IOT BASED ENERGY EFFICIENT ROUTING STRATEGY FOR AUTOMATED IRRIGATION SYSTEM

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Abstract
The robustness of communication networks is extremely important for both users and network providers. Specifically, Wireless communications are the rapidly growing sectors in the field of communication. It is foreseeable that the Wireless sensor networks (WSN) will become prevailing and take part in many applications. The recently growing IoT applications require insistent development in the usage of smart and personal wireless communications systems. Wireless data gathering has fast-tracked its rapidity with the progress in many fields. The wireless sensor networks used in the present days are undergone many concerns like limited energy constraint, bandwidth and data losses. The proposed system consists of sensors placed in the farm area, a control station and a base station. Wireless sensor network (WSN) uses ad-hoc networks which support flexibility and self configuration which is beneficial for agricultural application.In order to increase the lifetime of the sensor nodes in the network, one should make the nodes to consume less power. Therefore, the ultimate objective is to reduce the energy consumption. For achieving reduced energy consumption, many works have been presented which focused on reducing the data bits transmitted and a number of transmissions. These objectives are met out by employing compression, data suppression, correlation aware protocols, data prediction, censoring, etc. In those works, the energy consumption is attained in a different way and each has several drawbacks and overcome by using different techniques and algorithms.

Key Words: Irrigation System, Soil Moisture Sensor, Temperature Sensor, WSN.

I. INTRODUCTION

With the increasing WSN technology, the communication systems have been developing enormously. Specifically, Wireless communications are the rapidly growing sectors in the field of communication. The cellular systems have advanced massively in the recent years. It becomes a money making tool for many business magnets. The Wireless Local Area Network (WLAN), also takes part in many business organizations, educational institutions, homes (R. Silva, 2014). Wireless Sensor Network (WSN) is another communication system finds a prominent role in many applications. These advancements in wireless communication lead to many research for their growth. This chapter gives the brief introduction of the research work. The recently growing IoT applications require insistent development in the usage of smart and personal wireless communications systems. The channel interference is the significant restraining aspect which affects sensing coverage, reliability and performance in communication systems. Major barriers to the high volume transmission are unsystematic broadcasting channels, scarce radio spectrum, fading channel and inter-symbol interference (E. Fadel, 2015).

There are a lot of technical issues that disputes the designing of effective wireless network systems. These issues develop in all features of system implementation. The tiny devices presenting in the wireless network should be capable of performing many operations to encourage many applications. The bandwidth and random variations of channels of the wireless network will become worse if the performance of the network reduces. As the ad hoc networks are robust and flexible, they find a variety of applications.Aagricultural field WSN consists of a lot of small sensors, each called as a node, which is positioned at various places to do certain tasks such as sensing and gathering the data of the region where it is deployed (S.H. Yang, 2014). The sensors report the gathered data to the remote sink.

The microcontroller is the heart of the sensor node. It receives the data from the sensors through the ADC unit. Then manipulate the data and finds the place where the data is sent, as well as the time when it is sent. Also, the microcontroller must take care of the overall procedure of stack execution. Various microcontrollers are in use to accomplish these jobs. They differ in terms of flexibility, performance, energy consumption, and cost. TI's, MSP340, Atmel's ATmega 128L, and ARM7TDMI are used in practice.The hardware architecture of a sensor node of WSN is presented in Figure 1.

