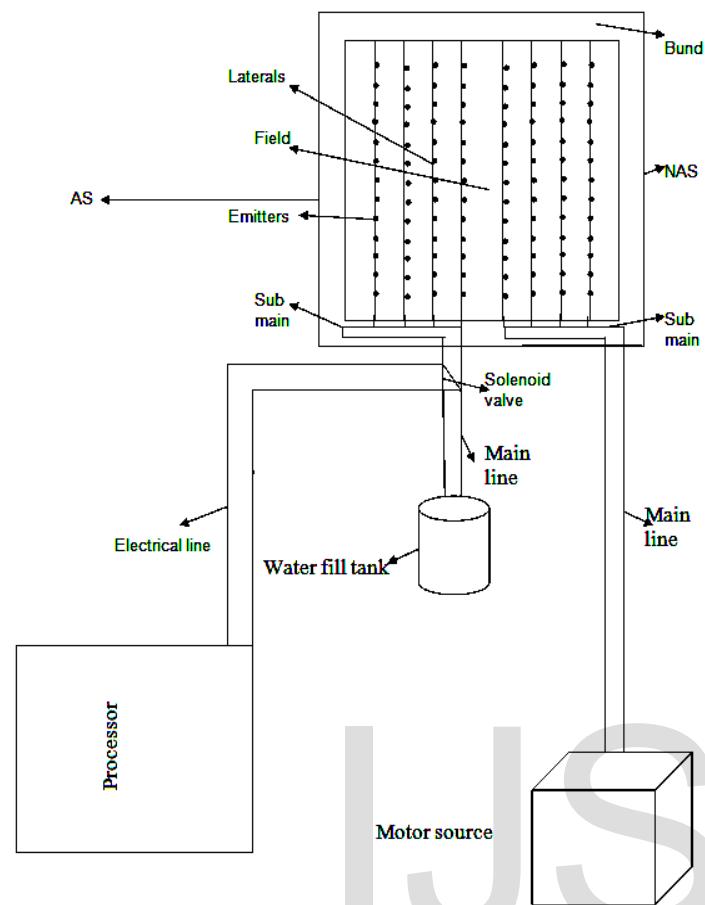


Fig. 1. Field layout. AS =Automated System, NAS = Non Automated System, No. of emitters = 13, Field area = 5x5 m<sup>2</sup>, Bundwidth = 0.4 m, Lateral length = 4.2 m, Emitter spacing = 0.3 m, Lateral spacing = 0.45 m, Motor main line length = 115 m, Tank main line length = 5 m, Sub main length = 1.8 m, Electrical line length = 20m.

### 3.2 Embedded Probes

Soil moisture is a parameter of higher variability. We chose to equip several sensors with two probes each as shown in Fig. 2.



Fig. 2. One of the embedded probes

We have implanted four sensors at spatially and operationally optimal points. The sensors sense the moisture level of the soil by measuring the conductivity of the soil which is due to the presence of flow ions contained in the soil. The flow of ions increases as the moisture content increases. Thus a decrease in the resistance of the soil indicates an increase in the moisture level. By measuring the voltage drop across the soil and by properly calibrating it against the moisture level, we measured the moisture content of the soil.

The sensors are all routed through underground pipelines to the processing system. Here each sensor has a separate circuit dedicated to it. The output of each sensor module is given to the four analog input pins of the IC. While fixing the lower and upper threshold (as given in Table 1), the moisture content of the soil was found out using gravimetric method to cross check the voltage.

TABLE 1  
THRESHOLD VOLTAGE CALIBRATION CORRESPONDING TO THE MOISTURE LEVEL

Lower threshold		Upper threshold	
Voltage (V)	Moisture (%)	Voltage (V)	Moisture (%)
1.4	60	3	100

### 3.3 Data Collection Subsystem

A centralized data-collection model was implemented, (as depicted by Fig. 3) where individual sensor nodes perform minimal data processing and send back the data to a single controller where they are processed. The chosen embedded processor system is PIC16F877A as it is widely used for collecting and processing analog data, quickly becoming a de facto standard. Ideally, the nodes have to perform autonomously for the duration of the cropping season (roughly 2 months), either on batteries or from main line. When the voltage across any one of the sensors falls below the lower threshold value, the solenoid valve is turned ON. It turns OFF only when all four sensors feed a value which is above the upper threshold. The ON condition of the relay opens a 15V DC Solenoid valve. The program was coded accordingly and a counter records the number of times the relay is turned on and off in the PCB circuit. This is shown to the user via an LCD monitor. A timer is simultaneously deployed to measure the amount of time the relay is switched on and this data can also be obtained for a comparative study.

