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Research Article

DEVELOPMENT OF FUZZY LOGIC BASED INTERNET OF THINGS TECHNOLOGY FOR FIRE MONITORING SYSTEM RESIDENTIAL FIRE

Abhinav Shukla[1] and Neelam Sahu[2]

[1]Department of IT, Scholar, Dr. C.V. Raman University, Bilaspur, India
[2]Department of IT, Dr. C.V. Raman University, Bilaspur, India

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ABSTRACT

In Internet of Things (IoT) technology the fire-fighting, fire monitoring and safety management system are an important applications. It discusses IoT system framework for fire-fighting, planning, and monitoring. It gives development points for providing research and development of IoT in fire-fighting, monitoring and safety management field. Intelligent fire monitoring systems need a key of accurate and effective firefighting software design. This paper also discusses about the requirements of user and key main issues of wireless sensor network hardware and software for monitoring fire. It also discusses application features of IoT technology and Wireless Sensor Network technology for according to fire-fighting requirements.

Considering that Wireless Sensor Networks (WSNs) are envisioned as integral part of arbitrary IoTs, and the potentially huge number of cooperating IoTs that are usually used in the real world phenomena monitoring and management, the reliability of individual sensor nodes and the overall network performance monitoring and improvement are definitely challenging issues. The incorporation of soft computing technologies, like fuzzy logic and genetic algorithm in sensor nodes has to be investigated in order to gain the manageable network performance monitoring/control and the maximal extension of components life cycle.

The Internet of Things (IoT) is one of these methodologies which transform current Internet communication to Machine-to-Machine (M2M) basis. The IoT can seamlessly connect the real world and cyberspace via physical objects that are embeded with various types of intelligent sensors. In this paper, we present the design of an integrated intelligent system for IoT device selection and placement in opportunistic networks using Fuzzy Logic and Genetic Algorithm. We introduce the system structure and present in details the design and implementation issues.

INTRODUCTION

Prevention of fire and fire risk level control difficulty are increased day by day. Fire-fighting and monitoring situations are very serious today. Public security keeps on insisting in increase of technology in firefighting and monitoring. They give special attention to improve the science and technology in resisting fire disasters. They are concerned about the application of new technology such as IoT and wireless sensor network in fire-fighting and monitoring field. IoT is very suitable for fire-fighting with wide scope along with wireless sensor network (WSN). IoT combined with WSN plays an important role in the fire alarm, fire control facility monitoring and fire equipment management. IoT technology is combined with fire fighting for hazard source monitoring, fire monitoring, fire-fighting rescue, fire early warning, prevention and early disposal.

The wireless systems are simple, flexible network structure, low cost and short delay. It could meet all the requirements of user. The forecasting ability, warning of fire and improvement in the reliability is also the advantages of the wireless fire alarm system.

The integration of fire-safety systems within building automation infrastructure, through fast delivery of sensed data, quick response, access control, video surveillance, fire detection and alarm, and emergency communications aides the effective incident management. One of the ways to monitor and detect fire is to use the Wireless Sensor Networks (WSN) composed of low-resourced sensor nodes. They are composed of spatially distributed nodes equipped with sensing devices, processing unit, communication components (wireless

Corresponding author:* **Abhinav Shukla
Department of IT, Scholar, Dr. C.V. Raman University, Bilaspur, India

transmitter/receiver), storage unit, and an energy source (power unit) (Fig.1).

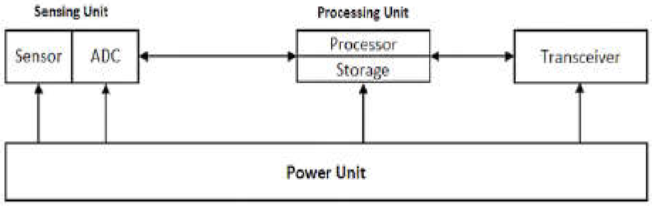

Fig 1 Typical architecture of a sensor node

To detect critical events like fire, one or a combination of sensors and detection algorithm is needed. The sensors might be part of a WSN or work independently. Thus, the detection of a critical event should be delivered to the user as soon as possible.