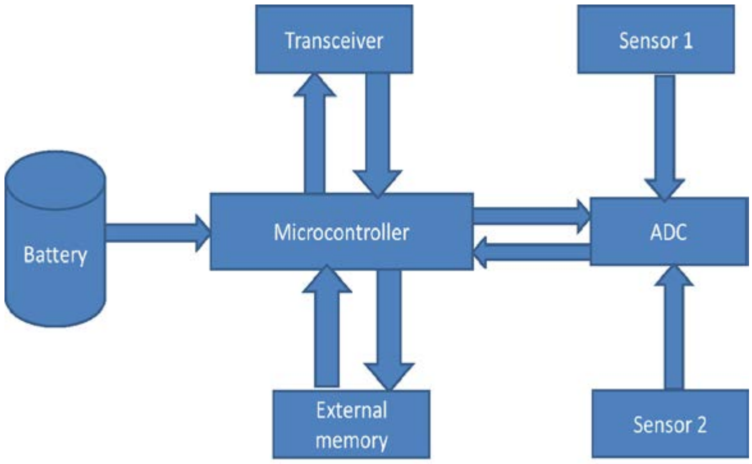

Figure 1 Block diagram of a node in agricultural WSN

Therefore, the ultimate objective is to reduce the energy consumption. For achieving reduced energy consumption, many works have been presented which focused on reducing the data bits transmitted and a number of transmissions. These objectives are met out by employing different techniques such as data compression, data suppression, correlation aware protocols, data prediction, censoring, etc (Y. Yao et al , 2015).

In those works, the energy consumption is attained in a different way and each has several drawbacks and overcome by using different techniques and algorithms.Hence, it is required to introduce a better communication protocol for the WSN with the aim of meeting the energy consumption requirements at low cost and with Minimum Mean Square Error (MMSE).In this research work, a WSN is designed and three methodologies were presented to reduce the energy utilized in the designed network (M. Mannan et al , 2015).

The proposed protocols are applied in the network to compute the results and evaluate the performance of the protocols. the proposed work the SC property of the WSN is taken and the prediction based model is presented using modified Least Mean Square (LMS) Algorithm for prediction. This algorithm differs from the conventional LMS Algorithm since it has an adaptive step size parameter. This prediction accuracy can be increased by using an adaptive step size parameter. The remainder of this dissertation is organized in the following fashion: In Chapter 2, a review of the published work on Association existing techniques in agricultural WSN is presented. Chapter 3, describes the proposed modal in agricultural WSN model in detail. Chapter 4 the results were compared and the performance of the model and the technique were discussed. In Chapter 5, summarizes the main contributions of the research.

II. LITERATURE REVIEW

A. NippunKumaar et al ,examined the use of Wireless Sensor Networks interfaced with light fittings and created a wire free system for existing buildings. They proved wireless sensor network reduces the size and cost of the system and is suitable for a lighting system which is more scalable and flexible .

AbdelrahmanElleithy et al, presented a model for the lifetime of wireless sensor networks. They developed a Matlab based simulator. Their model takes consideration of several parameters such as the total number of sensors, network size, percentage of sink nodes, location of sensors, the mobility of sensors, and power consumption. They presented four scenarios.

AlkaThapliyal et al, studied the effects of untreated and treated (phytoremediated) domestic wastewater on morphological, biochemical and growth characteristics of ladyfinger. They quantified heavy metal accumulation in soil and different plant parts. They showed the effects experimentally.

Amir AkhavanKharazian et al,demonstrated the simulation results on Adaptive clustering. They presented an algorithm on Adaptive clustering. In all cases, their proposed algorithm show better performance than LEACH and it has result almost like LEACH-C. They shown that LEACH-C is a centralized algorithm and the Adaptive clustering algorithm is distributed algorithm .

The concentration (μg ml-1) of heavy metals in waste water was highest for Zn followed by Pb, Cr, Ni, Cu and Cd. Heavy metal concentrations in clean irrigation water were below the detectable limits. The researchers showed introduced that to reduce the health risk and the extent of heavy metal contamination; steps must be taken for efficient treatment of sewage. Regular monitoring of heavy metals in the vegetables grown in waste water irrigated areas is also necessarydesribed in Anita Singh et al.B. Sivakumar et al, used high-performance embedded micro-controller and low-power technology wireless sensor network. They indicated by the experiment that the system has high stability and it can be used in water resources dispatch, flood prevention direction and so on.

