

# SMART FARMING USING ULTRASONIC SENSOR, MOISTURE AND PRESSURE SENSORS LEADING TO WATER CONSERVATION.

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**Abstract :** This study has been undertaken to investigate the incorporation of Information Technology and Machinery into the Agricultural production systems. By using new technologies like Internet of Things (IoT), Wireless Sensor Network (WSN) Technology we would expect increased development by using more robots and artificial intelligence leading to smart farming. Smart farming concept can be used in such areas where water for farming is not adequately available, and by doing so we can eventually take better yields also by utilizing only required amounts of water. Nearly 70% of water is consumed for irrigation purpose worldwide, where water is essential to maintain a good productivity. An effectively irrigation control can be achieved by having the handful reliable data about the actual plant water needs. By incorporating the fast, robust, portable and non-invasive techniques which are directly capable of measuring the actual plant water needs are much helpful and able to prove themselves in the world of using extensive water for agriculture which eventually leads to the water shortage.

Non-Contact resonant ultrasonic spectroscopy (NC-RUS) is a noninvasive ultrasonic technique where sensing of leaves for the water content is possible for different plant species. By using such ultrasonic transducers we can actually have a clear vision of providing water to a field to get maximum yield out of it. By using NC-RUS system we can get valuable information of water content and turgor pressure in the leaves. By analyzing and reviewing the main requirements for sensors, electronics, signal processing and also data analysis where we can develop a fast operating, efficient and powerful nondestructive, non-invasive NC-RUS system to analyze and monitor the leaves water content and turgor pressure.

By using Wireless Sensor Network (WSN) technology we can detect, trace out the pipeline leakages in the pipeline structure that are used for hill station and forest farming. Wireless sensing technology is a cost effective technology and can be used in many of the vulnerable areas where actual man power is not easily accessible.

**IndexTerms - Internet of Things (IoT), Non-Contact resonant ultrasonic spectroscopy (NC-RUS), Wireless Sensor Network (WSN) Technology.**

## I.INTRODUCTION

As per the estimated figures, world agriculture utilizes about 70% of fresh water per year to irrigate only about 17% of the world's cropland. The amount of irrigation land is expanding day by day to meet the increasing population requirements. The right agricultural practice and the supporting agricultural policy is then crucial, efficient use of water in crop irrigation can be largely improved by introducing more accurate and human friendly used systems to indicate and consume the actual water needed by a crop.

Water leakage globally is also a serious issue faced in many of the continents like Europe and in Africa where water leaked for many of the irrigation purposes causes shortage of water. Extensively water leakage into the fields where crop does not actually requires this amount of water can damage the crop in that particular field area by decaying the roots. This also leads to damage the soil quality by increasing the soil salts content which eventually forms a white salt layer above the soil, this salt formation above the soil damages the crop quality and such crops are eventually more prone to the pests of fields which alter the crop leaves and also the crop flowers and fruits which reduces the amount of final yield to be withdrawn at the end of the cultivation season. Thus, the only required amount of water to be provided into the fields without any water leakages is at the utmost importance. In a long distance pipeline structure for the irrigation purpose is a challenging task and should overcome this leakage drawback for the entire Worlds future betterment. Traditionally, the water detection is carried out and informed is done manually where actual observation and maintenance may not take place at the real time that is immediate leakage observation and maintenance may not be visualized by a farmer, which may lead to extensively amounts of water into an operating field. Maintenances of the pipeline structures manually is not an easy task and data provided by the person may not be accurate and real time so to provide accurate and real time results new technology can be used. Wireless Sensor Network (WSN) technology can be used to detect leakages in the irrigation pipeline structures. By using the Wireless Sensor Network (WSN) technology we can detect, trace out the pipeline leakages in the pipeline structure that are used for hill station and forest farming. Wireless sensing technology is a cost effective technology and can be used in many of the vulnerable areas where actual man power is not easily accessible.

