Matlab-Based Smart Watering System Laws

D. S. Veeranna[1], Sabavath Bala Naik[2], M. Subhadra[3]
[1&2]Department of Electrical & Electronics Engineering
[1&2]Guru Nanak Institutions Technical Campus (Autonomous), Hyderabad, Telangana, India.

ABSTRACT

The green spaces, gardens and urban grasslands play a very important role in big cities since they help the regeneration of air polluted by the peoples' daily activity. Although the automatic irrigation systems of these natural spaces are beginning to be improved, there is usually a fixed irrigation routine that does not take into account meteorological aspects such as the fact that it is raining or that the earth contains enough moisture to ensure the correct development of the grass. Taking into account these facts, this paper presents the design, development and test of an intelligent system for irrigation control of urban lawns. The system is based on the use of a multisensor node composed by humidity and temperature for soil and air, as well as a rain sensor. The multisensor node is controlled by an intelligent algorithm that takes into account the real time values provided by the sensors and the stored data of previous measurements. The intelligent algorithm is responsible for analyzing the data and deciding on the amount of water to be used in a given area. The multisensor node is integrated into a wireless sensor network that will allow us to control areas and specify different irrigation routines for areas with different requirements. Using actual annual meteorological values of Madrid (Spain) where different water requirements are observed throughout the year, the system's operation is simulated. The results show that for a landscaped area of about 140ha, we could save approximately the 6% of the irrigation water we would use in a fixed irrigation routine which would be equivalent to about 22 million liters of water.

1. INTRODUCTION

One of the major problems faced by water system utilities around the world in past decades has been the minimization of water losses; often approaching 30 percent or even 40 percent of the value of all water provided by drinking systems. Nowadays, in the current trend of privileging the sustainability of consumption and the conservation of the environment, the issues of water loss and water delivery systems management are both growing in concern. Both are also often a subject to considerable media and political visibility, especially when periods of shortage of water supplies arise or when the supply of water is inadequate in fast-growing areas. In order to ensure adequate supply, a thorough device assessment is required, which involves tests under various scenarios and operating conditions to investigate the different constraints. This will enable proper response to the required requirements in order to achieve full efficiency in terms of water control

through integrated analysis based on support tools related to system behavior. There have been several papers related to project, such as [1], which proposed a lawn and garden sprinkler that has a manifold extending from it, with one or more bendable tubes. To direct one or more streams of water to a desired position, the tubes can be bent. There is an internal water flow restrictor in a chosen design that allows for greater flow of water from certain tubes than others, so that optimal control of water dispersion is obtained. The bendable tubes are manufactured from flexible material in a desired configuration and have a ductile wire inside them. However, this proposed method [1] has an issue: no mentioning of water volume to flow during watering. Thus, it will be a waste if consumer does not manage the watering flow. There was also a proposal of a pressure control for leakage minimization in water distribution system management. This research aims at a solution that allows simultaneous optimization of the number of valves and its location, as well as valves opening adjustments for simulation in an extended period; depending on the system characteristics [2-5]. In this case study, the researcher used EPANET model to check and monitor the pressure. In the current situation, due to issues such as the financial expenses involved by utilities, possible risks to public health, and environmental burden associated with waste resources, the issue of leaks in water distribution systems has generated considerable interest. This issue has led to tougher penalties for ignoring leakage by water authorities, and has given the requisite incentives for investing in better leak detection technologies and improved leak prevention strategies [6-8]. Therefore, in this project, the proposed method is by using interface YFS201 Hall Effect Water Flow Sensor with Arduino UNO to measure the flow rate and volume of water. This system also uses an ultrasonic sensor to detect water level inside the tank. This ultrasonic sensor will send signals to reduce water wastage or spillover by monitoring the amount of water inside the tank. This system can be used for watering lawn and garden. Moreover, this project can be used to automatically measure water flowing through a pipe or container, or as base to create a control system based on the water flow rate or quantity. Instead of using manual calculation, this system is convenient to use, as it shows the amount of water used for watering on the LCD monitor. In addition, the system automatically detects water as leaking if the flow rate becomes low suddenly, and also will control the amount of water before doing the watering.

1.2. EXISTING AND PROPOSED SYSTEM

1.2.1. EXISTING SYSTEM

Traditional lawn watering systems typically rely on manual operation or basic timers, which may not account for current weather conditions, soil moisture levels, or plant water needs. This can result in overwatering or under watering, leading to inefficient water use and potential harm to the lawn.