Balambigai Subramanian et al, Electrocardiogram and heart rate are vital physiological signals that have received increasing attention in recent years. Research indicates that each year more than millions of people around the world die of cardiovascular disease. The Researcher deals with the easy monitoring of electrocardiogram signals for people who are leading a normal daily life and wireless transmission of the analyzed ECG signals is sent to the doctor in case of only abnormal beats and rhythms which leads to effective reduction in power consumption.

Basel A et al, showed Broccoli plants grown in soil amended with organic fertilizer on a vigorous vegetative growth (leaf number, fresh & dry weights), high yield and large head diameter comparing with application chemical fertilizer alone. They proved that application of a combination of organic and inorganic fertilizers gave the best values for all tested parameters.Bernhard Rabus et al (2015), were introduced a finite-difference time domain simulator that accurately models the interaction of microwaves with realistic soils, specifically from spaceborneinterferometric synthetic aperture radar (InSAR). The modeled soils are characterized by surface roughness, correlation length, bulk moisture content, vertical moisture gradient, and small air filled- void content. Simulation results were including both backscatter and interferometric phase.

D. D. Chaudhary et al, experimentally proved that the hardware develop by Cypress Inc. is the best solution which works on low power with less complexity and high reliability for greenhouse control. Researcher suggested in future if parameter still increase, then for WSN technology with currently available bandwidth is not sufficient, then WSN with cognitive radio technology is the solution.

D. G. Anand et al, energy-efficient coverage problems in the context of static WASNs, networks in which static sensor nodes and presented some details of the algorithms, assumptions, and results. A comprehensive comparison is given from the perspective of design objectives, assumptions, algorithm attributes and related results. D.L. Corwin et al,provided a review of the development and use of ECa measurements for agricultural purposes, particularly from a perspective of precision agriculture applications. They presented background information to provide the reader with (i) an understanding of the basic theories and principles of the ECa measurement, (ii) an overview of various ECa measurement techniques, (iii) applications of ECa measurements in agriculture, particularly site-specific crop management, (iv) guidelines for conducting an ECa survey, and (v) current trends and future developments in the application of ECa to precision agriculture [23].

BhavanaNarain et al,described the accessible energy –efficient MAC protocols for sensor networks. They discussed the architecture of their protocols and then compared those protocols depending on their Advantages and Disadvantages. They proved that Wireless sensor networks made up of one or more battery-operated sensor devices with embedded processor, small memory and low power radio (Bhagwan Bet al, 2014).

From literature review lot of technical equipments are developed for agriculture. Use of chemical fertilizers increased for taking more yield but its side effects are not considered. Still there is necessity to modernize the farming with technically, economically and effectively useful. The proposed objective and methodology have to be designed.

III. SYSTEM DESIGN

The proposed work is implementing a non-model based adaptive prediction scheme that does not require prior knowledge of the original data. In the following, the basic mechanisms of dual predictions are explained before dealing with the proposed LMS Prediction.

a) Prediction based reporting

In a clustered data aggregation scheme, data reduction is achieved by employing prediction based reporting, where the prediction process is performed at the sensor node as well as the CH concurrently using identical filters. In the sensor node, for every sampling period, the measurements obtained by the sensors are compared with the measurements obtained through the prediction model.

$$E_{initial} = E_{trans} + E_{receive} + E_{prediction}$$

Where$E$trans and Ereceive are the energy consumed during transmission and receiving of data energy of sensor and CH node respectively. $Epred$iction is the energy consumed by the node when executing the prediction model.

b) Prediction Based Monitoring

Let {d(t)} be the set of desired data which is to be transmitted from a source to sink. A minimal error value eth, also known as the threshold value is given at both source and sink. The sink must know value in d(t)±eth rather than the original data, d(t).If there is a deviation between the predicted data and original data and it is greater than eth, then the original data must be transmitted to the sink. Or else the LMS filter in sink generates the same prediction like source without any communication between them.

c) LMS Algorithm

In the proposed work, the prediction filter is built on the LMS algorithm. The functional features of an LMS based prediction filter are briefed in this part. A linear adaptive filter reads m number of data sequences (d) at time t, which is denoted as (t) and the prediction value is computed as in Equation (1)

(t)= $(t)\cdot d(t)$ ---(1)

Equation (1) is a linear combination of the former m samples of the sequence, weighted by the weight vector (t). Then the comparison is made between the predicted output (t) and the original data (t). The prediction error (t) is computed using Equation (2).