Water is the vital and the most essential source for life on the Earth. The amount of fresh water available on the Earth's surface is limited; hence, it is necessary to protect these available fresh water reserves and should utilize it efficiently. Up to 60% of water is wasted every year due to leaky pipes generating economic, environmental and possible human losses. As water resources become scarce, the conservation of water has a high priority around the globe, and water management and conservation have become important. Only approximately 0.01% of the water is available for use on a sustainable basis. Growing water demand in large urban centers, population growth, industrialization, and inadequate pricing policies make adequate access to water an issue, especially for low-income households. To meet the growing demand for the conservation of water resources, novel and interdisciplinary solutions must be developed and implemented. Pipeline fault detection methods like Vibration analysis, Pulse echo methodology, Acoustic

techniques, Negative pressure wave based leak detection system, Support Vector Machine (SVM) based pipeline leakage detection, Interferometry fiber sensor based leak detection, Filter Diagonalization Method, etc. used. It is found that these methods have been applied for specific fluids like oil, gas and water, for different layout patterns like straight and zigzag, for various lengths of pipeline like short and long and also depending on various operating conditions.

## II. MOTIVATION

Motivation behind this system is analysis of word wild bank for leakage detection. It is observed that at least one leakage every year. Pipeline leakage may lead to large economic loss and also causes an environmental pollution so, safety of pipeline structure is most important. In traditional pipeline leakage detection method depends on maintenance person, but that person unable to provide real time leakage information because of the long distance structure so, leakage may not be detected in time and causes economic loss, environmental pollution. According to word bank worldwide losses of water is estimated at 48.6 billion m<sup>3</sup>, thus a monetary loss approximately 14.6 billion US dollars per year. An international level fluid leakage is a serious problem as it causes shortage, at least 25% of water in Europe is being leaked in pipeline network and some other countries facing 50% of water leaks.

## III. LITERATURE SURVEY

### 3.1 Survey for Different Pipeline Structures

Water is a limited and important resource; hence it is needed to protect and use water efficiently. Also we should have to maintain a good quality of water for irrigation purpose For transportation of water, fuels, crude oil and natural gas from one city to another or one place to another is not safe through vehicle so, now it can be transferred through the pipeline. Mostly oil and water is transferred through the pipeline structures which are buried underground or above the ground. Different methods where used for identify the leakage in pipeline structure.

**The survey of methods used for various pipeline structures are presented below:**

S. Rashida et al. [1]. This paper presents the design, development and testing of a smart wireless sensor network (WSN) for leak detection and size estimation in long range pipelines. Uses wireless communication and machine learning (WML) algorithms to learn small leakages. In machine learning use support vector machine (SVM), K-nearest neighbor (KNN) and Gaussian mixture model (GMM).

S. M. Qasim, et al. [2]. Wireless Sensor Network (WSN) is increasingly required to optimize the reliability of the inspection and improve the accuracy of the water pipeline monitoring. It combines powerful leak detection and localization algorithms and an efficient wireless sensor node System on Chip (SoC) architecture. Water Pipeline Monitoring (WPM) method has been proposed using hybrid combination of Leak detection Predictive Kalman Filter (LPKF) and Modified Time Difference of Arrival (TDOA) method based on pressure measurements.

A. S. Almazayad, et al. [3]. This paper gives a scalable design and simulation of a water pipeline leakage monitoring system using Radio Frequency Identification (RFID) and WSN technology. Different type of sensors, such as temperature sensor, pressure sensor, acoustic sensor, flow sensor and pH sensor are typically used for water pipeline monitoring.

E. Magiera, et al. [4]. To increase the awareness of water consumption at the household level, an information system for gathering, interpreting, and sharing data about water usage is planned. Reduce water consumption in the city. Reduce leaks, taking into account the complex water delivery system.

T. AL-Kadi et al. [5]. This paper discussed the different solutions for leaks in pipelines using wireless sensor networks (WSNs). The WSN-based solutions are magnetic induction based, continuous pressure monitoring, underground to above ground radio propagation and wireless signal networks (WSiN).

G. Owojaiye et al. [6]. Identify vital design issues that must be considered to facilitate the employment of WSN for pipeline monitoring. Classify these design issues into five different categories namely; sensing modality, power efficiency, energy harvesting, network reliability and localization. In addition, discuss the concept of cooperative communication for pipeline-monitoring sensor networks deployed in sub-sea environments. Also, study the employment of sensor networks for monitoring underground pipelines.