Recent advances in WSN technology and the use of the Internet Protocol (IP) in resource constrained devices has radically changed the Internet landscape creating a new form called Internet of Things (IoT). The IoT will connect physical (analog) environments to the (digital) Internet, unleashing exciting possibilities and challenges for a variety of application domains, such as smart metering, e-health logistics, building and home automation.

In order to show how the WSN based system for continuous monitoring and/or recording critical temperature values, powered by fuzzy logic detection mechanism and web enablement, can be designed and deploy. The Internet of Things (IoT) is one of these methodologies which transform current Internet communication to Machine-to-Machine (M2M) basis. The IoT can seamlessly connect the real world and cyberspace via physical objects that embed with various types of intelligent sensors. A Fuzzy Logic System (FLS) is able to simultaneously handle numerical data and linguistic knowledge. It is a nonlinear mapping of an input data (feature) vector into a scalar output. Fuzzy set theory and Fuzzy Logic (FL) establish the specifics of the nonlinear mapping. Genetic Algorithms (GAs) are a family of computational models inspired by evolution. These algorithms encode a potential solution to a specific problem on a simple chromosome-like data structure and apply recombination operators to these structures so as to preserve critical information. The GAs are often viewed as function optimizers, although the range of problems to which GAs have been applied is quite broad. An implementation of a GA begins with a population of (typically random) chromosomes. Then evaluates these structures and allocates reproductive opportunities in such a way that those chromosomes which represent a better solution to the target problem are given more chances to reproduce than those chromosomes which are poorer solutions.

Design requirements of iot system frame work for fire monitoring

IoT is a network of linking things through sensors and communication equipment, linking things among themselves and finally linking between people and things. In IoT technology, RFID (Radio Frequency Identification), wireless sensor network, pervasive computing, cloud computing, real time monitoring and other technologies are integrated to realize intelligent real time monitoring, management and control of fire. The fire monitoring IoT system frame is planned in accordance with the requirement of fire prevention and control, firefighting, emergency rescue and so on. It is planned to the technical characteristics of IoT and the need of fire monitoring. This structure includes sensing layer, transport layer, service layer and application layer.

Sensing layer

This layer is mainly used for complete collection of object and environment information. For collecting real time information about various objects using sensors, video, RFID and other technologies involved in fire fighting safety management. Intelligent equipment, sensors and RFID are useful for collecting information such as people, events, environments, materials, fire-fighting products, fire-fighting facilities and fire-fighting equipment. The collected information is communicated layer by layer, so sensing and control of fire event can be realized in real time.

Transport layer

It is used to realize the transmission of sensor information to different networks. The proper transmission and access methods are selected depends on different situation such as Internet, LAN, mobile network and police special network etc. It ensures the proper information transmission and achieves data exchange between different objects and platforms.

Service layer

This layer is mainly used for data storage, integration and interface of heterogeneous networks, data mining and visualization of services for different information resources. It supports reliable platform for service management. It ensures the establishment of fire-fighting safety application. It manages network equipment, converting information, integrating business information and device information.

Application layer

This layer is used for sharing information, integration of user, intelligent analysis and process control for firefighting IoT. It provides application services for service providers, manufacturers, intermediates, government institutions, fire brigade, social units and family. Finally it supports fire-fighting and monitoring business work.

Fire-fighting product identification system

It includes fire-fighting product identification codes, resolution and management. The system is designed to do the following works. They are 1. Fire-fighting product supervision, 2. Management of the products, 3. Improving firefighting product quality 4. Establishing fire-fighting product market order 5. Preventing production and circulation of fraud imitation fire-fighting products and so on.

Fire-fighting facility monitoring system

It includes the following division of works. They are 1.Fire-fighting facility state perception, 2. Fire disaster early warning, 3. Household fire alarm, 4. Remote network transmission, 5. Video surveillance access and transmission, 6. Remote monitoring information platform of fire-fighting facilities, 7. Fire-fighting facility availability assessment and diagnostic analysis, 8. Fire-fighting facility maintenance and inspection information management, 9. Fire control supervision, 10. Emergency field information services and so on.

