Chapter 38
Fuzzy Rule Based Environment Monitoring System for Weather Controlled Laboratories Using Arduino

S. Sasirekha
SSN College of Engineering, India

S. Swamynathan
Anna University, India

ABSTRACT

Weather controlled laboratories such as blood banks, plasma centers, biomedical, research, pharmacy and healthcare always require a portable, low cost and web-based centralized wireless monitoring system. However, it has become more stringent to monitor various weather controlling devices of these laboratories in order to reduce the risk of non-compliance with accreditation requirements. In literature, it is inferred that the majority of existing event detection approaches relies only on precise value to specify event thresholds, but those values cannot adequately handle the imprecise sensor reading. Therefore, in this work, one of the soft computing technologies, fuzzy logic is adopted to demonstrate that fuzzy rule based value significantly improves the accuracy of event detection. The prototype built is tested in a physical laboratory as a personal mobile weather station for monitoring and analyzing the environmental conditions using fuzzy simulated values.

INTRODUCTION

Wireless Sensor Network (WSN) and environmental care have been always very close to each other. It is because they have been evolving alongside one another during the last decade or its features seem to suit very well into the environmental evaluation requirements (Valverde et al., 2012). The WSN consists of a number of sensors nodes (few tens to thousands) working together to monitor a region to obtain data about the environment (Jennifer et al., 2008) These interconnected nodes cooperatively pass their

DOI: 10.4018/978-1-5225-1908-9.ch038

data through the network to a centralized location for further processing. WSN serves as a contemporary technology for bridging the physical and virtual world thus enabling them to interact. A Recent advance in the Wireless Sensor technologies has led to the development of low cost, low power, compact sensor nodes providing opportunities in research and development of various applications. WSN's are usually built on a structured or unstructured infrastructure (Deborah et al., 1999). In the structured WSN, sensor nodes are deployed in a predetermined location. They are deployed with fewer nodes covering a short range with lower network maintenance and management costs. In unstructured WSN on the other hand, sensor nodes are often deployed in large number in an ad-hoc manner where human intervention is less. In the current state-of-the-art of WSN, it is possible to find many environmental solutions based on WSN's such as habitat monitoring systems (Szewczyk et al., 2004), water monitoring (Xia et al., 2009), health monitoring (Jafari et al., 2005), Human activity detection (Hemalatha, 2014), smart buildings (Nguyen et al., 2010), target tracking (Yick et al., 2005), precision agriculture (Ghobakhlou et al., 2011) or energy management solutions to reduce both the amount of resources needed and the atmospheric emissions.

The environmental monitoring includes various actions, processes and data collection methods to observe the conditions of the environment (Artiola et al., 2004). These collected environmental data inputs are essential for many consumer and industrial process to monitor, control, analysis, conserve and sustain the environmental condition (Chatzigiannakis et al., 2009 & Corke et al., 2010). The medical and clinical laboratories which includes products of pharmaceuticals and cosmetics, the Argo food storage room in restaurant and kitchens, the research laboratories especially in microbiology labs which has incubators, autoclaves, refrigerators or ultra low temperature freezer, cold rooms and during transporting perishable items there is always a need for a weather controlled environment. Moreover, the industrial regulations are also becoming more and more stringent, and so the requirement for mastery of storage conditions and treatment of products and an internationalization of demands presents a continually increasing interest for the centralized and personal monitoring system.

The physical parameters such as temperature, humidity, CO_2, pressure, particles count, dry contact (door opening), and pH are the key factors concerned in maintaining a sustainable environmental condition (CIAA, 2008). Hence, to attain a high quality of service and a perfect solution to have a control of storage conditions, experimental conditions, and conservation of essential items and to alert in case if a problem occurs there is a desperate need for data to be congregated. For this purpose, low cost, low power, and the compact sensor have to be deployed in a structured infrastructure to closely monitor and measure these parameters. The real-time sensor data collected can be used for accurate illustrations of current conditions and to forecast future conditions and risks (Burghher et al., 2005). However, the main issue in identifying the appropriate thresholds for detecting the out-of-tolerance conditions. Most of the existing event detection applications based on WSN uses precise or crisp values to specify the parameters that characterize an event. Consider, for example, an environment monitoring application can be built to detect and prompt if the temperature of the room goes below -5º C. However, considering the important issue of sensor readings due to various parameters such as reading inaccuracy, discrete sampling and network delays are always imprecise. If two sensors are deployed in same location they may provide two varied values say 4.95 º C and 5.2 º C respectively. In case for some reason, if any one of the sensors provided data is inaccurate, it will lead to false detection for any sensitive application. The situation worsens if number of sensor measurements is used for event detection. Hence, it is clearly understood that using crisp values to describe WSN events is not the most suitable approach. Whereas, the fuzzy logic on the other hand perhaps will be able to address the problems in a better way that are challenging for crisp logic. Literature studies show that the properties of fuzzy logic make it more suitable for