The Deployment of TikiriDB for Monitoring Palm Sap Production

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Abstract. Nowadays, the industry of harvesting palm sap in Sri Lanka is facing many problems due to theft and environmental affects. In this paper, we propose a solution for the particular problem by using a wireless sensor network based system to monitor the palm sap production of a large plantation area. We are using an enhanced version of TikiriDB which provides a database abstraction on the sensor network to make the process of data collecting and analyzing more efficient. TikiriDB can be used to reduce restrictions on accessing traditional sensor networks by enabling the user to access the sensor network using multiple queries through multiple access points simultaneously.

Keywords: Wireless Sensor Networks, Database Abstraction, Liquid level Sensor , Multiple User Access, Palm Sap.

1 Introduction

Palm sap production is a traditional industry in Sri Lanka which has a huge demand in the local market. It is obtained from different types of locally available palm trees. Owners of large palm tree estates employ rural people for tapping palm trees to collect the essence of palm flowers. The tappers climb to tree tops to slice palm tree flower and hang a special container to collect the liquid. They have to climb again to collect the containers with the liquid. Some times they use small bowser to transport the collected palm sap to main storage. Palm plantations may span over many acres of land area.

Therefore it is challenging to manage such plantations. Owners are facing the the difficulty of protecting the product from theft. Not only outsiders, but also employed tappers may involve in palm sap theft. It's practically very difficult to monitor the production by employing watchers due to the size of the land area. It's even hard to track the thefts done by the tappers who are employed in a particular palm state. In addition to that there are several more requirements to fulfill when deploying a system to solve above mentioned problem. Productivity of palm trees may depend on different environmental conditions such as temperature and humidity. Therefore, monitoring such conditions is necessary

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to arrange necessary measures to increase productivity. This requires considerable amount of environmental data with relate to a particular palm tree and tree's productivity measures. Therefore the people in this industry, specially the owners of palm states, are seeking for a feasible and effective solution to monitor and protect the palm sap production.

2 Our Approach

We propose a solution to the mentioned problem by deploying a sensor network where each palm tree have sensors. A palm sap liquid level measuring sensor is fixed to each and every sap collecting container. Thereby, we can track the changes of palm sap liquid level in regular time intervals. Sensors to measure the environmental conditions such as humidity and temperature are also fixed to the sap containers in each palm tree. However, to analyze and produce required reports regarding the collected measures, it is required to collect these information into a central location. Since, the palm tree plantations can be spread over many acres of land area, its not effective and feasible to use wired communication. Hence, using a wireless sensor network would be an effective way of solving the problem.

Wireless sensor networks (WSN) have emerged a new wave in the community of researchers of various fields such as computer science, health care, habitat monitoring, military and disaster management etc. Since most of the devices used for WSN applications are so small, researchers have been able to obtain information from environments where they couldn't reach before. These scare resourced devices are networked through special protocols to communicate with similar motes in the network and with external computers. Therefore, using WSN requires a considerable amount of technical knowledge about the devices, protocols used, sensors, etc. However, most of the users of wireless sensor networks are not technical people i.e. zoologist, military personal, medical doctors, etc. Therefore it is better to provide them with an abstraction to the sensor network which would hide technical details from the user and at the same time provide facilities to interact with the WSN in an easier and efficient way. For example a WSN can be viewed as a file system or a database. Since, there are no WSN literal personal in the plantation, using such abstraction would be an added advantage.

File system abstractions for WSN use read and write operations to communicate with WSN where database abstractions use specific Structured Quarry Languages(SQL). Researchers from University of California, Berkeley have developed a solution called tinyDB [1] which gives a database abstraction to sensor networks using TinyOS. A similar approach has been followed by the researchers at University of Colombo School of Computing in Sri Lanka called tikiriDB [2] which also gives a database abstraction layer to sensor networks using Contiki OS. We opted to use database abstraction technologies because, palm plantations have different kinds of people who have different interests regarding the information related to the palm plantation, and database abstraction gives a flexible way to develop applications to meet the vague requirements.