(t)= $(t)-d(t)$ ---- (2)

This equation is applied into the adaptation algorithm, and the filter weights W are updated for each instant t to get less Mean Square Error (MSE). Thus the system accuracy is ensured. In Figure 3.3 and Figure 3.4 show the basic adaptive filter and its application in prediction.In the normalized LMS model, the normalization of step size is carried out in every instant. Consequently, the sensitivity to the input signal is decreased. In LMS prediction scheme, the step size plays a crucial part in improving data accuracy and energy efficiency in the prediction based reporting. There is no specific optimum value for step size since it is context dependent. On a larger deviation, step size must be higher to converge quickly. Near the point of convergence, smaller step sizes realize steady state prediction. The work adapts the step size as per the state of prediction to quicken the convergence process and to reduce deviations.LMS algorithm is one of the widely used adaptive algorithms today. They very simple algorithm and gives a good performance in many cases, so they are used in a wide range of WSN applications.

$w(t+1)=w(t)+\mu.u(t).e(t)$ ---- (3)$w(m)=(w1(m).w2(m)\ldots.wn(m))T$----(4)
$u(m)=(u(m-1).u(m-2)\ldots.u(m-M))T$ ----(5)

A successive prediction can be made by introducing the delay unit with the present input value u(t) by single time period. Then this signal is used as reference signal d(t). In real world applications, the LMS algorithm can be used in data prediction in WSN by using identical predictive filters. The filters are to be implemented at both the source and the sink nodes. LMS Dual Prediction Scheme (henceforth referred to as LMS-DPS) can run both filters simultaneously at source and sink.

IV. RESULT AND DISCUSSIONS

The implementation of the proposed adaptive LMS prediction scheme in WSN and the results obtained for the work is described in this section. A WSN is considered and deployed in a region to monitor different parameters like temperature, humidity, light and wind. Using the proposed approach, the number of transmitted data is reduced. The performance of the proposed method is evaluated for different error threshold value. The performance of the proposed method can also be investigated by considering the energy consumption and RMSE between the measured data and the collected data at the BS.

Initially, the desired value which is the actual value measured by the source node is considered. On the other side, the values are predicted at source and sink. These both values are compared and analysed. This graph (Figure 2) considers 1000 samples at a node, which are to be predicted, the predicted values are shown in the red line and the desired value transmission is shown in the blue line. From the graph, it can be concluded that only very slight variations occur when the predicted value is compared with the original value. Thus it is clear that this system with Adaptive Step Size can give a very high prediction rate. The output graph which compares the desired and predicted value is shown in the Figure 2.