1.2.2. PROPOSED SYSTEM

The proposed smart watering system for lawns utilizes IoT sensors to monitor soil moisture, weather conditions, and plant water requirements

in real-time. By integrating this data with an automated irrigation system, the smart watering system can optimize watering schedules and amounts, ensuring efficient water use and healthy lawn maintenance. This system aims to provide a sustainable and convenient solution for lawn care by minimizing water waste and enhancing plant health.

1.3. GENERAL INTRODUCTION TO EMBEDDED SYSTEM

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called "firm ware". The desktop/laptop computer is a general-purpose computer. You can use it for a variety of applications such as playing games, *word* processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

Embedded systems do a very specific task; they cannot be programmed to do different things. Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low. Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

1.3.1. APPLICATION AREAS

Nearly 99 per cent of the processors manufactured end up in embedded systems. The embedded system market is one of the highest growth areas as these systems are used in very market segment-consumer electronics, office automation, industrial automation, biomedical engineering, wireless communication, data communication, telecommunications, transportation, military and so on.

1.3.2. CONSUMER APPLIANCES

At home we use a number of embedded systems which include digital camera, digital diary, DVD player, electronic toys, microwave oven, remote controls for TV and air-conditioner, VCO player, video game consoles, video recorders etc. Today's high-tech car has about 20 embedded systems for transmission control, engine spark control, air-conditioning, navigation etc. Even wristwatches are now becoming embedded systems. The palmtops are powerful embedded systems using which we can carry out many general-purpose tasks such as playing games and word processing.

1.3.3. OFFICE AUTOMATION

The office automation products using embedded systems are copying machine, fax machine, key telephone, modem, printer, scanner etc.

1.3.4. INDUSTRIAL AUTOMATION

Today a lot of industries use embedded systems for process control. These include pharmaceutical, cement, sugar, oil exploration, nuclear energy, electricity generation and transmission. The embedded systems for industrial use are designed to carry out specific tasks such as monitoring the temperature, pressure, humidity, voltage, current etc., and then take appropriate action based on the monitored levels to control other devices or to send information to a centralized monitoring station. In hazardous industrial environment, where human presence has to be avoided, robots are used, which are programmed to do specific jobs. The robots are now becoming very powerful and carry out many interesting and complicated tasks such as hardware assembly.

1.3.5. MEDICAL ELECTRONICS

Almost every medical equipment in the hospital is an embedded system. These equipment's include diagnostic aids such as ECG, EEG, blood pressure measuring devices, X-ray scanners; equipment used in blood analysis, radiation, colonoscopy, endoscopy etc. Developments in medical electronics have paved way for more accurate diagnosis of diseases.

1.3.6. COMPUTER NETWORKING

Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router's function is to obtain the data packets from incoming pores, analyze the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipment's, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

1.3.7. TELECOMMUNICATIONS

In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Dissemblers (PADs), sate11ite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

1.3.8. WIRELESS TECHNOLOGIES

Advances in mobile communications are paving way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20'h century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital Assistants and the palmtops can now be used to access multimedia service over the Internet. Mobile communication infrastructure

such as base station controllers, mobile switching centers are also powerful embedded systems.

1.3.9. INSEMINATION

Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyzer, logic analyzer, protocol analyzer, radio communication test set etc. are embedded systems built around powerful processors. Thank to miniaturization, the test and measuring equipment are now becoming portable facilitating easy testing and measurement in the field by field-personnel.

1.3.10. SECURITY

Security of persons and information has always been a major issue. We need to protect our homes and offices; and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in~ embedded systems. Embedded systems find applications in every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial automation, data communication, telecommunication, defense, security etc. Used to encrypt the data/voice being transmitted on communication links such as telephone lines. Biometric systems using fingerprint and face recognition are now being extensively used for user authentication in banking applications as well as for access control in high security buildings.

1.3.11. FINANCE

Financial dealing through cash and cheques are now slowly paving way for transactions using smart cards and ATM (Automatic Teller Machine, also expanded as Any Time Money) machines. Smart card, of the size of a credit card, has a small micro-controller and memory; and it interacts with the smart card reader! ATM machine and acts as an electronic wallet. Smart card technology has the capability of ushering in a cashless society. Well, the list goes on. It is no exaggeration to say that eyes wherever you go, you can see, or at least feel, the work of an embedded system.