A. Candelieri et al. [7]. An approach based on hydraulic simulation and machine learning is presented, aimed at improving leakage management via analytical leak localization and reducing time and costs for investigation and rehabilitation of the Water Distribution Network. Hydraulic simulation is used to run different leakage scenarios by introducing a leak on each pipe.

S. Datta et al. [8]. In this paper brief discussion is made on various pipeline fault detection methods viz. Vibration analysis, Pulse echo methodology, Acoustic techniques, Negative pressure wave based leak detection system, Support Vector Machine (SVM) based pipeline leakage detection, Interferometric fibre sensor based leak detection, Filter Diagonalization Method (FDM), etc. Merit and demerits of all methods are discussed. It is found that these methods have been applied for specific fluids like oil, gas and water, for different layout patterns like straight and zigzag, for various lengths of pipeline like short and long and also depending on various operating conditions.

### 3.2 Survey for Different Non-Contact Resonant Ultrasonic Spectroscopy (NC - RUS)

Fresh water is a key natural resource for food production, sanitation and industrial uses and has a high environmental value. The largest water use worldwide (~70%) corresponds to irrigation in agriculture, where use of water is becoming essential to maintain productivity. Efficient irrigation control largely depends on having access to reliable information about the actual plant water needs.

Therefore, fast, portable and non-invasive sensing techniques able to measure water requirements directly on the plant are essential to face the huge challenge posed by the extensive water use in agriculture, the increasing water shortage and the impact of climate change.

Non-contact resonant ultrasonic spectroscopy (NC-RUS) in the frequency range 0.1–1.2 MHz has revealed as an efficient and powerful non-destructive, non-invasive and in vivo sensing technique for leaves of different plant species. In particular, NC-RUS allows determining surface mass, thickness and elastic modulus of the leaves. Hence, valuable information can be obtained about water content and turgor pressure.

### **The survey of methods used for various Ultrasonic Spectroscopy is presented below:**

Simon X. Yang et al. [9]. Ultrasonic Sensing of Plant Water needs for Agriculture. This paper presents the design, development and testing of a Smart NC-RUS system to measure thickness resonance in plant leaves. These elements can be grouped in four categories sensors, electronics, software and structural elements.

Zadler, B. J. Le Rousseau, J. H. L. Scales, J. A. and Smith, et al. [10]. M. L. 2004 Resonant Ultrasound Spectroscopy: theory and application, Geophys. J. Int., 156, 154–169.

Sensors 2011, 1 1, 2177-2194 et al. [11]. "Ultrasonic and LIDAR Sensors for Electronic Canopy Characterization in Vineyards: Advances to Improve Pesticide Application Methods" by Jordi Llorens, Emilio Gil, Jordi Llop & Alexandre Escola.

S. Hashimoto et al. [12]. "Evaluation of Water Quality of Healthy and/or Tasty Drinking Water and Its Application to Japanese Waters (in Japanese)," Journal of SHASE, Vol. 63, No. 6, 1989, pp. 463-468.

### **3.3 Summary of Literature Survey.**

Overall, the above mentioned brief literature survey of different system demonstrates that previous work has significantly promoted the understandings of emergency of water leakage system. The literature survey motivates to propose the new system which is cost effective, easily available and work in any vulnerable areas. The water leakage detection system is design to identify real time water leakage in pipeline. The Non – Resonant Ultrasonic Spectroscopy System is designed to identify real time non-contact sensing and non-destructive sensing of relative water content for irrigation control.

### **From literature survey we can conclude the following points:**

3.3.1 The water pipeline leakage detection system is simple to implement primarily because of their reliance on wireless communication.

3.3.2 The main requirements for Ultrasonic Sensing of Plant Water Needs for Agriculture are sensors, electronics, and signal processing and data analysis in order to develop a fast, portable, robust and non-invasive NC-RUS system to monitor variations in leaves water content or turgor pressure.

3.3.3 From literature survey it is understood that there are various ways (methods) to implement for leakage detection system but having some disadvantages like real time leakage detection is not possible, less availability of maintenance for pipeline structure and accuracy. This survey motivates to present an approach to design a system to overcome these drawbacks and designing new system for that.