Hazard source monitoring and warning system

It includes the following functions. They are 1. Hazard source status monitoring, 2. Hazard source environmental monitoring, 3. Safety hazard inspection and monitoring, 4. Hazard source logistics trajectory control, 5. Hazard source warning judgment, 6. Project construction site hazard source monitoring, 7. Hazard source emergency treatment plan, 8. Emergency response linkage platform and so on.

Fire-fighting equipment and material monitoring system

It includes intelligent deployment and monitoring of fire-fighting equipment, intelligent management of firefighting equipment emergency repository, fire-fighting equipment deployment and monitoring, fire-fighting equipment data analysis, national fire-fighting equipment support system and so on.

The emergency field management and control system

It includes on-site monitoring of environmental parameters, fire-fighters personnel positioning and sensing, fire vehicle dynamic monitoring, on-site fire-fighting equipment and material supervision, on-site fire spread trend forecasting, fire-fighting force situation management, and emergency evacuation personnel location perception and so on.

Fuzzy logic usage in WSN for fire detection

One of the astonishing features of human reasoning is that it may use imprecise or incomplete information. Moreover, in the real world, there exists a lot of this kind of data and in everyday life, people use several linguistic labels to express abstract concepts. Fuzzy sets and logic are introduced by L. Zadeh with intention to deal with problems involving knowledge expressed in vague, linguistic terms. In other words, fuzzy logic became a mathematical discipline for describing human reasoning with rigorous mathematical notation. It is a multi-valued logic that allows the definition of intermediate values between conventional evaluations like true/false, yes/no, high/low, small/big, short/long, etc. Notions like rather long or very long, small or very small can be formulated and processed mathematically.

In order to determine the confidence of fire we have proposed the use of sensor nodes equipped only with temperature sensors and showed two approaches that involve temporal properties of monitored event in decision making process. As temperature sensors, two heat detectors are used: fixed temperature heat detector and rate of rise heat detector. A fixed temperature heat detector utilizes a temperature sensing element which generates an alarm condition if the temperature, within the protected area, reaches a predetermined level (e.g. 57ºC, 63ºC, 74ºC or 90ºC). The most suitable fixed temperature trigger point should be selected for the particular application. These detectors are used if high ambient temperatures exist or sudden changes in temperature occur (e.g. Kitchens, boiler rooms and foundries, etc.). A rate of rise heat detector includes a fixed temperature element, as above, and a temperature sensing element which can detect a sudden temperature change. This is a device that responds when the temperature rises at a rate exceeding a predetermined value (e.g. 8.33ºC/min, 9ºC/min or 11ºC/min). This type of detector is more sensitive than a simple fixed temperature heat detector and represents a good choice for the applications where reliable performance and early warning are critical but the environment makes smoke detection unsuitable. Both types of detectors trigger when predetermined value is exceeded.

Implementation of the IoT function for fire monitoring in WSN

The wireless sensor network fire monitoring system is mainly for the control of entire system related with fire monitoring operation. The system is developed to perform the following operations. 1. The node will read the building parameters from the fire wireless sensor network. , 2. It operates the fire alarm of the building. , 3. It processes the collected data and finds abnormal by the algorithm related. , 4. It displays the read data and results measured by the node. , 5. Based on results and measurements the system makes the appropriate response mechanisms. , 6. It works and correlates with fire brigade department, administrators, house owners, 7. The system interacts simultaneously with different types of users, 8. The measurement data received by the computer system from sensor node also periodically saved in the database server in the building.

The software system is divided in to four different modules as said above. Again the system is divided as shown in figure 2.

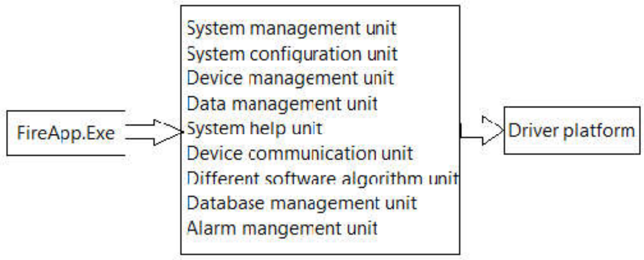

Fig 2 Fire monitoring system software design

IoT

Architecture: The typical IoT architecture can be divided into five layers as shown in Fig.3. Each layer is briefly described below.