### 3.4 Power Backup

The whole circuit can either be powered from the main line (AC 220V/50Hz) or from the battery. A battery backup circuit was also designed (Fig. 4) and set up so that the system is powered at all times using the rechargeable battery whenever main line power is cut off. The battery is charged at 17V through an LM317 3-Terminal Positive Adjustable Voltage Regulator, designed to supply more than 1.5A of load current with an output voltage adjustable over a 1.2V to 37V.

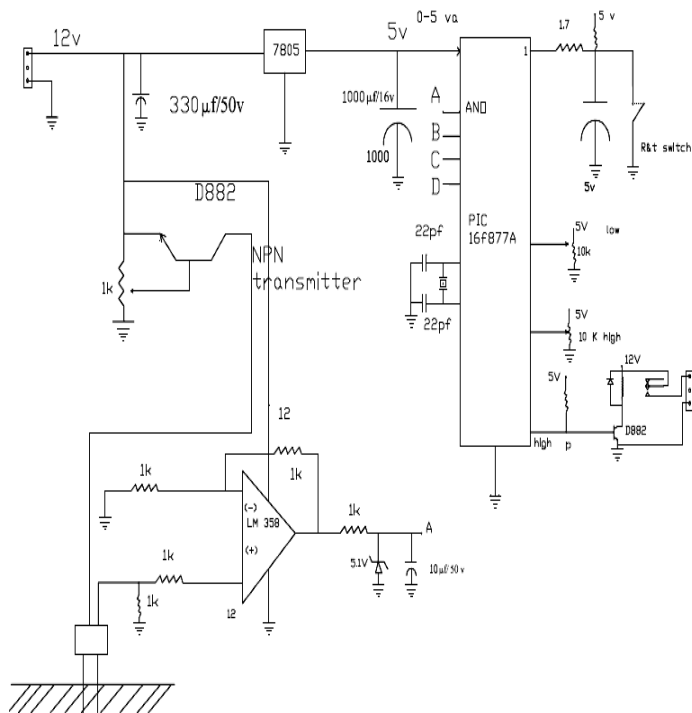


Fig. 3. Main module circuit diagram.

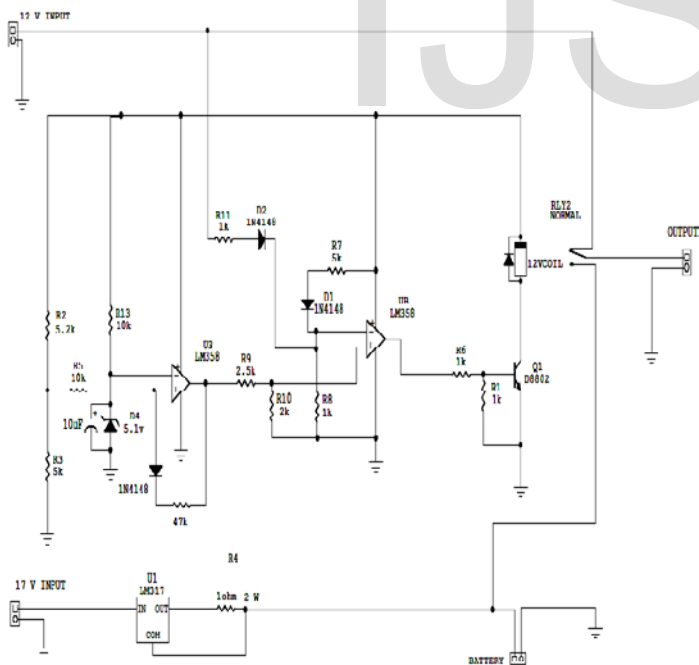


Fig 4. Power backup circuit diagram

It employs internal current limiting, thermal shut-down and safe area compensation. The 12V adapter is connected in a voltage stabilizing circuit that employs an LM358 which consists of two independent, high gain internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range

of voltage.