## **IV. SPECIFICATION OF THE SYSTEM**

Water is very important part in day to day life so, wastage of water which causes shortage and this system provide solution for the water leakage. The main objective of this system is give information about real time leakage in water pipeline. This system is designed under wireless sensor network. System specifications are based upon which type of area is used for the working. Here, given system consist of above ground pipeline structure in this sensors are half mounted above pipeline and sensing part of sensor is mounted under pipeline structure. The detail specification of the system is as follows.

### **Availability of Sensors.**

- Three same sort of Generic G ¼ pressure transducer sensor is used to sense the pressure present on pipeline due to water force. This sensor is used, among other sensors because it is easily available in the market and it gives higher efficiency. Sensor required voltage as 0-5 VDC here at 0 volt sensor gives low pressure and at 5 volts it gives high pressure and pressure range is 0-0.8Mpa. These sensors are easily available in the market.
- A couple of wideband and high sensitivity air-coupled ultrasonic transducers (transmitter: Tx and receiver: Rx) is used to determine surface mass, thickness and elastic modulus of the leaves..
- A pulse/receiver to excite Tx and to filter, amplify and digitize the electrical signal in Rx. If an analog pulse/receiver is used, then a digital oscilloscope or a similar device is required to digitize the received signal.
- SUNROM's Soil Moisture Sensor - Digital + Analog Output Sensor transducer is used to sense the dielectric constant of the soil in order to find its volumetric water
- Content (VWC).
- SUNROM Moisture Sensor has a low power requirement and very high resolution. This gives the ability to make
- Many measurements (i.e. hourly) over a long period of time with minimal battery usage.

### **Less Power Consumption.**

The system is designed on 9v to 12v power supply, and power consumption of this system is very less as compared other systems. Actual power supply of the ARM is 3.3V and for sensors power used is 5v that means power utilization of the system is very less.

**Wireless Communication.**

This system is designed to implement WSN via 2 slaves and a master communication. For this, it is using Request and Respond Protocol in which the master sends a request over the network with the destination ID. As soon as the destination slave receives the frame it responds with data, also implementing cooperative communication in which the data is transmitted over other slaves. Wireless sensor network is popularly known because of its advantages such as low cost, low power and small multifunctional sensor nodes. WSN has short distance communication ability. WSN is for development of multifunctional sensor nodes, it can sense and process data within its all communicative nodes. It supports up to 3 network topologies namely star, mesh and cluster tree.

**Real time sensing of plant water needs for Agriculture.**

Resonant ultrasonic spectroscopy (RUS) is a well know technique to obtain the elastic constants of solid materials. Transducers used to excite and sense these resonances employ point contact with the samples to minimize any mechanical load that could shift the resonant frequency of any mode and so produce misleading results.

The results of the application of NC-RUS to the study of filtration membranes have been published in J. Member. Sci. (Alvarez-Arenas 2003a) and in IEEE Trans. Ultrasound. Ferroelec. Freq. Control (Alvarez-Arenas 2003b). Filtration membranes are highly porous (open-pore porosity > 70%) and thin (thickness about 100 micron) polymer films. First thickness resonance normally appears between 0.1 and 2.0 MHz, so use of non-contact resonant ultrasonic spectroscopy is a convenient way to characterize these materials.



**Figure 1 :** Specially designed pair of air-coupled transducers mounted on an U-shaped holder to take NC-RUS measurements in *Vitis vinifera* leaves.

**Real time leakage detection**

As in traditional pipeline a physical pipeline structure is checked by the maintenance man itself so, the real time water leakage information is not available. Because of this lot of water is lost which causes serious shortage of water in future. By using this system water pipeline structure is under observation at any time, if leakage is found in pipeline structure within a minute of time the leakage information is transfer to the service center. Service center make necessary action on the same and lot of water loss is avoided.

**IV. REFERENCES**

S. Rashida et al. [1]. This paper presents the design, development and testing of a smart wireless sensor network (WSN) for leak detection and size estimation in long range pipelines. Uses wireless communication and machine learning (WML) algorithms to learn small leakages. In machine learning use support vector machine (SVM), K-nearest neighbor (KNN) and Gaussian mixture model (GMM).

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