Perception Layer: The perception layer is similar to physical layer in OSI model which consists of the different types of sensor (i.e. RFID, Zigbee, QR code, Infrared, etc.) devices and environmental elements. This layer generally copes with the overall device management (identification and collection of specific information by each type of sensor devices). The gathered information can be location, wind speed, vibration, pH level, humidity, amount of dust in the air and so on. The gathered information is transmitted through the Network Layer for its secure communication toward central information processing system.

Network Layer: The Network Layer plays an important role in securely transfers and keeps the sensitive information confidential from sensor devices to the central information processing system through 3G, 4G, UMTS, WiFi, WiMAX, RFID, Infrared and Satellite depending on the type of sensors devices. This layer is mainly responsible for transfering the information from Perception Layer to upper layer.

Middleware Layer: The devices in the IoT system may generate various types of services when they are connected and communicated with others. Middleware Layer has two essential functions, including service management and store the lower layer information into the database. Moreover, this layer has capability to retrieve, process, compute information, and then automatically makes decision based on the computational results.

Application Layer: Application Layer is responsible for inclusive applications management based on the processed information in the Middleware Layer. The IoT applications can be smart postal, smart heath, smart car, smart glasses, smart home, smart independent living, and smart transportation so on.

Business Layer: This layer functions cover the whole IoT applications and services management. It can create practically graphs, business models, flow chart and executive report based on the amount of accurate data received from lower layer and effective data analysis process. Based on the good analysis results, it will help the functional managers or executives to make more accurate decisions about the business strategies and roadmaps.

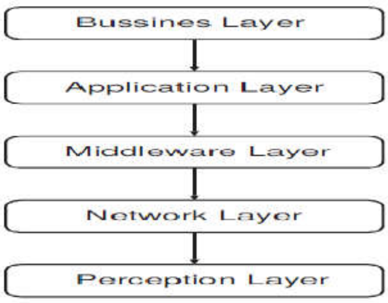

Fig 3 IoT Architecture Layers

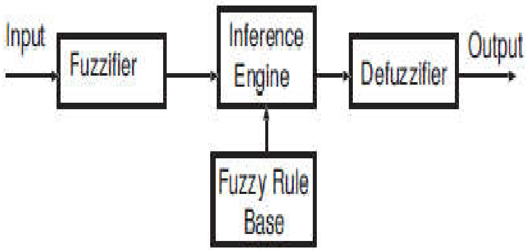

Fig 4 Fuzzy Logic Controller

IoT Protocols: Protocol is the special set of rules and regulations that end point in a telecommunication connection use when they need to communicate to other end point which is connected to the same/different network. Here, we briefly describe about the most frequently used protocols for Machine-to-Machine (M2M) communication: MQTT (Message Queue Telemetry Transport). The MQTT is a Client Server publishes or subscribes messaging transport protocol. It is light weight, open, simple and designed so as to be easy to implement. The protocol runs over TCP/IP or over other network protocols that provided ordered, lossless, bi-directional connections.

Fuzzy Logic and Genetic Algorithms

Fuzzy Logic

In FL a proposition may be true or false or have an intermediate truth-value, such as maybe true. The richness of FL is that there are enormous numbers of possibilities that lead to lots of different mappings. This richness does require a careful understanding of FL and the elements that comprise a FLS.

Genetic Algorithms

The GA is a method for moving from one population of chromosomes (e.g., strings of bits representing candidate solutions to a problem) to a new population, using selection together with the genetics-inspired operators of crossover, mutation, and inversion. Each chromosome consists of genes (e.g., bits), with each gene being an instance of a particular allele (e.g., 0 or 1). The selection operator chooses those chromosomes in the population that will be allowed to reproduce, with fitter chromosomes producing on average more offspring than less fit ones. Crossover exchanges subparts of two chromosomes, roughly mimicking biological recombination between two single-chromosome (haploid) organisms; mutation randomly changes the allele values of some locations in the chromosome; and inversion reverses the order of a contiguous section of the chromosome, thus rearranging the order in which genes are arrayed.