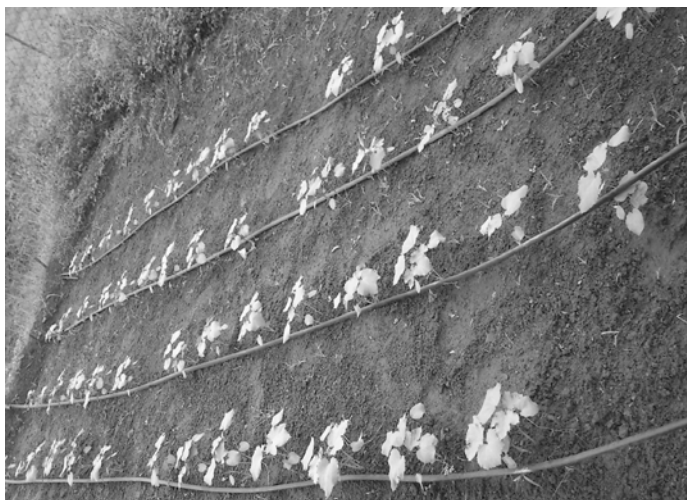


Fig.5 Research field area.

#### 4 CONCLUSION

The average yield difference of Okra between the non-automated and the automated system was 0.502 kg / 25 m<sup>2</sup>. i.e., the automated system exhibited promising results when compared to the other system. The cumulative water consumption difference between the two systems was 39.468 litres for 65 days. The automated system satisfactorily minimizes the water requirement of the crops compared to the other one as the water supply is cut off once when the moisture reaches the upper threshold, whereas no such control is there in the non-automated system.

In spite of certain limitations, the automated system proved itself by the increased yield, minimized water consumption and requirement of labour.

#### ACKNOWLEDGMENT

The authors wish to thank the Director, Centre for Water Resources and the Head, Department of Civil Engineering, Anna University for their encouragement. This project was supported by a grant from Centre for Technology Development and Transfer, Anna University, Chennai.

#### REFERENCES

- [1] Benzekri. A. "Design And Implementation Of A Microprocessor-Based Interrupt-Driven Control For An Irrigation System", *E-Learning in Industrial Electronics*, pp. 18-20, Dec. 2006, 1st IEEE International Conference.
- [2] Dube. V, Dubey. N and Chouhan. S.S. "Wireless Sensor Network Based Remote Irrigation Control System And Automation Using DTMF", *Communication Systems and Network Technologies (CSNT)*, pp. 3-5 June 2011, International Conference.
- [3] MahirDursun and SemihOzden, "A Wireless Application Of Drip Irrigation

Automation Supported By Soil Moisture Sensors", Department of Electrical Education, Technical Education Faculty, Gazi University, 06500, Teknikokullar, Ankara, Turkey, 2011.

- [4] Mark E. Casada, P.E., "Wheat Moisture Measurement With A Fringing Field Capacitive Sensor", USDA ARS Grain Marketing and Production Research Center Manhattan, Kansas Written for presentation at the ASABE Annual International Meeting Sponsored by ASABE Rhode Island Convention Center Providence, Rhode Island, June 29 – July 2, 2008.
- [5] Pfitscher, L.L., "An Automated Irrigation System For Rice Cropping With Remote Supervision", *Power Engineering, Energy and Electrical Drives (POWERENG)*, International Conference, 2011.
- [6] Robert B. McIntosh and Mark E. Casada "Fringing Field Capacitance Sensor For Measuring The Moisture Content Of Agricultural Commodities", *IEEE sensors journal*, VOL. 8, NO. 3, 2008.
- [7] Wobschall .D, "Wireless Soil Moisture Sensor Based On Fringing Capacitance", *Sensors, IEEE*, Oct. 30 2005-Nov. 3 2005.
- [8] Dr. Vandana Tyagi, "India's Agriculture: Challenges for Growth & Development in Present Scenario", *IJPSS*, Volume 2, Issue 5, May, 2012.

IJSER