2. BLOCK DIAGRAM

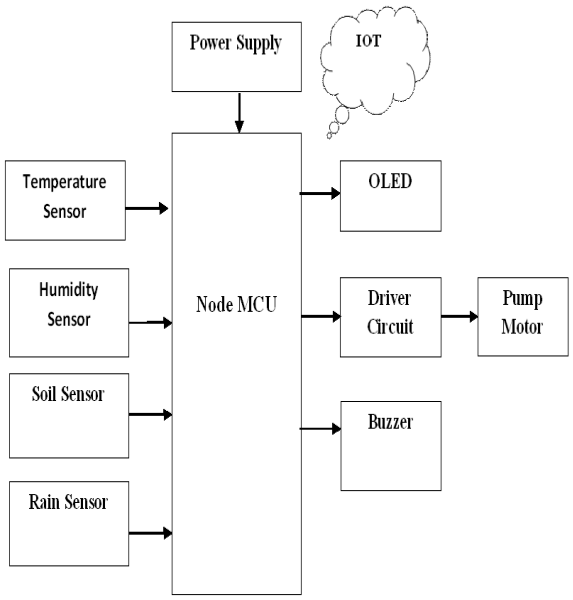

Fig.2.Block Diagram of Smart Watering System for Lawns

3. SOFTWARE SPECIFICATION

3.1 THE ARDUINO INTEGRATED DEVELOPMENT ENVIRONMENT

Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

3.2 LIBRARIES

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #includestatements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

To write your own library, see this tutorial.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

4. SCHEMATIC

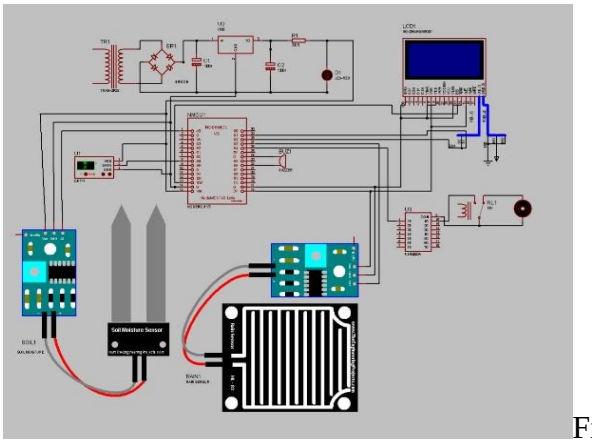

Fig. 4. Circuit diagram of smart watering system for lawns

5. Simulation And Design

5.1 Output Screen Shots

Fig. 5.1. Temperature sensor output.

Fig. 5.2. Soil Sensor output.

Fig. 5.3. Humidity Sensor Output.

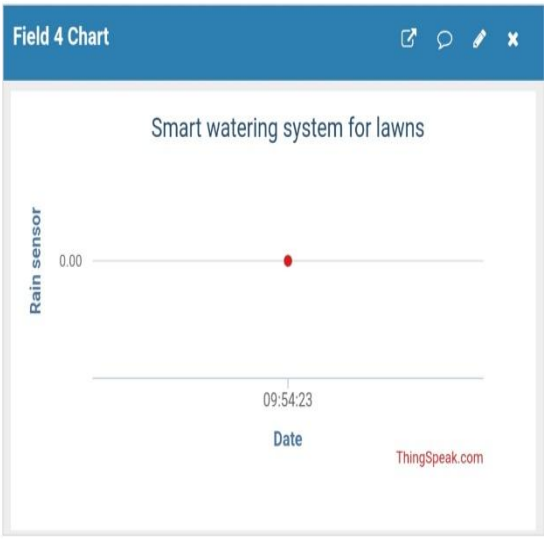

Fig. 5.4. Rain Sensor Output.

6.CONCLUSION & FUTURE WORK

6.1 CONCLUSION

This paper has presented a design of smart lawn and water sprinkler for the garden by using Arduino Uno. The application of the microcontroller, which is the Arduino in this project, enhances the monitoring of the capacity of the water tank, water leakage detection, and control of the watering system to the lawn. The implementation of IoT in this project also increases the ability of users to monitor and control this system. The BLYNK application used in this project is also more practical to monitor the system, plus it is easy to manage the GUI on the smartphone according to the user demand.