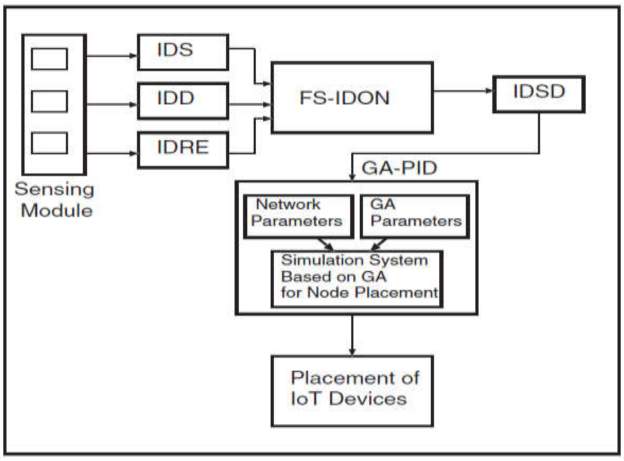

Fig 5 Proposed system structure

Proposed system

The structure of our integrated system is shown in Fig.5. First, the input parameters of Fuzzy System-IoT Devices for Opportunistic Network (FS-IDON) are sensed by the Sensing Module and then the FS-IDON makes the selection of an appropriate IoT device for a required task. After that the Genetic Algorithm-Placement of IoT Device (GA-PID) decides the placement point where the IoT device should be allocated to carry out the task. Based on opportunistic networks characteristics and challenges, we consider the following parameters for implementation of FS-IDON system. IoT Device Speed (IDS): There are different types of IoT devices in opportunistic networks scenarios. There are IoT devices such as: mobile phone terminals, computers, cars, trains, plains, robots and so on. Considering that high speed nodes can transfer the information faster, they will be selected with high probability. IoT Device Density (IDD): The number of IoT devices in an opportunistic network scenario can be different. When there are many devices, the present device will not be selected in order to save the energy. Otherwise if the density of IoT devices is low, the present device will be selected with high probability.

The GA-PID system is based on Rust. Rust is a system programming language focused on three goals: safety, speed, and concurrency. Rust supports a mixture of programming styles: imperative procedural, concurrent actor, object oriented and functional. Our GA-PID system can generate instances of the problem using different distributions of events, sensor nodes and actor nodes. For the network configuration, we use: distribution of events, number of events, number of sensor nodes, number of actor nodes, area size, radius of communication range and radius of sensing range. For the GA parameter configuration, we use: number of independent runs, GA evolution steps, population size, crossover probability, mutation probability, initial placement methods, selection methods.

Function realization

There are mainly three parts of core functions.

1. Analyzing the data from database for the various parameters of fire sensors, appropriate algorithm for its storage, processing and judgment of fire.
2. Fire actions according to plans made for dealing with unusual situations.
3. Provides the user interface functions.

System software is divided in the 3 layers. The first layer is data analysis layer. This is responsible for the data base via serial port to transform into parameters data such as temperature, humidity and image. It is used to maintain classification table for easy transporting query. The second layer is business layer. It is the core of the program. It is used to process the obtained data using different variety of algorithms and based on results the arranged plan is implemented. The third layer is user interface interaction layer. It is used for maintenance of user interface and displays sensor information for fire status monitoring. User can view the data of temperature, humidity, atmospheric pressure, light and three dimensional acceleration information related to fire monitoring..

Fuzzy logic Algorithm

The characteristics of fuzzy logic algorithm are based on information fusion. The algorithm fuses fire parameters of multi sensors for determining fire occur or not according to different kinds of fire parameters. These methods overcome the limitation of using single sensor. This algorithm effectively improves the reliability and reduces the rate of false findings. The algorithm of multi parameter on the fire source localization and different analyze can be done from different fire fighting nodes quickly and accurately decide fire sources according to fuzzy methods and track the trends of fire. The faulty node is found based on received signal strength indication method. After the occurrence of danger, the system gives the reference scenario to the fire department, so that they could make decision rapidly using command and control.

