A Fuzzy Markup Language-Based Approach for a Quality of Location Inference as An Environmental Health Awareness

Majed Alowaidi, University of Ottawa, Ottawa, Canada
Mohammad Al-Ja’afreh, University of Ottawa, Ottawa, Canada
Ali Karime, University of Ottawa, Ottawa, Canada
Abdulmotaleb El Saddik, University of Ottawa, Ottawa, Canada

DOI: https://orcid.org/0000-0002-7690-8547

ABSTRACT

In a recent study conducted over a two-month period, the authors have concluded that there exists a correlation between two environmental parameters, namely air quality and noise. The correlation efficiency results obtained were quantitative in nature, and thus cannot be intuitively interpreted by humans. In this article, the authors propose a Fuzzy-markup language (FML) model that aims to translate the degree of correlation that may exist among IoT environmental parameters into a linguistic set of indicators. For that purpose, the authors have developed a Fuzzy-Inference System (FIS) that infers the quality of location status according to people’s surroundings and provide health-aware notifications accordingly. The initial FIS results show the significance of timeframe that should be considered according to each sensory data source. In other words, the correlation degree of the two sensory set is clearly affected by time frame variations.

KEYWORDS

Environmental health, Environmental Sensory Observation, FML, Fuzzy Systems, Internet of Things (IoT)

INTRODUCTION

IoT applications appear to benefit human beings in many commonplace fields (Bainbridge & Steinberg, 2010; Celdrán, Clemente, Pérez, & Pérez, 2016; Gubbi, Buyya, Marusic, & Palaniswami, 2013; Murty et al., 2008). One of its advantages is that it can enrich people’s environments in a much intuitive status. Health care, critical monitoring, and controlling are significant factors in people’s lives, and can greatly benefit from the development of IoT technologies. In health, IoT technologies such as RFID, WSN, and smartphones offer complete cooperative biomedical services in hospitals and homes to monitor and track patients’ activity. Amendola et al. (Amendola, Lodato, Manzari, Occhiuzzi, & Marrocco, 2014) studied IoT applications for people’s health and wellness. For example, RFID tags used to sense volatile compound materials are positioned in walls, food and drug locations, fire detection devices, and high heat indoor appliances. Similarly, an RFID labeling chip implanted in a human body can provide real-time or on-demand patient’s status. Rohokale et al. (Rohokale, Prasad, & Prasad, 2011) proposed a cooperative IoT approach to monitor and control health in rural locations. Their model can

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monitor heartbeats, as well as blood pressure and blood sugar levels, which can be used for energy efficient motherhood health-care programs. In critical or emergency cases, such as heart attacks, installed IoT nodes with ECG and gyroscope sensors can monitor irregular heartbeats or sense if a patient has fallen in their indoor environment, and subsequently send a real-time notification to the person in charge, such as a family physician or a relative. This notification is based on a cooperation threshold between all sensors for specific monitoring and tracking requirements.

Fuzzy computing has been adopted in the literature to overcome uncertainty or vagueness in diverse people’s commonplace applications. Fuzzy inference systems are leveraged in many applications and usages (Elizabeth J. Chang, Omar K. Hussain, 2013), one of which is to enrich the revolution of smart environments that are a part of IoT applications to provide awareness about the quality of location. People often tend to reside and have their well-beings in locations where nowadays pollution sources are declined to the minimum exposure (European Environment Agency, 2016; Stansfeld, 2015). IoT is capable to enrich people’s understanding of their environments in a way that can provide awareness in their places of interest, so they can be alerted of events that have health impact or lack of quietness vulnerability (Perera, Zaslavsky, & Christen, 2014). Measuring people’s environment whether indoor or outdoor is normally done through using a measurement unit per sensory data value. For example, inferring a quality of indoor location may involve air quality, noise, temperature and/or motion to measure pollution level, sound intensity, room temperature in C or F, and/or human movement. This method only gives a one-dimensional aspect of sensory feedback. The complexity of understanding people’s surroundings requires a system that captures people’s preferences of locations like crowdedness level, reading-suitability, atmosphere quality, etc. and reacts according to their desires. The Quality of location plays an important role in people’s daily lives and ubiquitous environments (Andersen et al., 2011; Cai et al., 2017).

The researchers adopted a Fuzzy Markup Language (FML) approach (Acampora, Gaeta, Loia, & Acampora, 2010) to describe any imprecise notifications of raw environmental sensory data, so by using FML, the notifications can be implemented according to knowledge base and fuzzy rule base. The aim of using FIS in describing people’s environments instead of other approaches like machine learning is that the ability of Fuzzy logic to mimic the way humans think, and therefore the information can be processed in a human-like manner. Also, mathematical modeling of machines learning approaches involves higher processing demands than FIS’s. Therefore, using FIS will make implementation phase much simpler and faster than traditional machine learning approaches. Last but not least, updating fuzzy-logic rules can be done in a straightforward manner which makes the customization of the system much easier.

The fuzzy approach is aimed to make the system as agile as possible, so it can accept more sensory feedback that might not be captured by knowledge construction mechanisms, which are considered restricted approaches, like an ontology. The authors initially constructed a knowledge base of the commonplace sensory data sources using fuzzification variables and the relevant membership functions. Then, they defined their fuzzification rules and adopted the Mamdani type as the defuzzifier for the FML model. The reason behind the use of FML as our FIS is to provide the system implementation in a way that can be perceivable by human and independent of hardware. Nowadays, smart environments development needs to construct knowledge-based and reasoning representation by utilizing two or more logic-based inference solutions. However, considering only ontological approaches might have troubles once dealing with possible uncertainty or ambiguity of sensory data (Bobillo & Straccia, 2010).

According to a statistical analysis conducted in a previous work (Alowaidi, Karime, Aljaafrah, & Saddik, 2018) on a set of environmental IoT data that was collected from different locations, a tie correlation between noise and air quality was found to exist. In this article, a fuzzy inference system (FIS) that aims to estimate quantitatively the quality of location (QoL) is proposed. Furthermore, the article presents an initial mathematical model of a fuzzy system that contains two selections of events notifications based on user preference and based on accumulative sensory data.
Generating Simulated DT-MRI Dataset
www.igi-global.com/chapter/generating-simulated-mri-dataset/12993?camid=4v1a