6.2 FUTURE WORK

The future of smart watering systems for lawns holds significant promise as technology continues to evolve. Key areas of development include:

1. **AI-DRIVEN WATERING ALGORITHMS**

Advanced artificial intelligence (AI) could optimize watering schedules based on real-time data such as soil moisture, weather forecasts, and lawn type. These algorithms would adapt dynamically to changing conditions, ensuring efficient water usage while maintaining a healthy lawn.

2. **INTEGRATION WITH WEATHER FORECASTING**

smart watering systems could become more integrated with weather services, adjusting watering schedules automatically to avoid watering before a predicted rainfall or during periods of high humidity, reducing water waste.

3. **SENSOR ADVANCEMENTS**

More sophisticated sensors could be developed to measure various factors such as soil pH, temperature, and even plant health. These sensors would provide a deeper understanding of lawn needs, leading to more precise irrigation.

4. **WATER CONSERVATION AND SUSTAINABILITY**

Future systems will likely focus on maximizing water efficiency. This could involve more granular control over different areas of a lawn, ensuring that regions with higher water needs are given more irrigation while drier areas receive less.

5. **INTEGRATION WITH SMART HOME ECOSYSTEMS**

Smart watering systems could be incorporated into broader smart home networks. This would allow homeowners to control and monitor their irrigation systems remotely, using voice assistants or smartphone apps.

6. **SOLAR-POWERED SYSTEMS**

The integration of solar panels to power watering systems could reduce energy consumption, making these systems more sustainable and cost-effective in the long run.

7. **DATA ANALYTICS FOR LAWN HEALTH**

Future systems might not only focus on watering but could also offer insights into the overall health of a lawn, such as detecting signs of disease or pest infestation, and recommending actions to remedy these issues.

8. **AUTOMATED MAINTENANCE ALERTS**

As these systems become more complex, they could offer automated alerts for maintenance, notifying homeowners when filters need cleaning or when sensors need calibration, ensuring optimal performance.

9. **SMART WATERING FOR DIFFERENT PLANT TYPE**

In the future, smart watering systems could differentiate between various types of plants in a landscape (e.g., trees, shrubs, grass), and tailor watering schedules to suit the needs of each plant type for improved overall garden health.

These advancements will likely contribute to more water-efficient, eco-friendly, and easy-to-manage lawn care systems in the coming years.

REFERENCES

[1] Cooper R. (1998). Lawn and Garden Sprinkler with Bendable Tubes. United State COOPER, 5826803.

[2] Araujo, L. S., Ramos, H., & Coelho, S. T. (2006). Pressure control for leakage minimization in water distribution systems management. Water resources management, 20(1), 133-149.

[3] Vairavamoorthy, K., & Lumbers, J. (1998). Leakage reduction in water distribution systems: Optimal valve control. Journal of hydraulic Engineering, 124(11), 1146-1154.

[4] Ayala–Cabrera, D., Herrera, M., Izquierdo, J., Ocana–Levario, S. J., & Pérez–García, R. (2013). GPR-based water leak models in water distribution systems. Sensors, 13(12), 15912-15936.

[5] Li, W., Ling, W., Liu, S., Zhao, J., Liu, R., Chen, Q., ... & Qu, J. (2011). Development of systems for detection, early warning, and control of pipeline leakage in drinking water distribution: A case study. Journal of Environmental Sciences, 23(11), 1816-1822.

[6] Deepiga, T., & Sivasankari, A. (2015). Smart water monitoring system using wireless sensor network at home/office. International Research Journal of Engineering and Technology, 2(4), 1305-1314.

[7] Adsul, S., Sharma, A. K., & Mevekari, R. G. (2016, September). Development of leakage detection system. In 2016 International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT) (pp. 673-677). IEEE.

[8] Colombo, A. F., Lee, P., & Karney, B. W. (2009). A selective literature review of transient based leak detection methods. Journal of hydro-environment research, 2(4), 212-227.

[9] El Shafee A. and Hamed K. A. (2012) Design and implementation of a WIFI based home automation system. World academy of science, engineering and technology, 68, pp: 2177- 2180.

[10] M. S. S. M. Basir, M. S. M. A. Kader, K. H. Yusof, N. Ripin, S. S, Jamaluddiin, K. A. Yusof, S. M. Mazalan and N. H. Shahadan, (2020). IOT based emergency power shut down switch for industrial machines, Proceedings of Mechanical Engineering Research Day, pp: 187-188.