For example, a botanist in the plantation may require sensor readings in an increased sample rate to measure the correlation between environmental factors and palm sap productivity for a particular tree. One solution would be to set sensors to take readings at the maximum rate they can perform. This would increase the battery consumption of sensors and hence would wear out the batteries very quickly. However, if we use a database abstraction to WSN, it is possible to specify what data required in which rate in the query. This would save a considerable amount of power with regard to previous situation. If a file system abstraction is used, implementation would be more complicated than issuing a query.

It is a requirement that the solution provides access to the WSN at any location for different parties. For an example when a bowser collects the liquid from the containers which were hanged on palm trees, wireless node in the bowser should be able to gather the information about the amount of liquid in each container of palm trees by sending a query to each tree. Therefore, the solution should be able to handle multiple concurrent access. TinyDB, doesnt allow a user to query the WSN by accessing it from any sensor node. It is only allowed to access though a defined root node for a particular WSN. However, TikiriDB database abstraction supports shared WSN system with multiple access points. Therefore, we opted tikiriDB as the database abstraction when providing the solution for palm tree plantation.

3 Implementation

We have done several enhancements to TikiriDB to adapt it into our solution such as functionality to create storage pointers, and enhancing querying language to handle event queries [3]. Storage points is a concept to store data temporarily in the nodes itself until that stored data are collected. Event queries let the user to set a query to be executed when a special event is triggered.

According to the figure 1, the system has a very modular architecture with fully distributed components over the WSN. All sensor nodes are embedded in

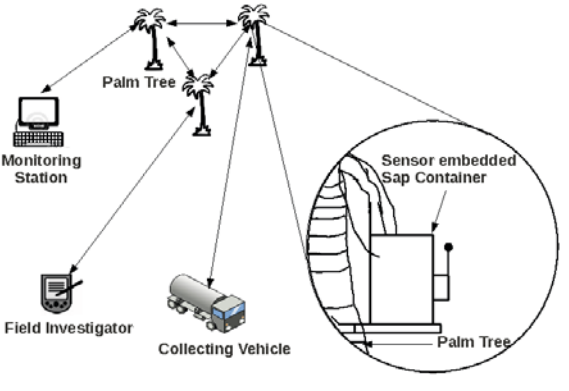

Fig. 1. High Level Overview of the System

specifically designed container which is capable of measuring the liquid level, temperature, humidity, and pressure caused due to the weight of the liquid. A combination of sensor values are used to come to a conclusion on palm theft. In addition to the automated data collection, the sensor network provides functionalities to send queries and retrieve data in real time.

At the calibration stage of the device which we are creating to get information about the collected palm sap, we identified a requirement of obtaining external variables which affects the rate of flow of palm sap. The flow of palm sap may depend on temperature, humidity, and some other factors which controls the productivity of palm sap such as the age of a particular tree. However, temperature, humidity can be obtained from the sensor nodes at trees and other factors can be obtained from external sources of data. These, data can further be used to make predictions on future productivity of a tree and total palm sap production.

4 Conclusions and Future Works

Real world deployment of WSN applications involves a lot of effort in calibrating sensors and configuring hardware components to meet the required functionality from the sensor network. Therefore the approaches to simplify the complexity by giving different abstractions can play a major role in real world deployments of WSN systems. Even though WSN based systems can show good results in experimental level, they can be inapplicable in real world implementations. Therefore the best way to evaluate a WSN system is applying it in real world problems. The initial works on palm sap production monitoring system has taught us a lot about real WSN.

By working on this palm sap production monitoring system, we realized that tikiriDB can be a part of many real world WSN deployments which has similar requirements to this project. From its original design, it has the flexibility that most of the WSN applications in the real world needs. Currently, tikiriDB developers are working on further enhancements and developments of it to provide a comprehensive database abstraction for Contiki based WSN. Therefore we can expect that it will appear in more and more real world applications in the future.

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