In proposed approach the system, equivalent to sensor node equipped only with a fixed heat detector, is considered. For determining the confidence of fire: previous temperature, current temperature and linguistic variable that serve as a temporal guard are used. Simulations are performed using MATLAB 7.12.0 software tool. Structure of fuzzy logic system is shown in Fig.6.

Membership functions of previous and current temperature are the same and have variables: Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH) (Fig.7). Trapezoidal and triangular shapes of membership functions are chosen because they are suitable for real-time operation (low communication complexity joined with enough accuracy).

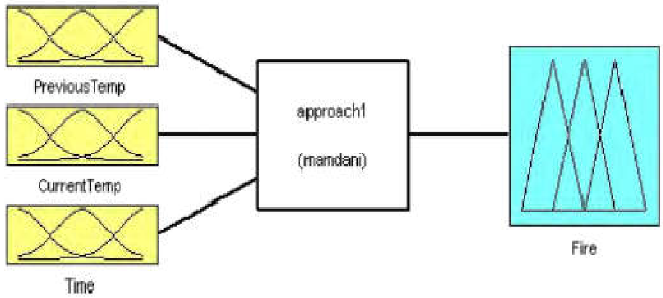

Fig 6 Fuzzy Logic System

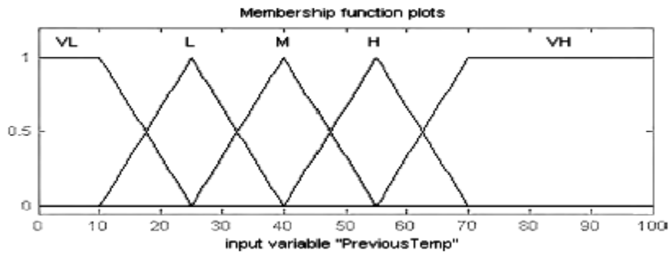

Fig 7 Membership function of input variables “previous temperature” and “current temperature”

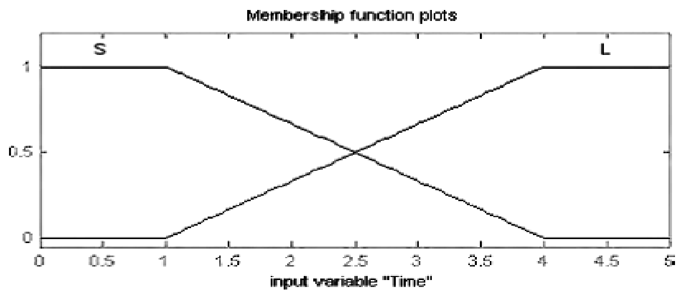

Fig 8 Membership function of input variable “time”

The horizontal axis represents the range of input crisp that is from 0 to 100 °C. Vertical axis is normalized and indicates degree of membership (Fig.6).

Variable time represents the difference in the generation times of the sensor readings. Knowing that rate of rise heat detector are activated when temperature change reaches 8.33 ºC/min, 9 ºC/min or 11 ºC/min, in proposed fire detection scenario time interval of 1 min is considered as an important one and variable time is defined with two semantic values - Short (S) and Long (L) (Fig. 7). In this way the information about the period, within the sensor readings have been generated, is included in the decision process.

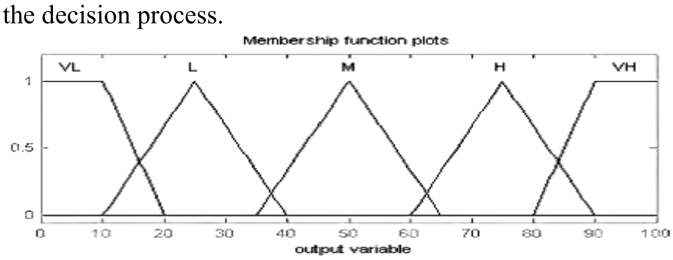

Fig 9 Membership function of output variable

Table 1 First 10 rules of Fuzzy logic in approach 1

Rule	Previous temperature	Current temperature	Time	Fire confidence
	VL	VL	S	VL
	VL	VL	L	VL
	VL	L	S	L
	VL	L	L	VL
	VL	M	S	M
	VL	M	L	L
	VL	H	S	M
	VL	H	L	M
	VL	VH	S	H
	VL	VH	L	M

"fire confidence" Confidence of fire is defined as the output. Membership function of the output variable is divided into five levels: Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH) (Fig. 9).