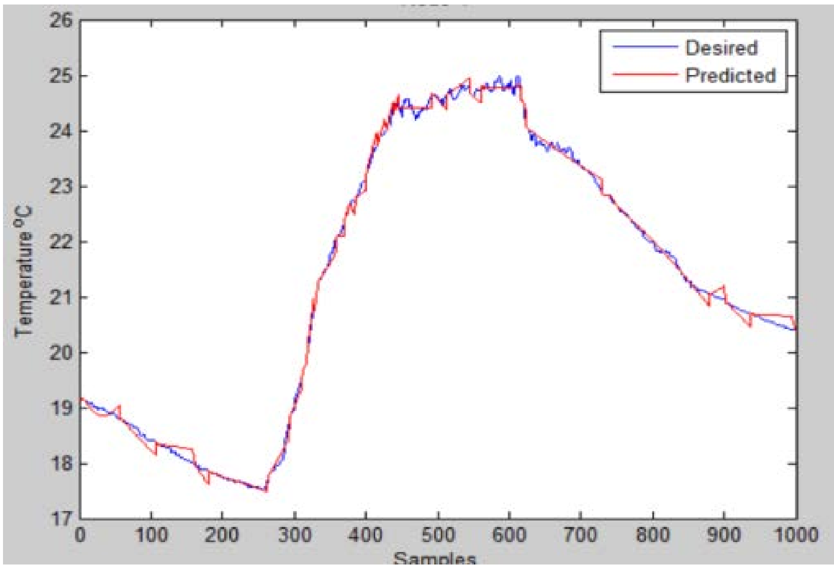

Figure 2 Comparison of desired value with the predicted value

Table 1 compares the energy consumption for different data and analyses the performance for different error threshold values. When error threshold is set to 0.25, the energy consumption for humidity and wind is 20.1J for all dataset except wind while it is equal to 20.15J for wind. When the error threshold is set to 0.5, energy consumption for all data except humidity is 19.6J, whereas it is 19.62J when humidity is sensed.

When the error threshold is set to 0.75, energy consumption is 18.9J when sensing temperature, humidity and wind whereas it is 18.93J when the light is sensed. Similarly, when the error threshold is set to 1, energy consumption is 17.75J when sensing temperature, light and wind whereas it is 17.74J when humidity is sensed. When the error threshold is set to 1.25, energy consumption is 16.25J when sensing all parameters except light and when sensing light it is observed as 16.23J. Figure 3 depicts the barchart comparison for the values illustrated in Table 1

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Table 1 Comparison of energy for different dataset

Error Threshold	Energy (J) Temperature	Energy (J) humidity	Energy (J) light	Energy (J) Wind
0.25	0.18	0.183	0.182	0.183
0.5	0.45	0.454	0.451	0.454
0.75	0.5	0.52	0.51	0.51
1	0.57	0.571	0.57	0.57
1.25	0.72	0.7213	0.7	0.72

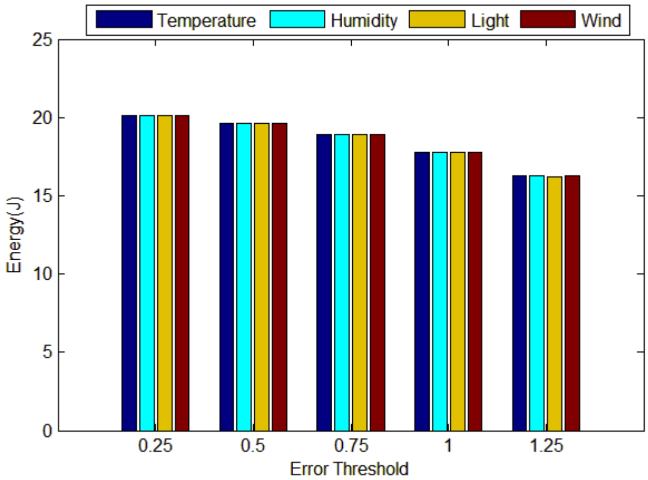

Figure 3 Comparison of energy consumption for different dataset

Table 1 compares the energy consumption for different data and analyses the performance for different error threshold values. When error threshold is set to 0.25, the energy consumption for humidity and wind is 20.1J for all dataset except wind while it is equal to 20.15J for wind.

V. CONCLUSIONS

In this proposed system, the LMS algorithm with adaptive Step Size is used to attain a minimum data transmission rate. The simulation result shows that by using this methodology a prediction accuracy of 97% can be obtained and very less amount of original data transmission occurs during the entire process. The RMSE for the node varies with the error threshold it seems to be high for higher error threshold values. However, the energy consumption reduces with higher values of error threshold.

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