The rule-base is simply a series of IF-THEN rules that relate the input fuzzy variables with the output fuzzy variables using linguistic variables, described by a fuzzy set, and fuzzy implication operators. All the rules in the rule-base are processed in a parallel manner by the fuzzy inference engine. Any rule that triggers contributes to the final fuzzy solution space. Maximum number of rules in approach 1 is 50 (5*5*2). Although it is not necessary to complete all the rules, but for getting the result, all possible 50 rules are precisely defined. The first 10 rules are given in Table 1. The fuzzy system used in the inference engine is the Mamdani fuzzy system. For every input the centroid method of deffuzification is applied to obtain a crisp output.

Creating Sensor Web system for online data reading and visualization

In a future Internet of Things (IoT) a large number of embedded, possibly mobile computing devices will be interconnected through WSNs, constituting various autonomous subsystems that provide intelligent services for end users. Therefore, Internet connectivity in WSNs of the IoT is highly desirable, featuring sensing services at a global scale all over the world. The range of sensor network applications is nearly unlimited, thus, in order to flexibly integrate any kind of sensor into any type of (software) system, the Open Geospatial Consortium (OGC) established the Sensor Web Enablement (SWE) initiative that specifies standard interfaces and encodings to remotely access, encode and exchange the sensed data. Sensor Web applications became practical based on the present revolutions in computation and telecommunication hardware and are traditionally defined as a web of interconnected heterogeneous sensors that are interoperable, intelligent, dynamic, flexible and scalable.

Sensor Web software architecture

In order to meet the basic requirements of a Sensor Web structure prototype, it is necessary to enable the distribution of sensed data over the Internet. To fulfill this requirement, it is necessary to set up a service on processing unit that will be the mediator between the sensor driver and an end-user or a customer. The infrastructure diagram of prototype model is shown in Fig. 10. The diagram is divided into three main components: the client, the communication channel and service which is a Sensor Web element. At the client side, it is important to note that it is possible to use any client that supports the execution of Java programs, to access a Sensor Web. The majority of currently used systems posses this support by default. Communication channel used to access the Sensor Web is the Internet itself - based on the TCP/IP protocol. Sensor Web element includes all remaining elements, communication unit (which owns the IP address), the CPU (which is able to collect, process and disseminate data), and sensors with Analog to Digital Converter (ADC).

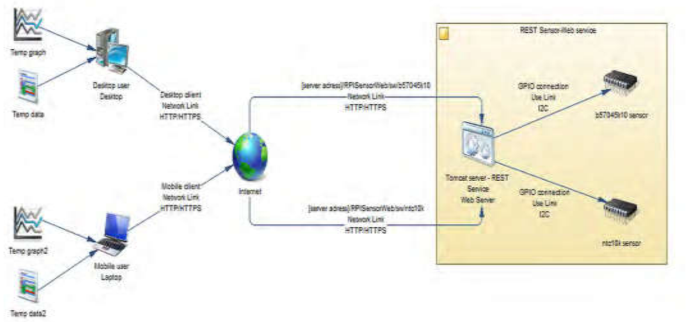

Fig 10 The infrastructure diagram of prototype model

Measurements and results analysis

In this section obtained simulation results are presented and discussed. Fig. 11 and 12 present measured current and previous values of temperature and fire confidences obtained using temperature sensors. In this diagram, horizontal axis presents the measurement number while temperature values are shown on vertical axis. Sensor readings are recorded each 60s (time is short). Temperature sensor is used to simulate temperature changes at lower temperatures. Fig. 11 and 12 show that first approach for determining confidence of fire smoothly "follows" previous and current temperature and that there are no extreme peaks.

The outputs obtained from test are the probability ("p-value") of getting the statistic calculated for datasets. As a general rule, if p-value is less than the critical value of .05 it means that the results are significant and therefore support an alternative hypothesis which states that there is a difference in the distributions of two datasets. (Although in theory and practice many numbers can be used for alpha, the most commonly used is 0.05.

According to performed statistical tests it is obvious that model delivers quite good result regarding the model of temperature sensor temporal semantic together with temperature change fuzzy logic system and genetic algorithm becomes more sensitive to high temperature rises and has double fewer rules compared to the first one.

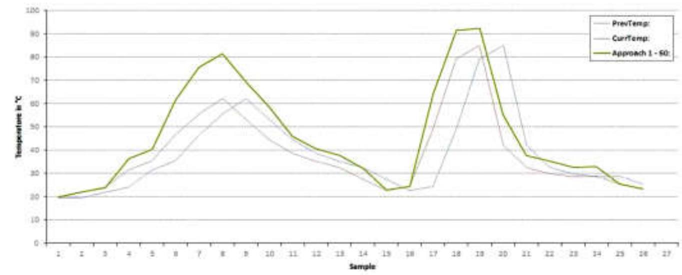

Fig 11 Measured values of previous and current temperature and obtained fire confidence using approach 1

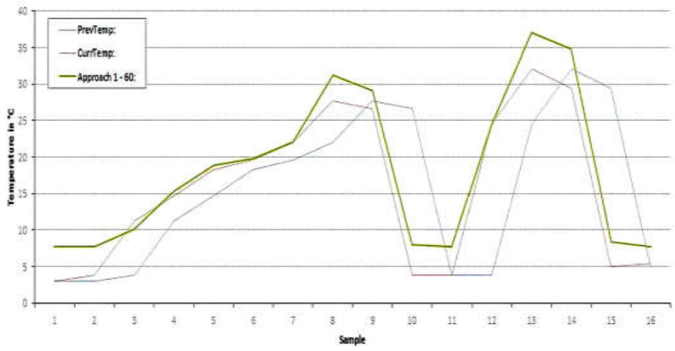

Fig 12 Measured values of previous and current temperature and obtained fire confidence using approach 1

Assumed that the same sensor readings are recorded each 2.5th and 4th minute, obtained fire confidences would be less compared to one shown in Fig.11 and Fig.12. Thus, from Fig. 13 and Fig. 14 it can be seen that the confidence of determining fire presence is higher if the temporal distance between the sensor readings is shorter and vice versa.

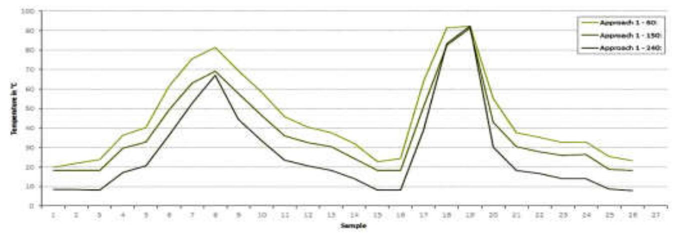

Fig 13 Obtained fire confidence vs. time of sensor readings

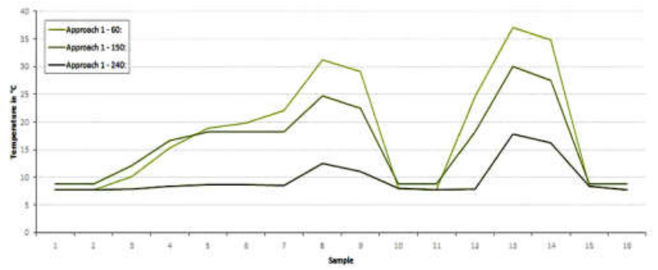

Fig 14 Obtained fire confidence vs. time of sensor readings

CONCLUSIONS

In this paper, we presented the design of an integrated intelligent system for IoT device selection and placement in opportunistic networks using FL and GA. The FS-IDON system makes the selection of an appropriate IoT device for a required task. The GA-PID decides the placement of IoT device in an opportunistic network in order to carry out a required task. We introduce the system structure and present in details the design and implementation issues. Fire fighting IoT standard system construction can be accelerated, and nationwide IoT platform can be constructed by actively carrying out system integration and information sharing of fire-fighting remote monitoring system. The IoT technology improves the fire-fighting safety management work from traditional fire-fighting to modern fire-fighting.

The use of fuzzy logic in WSNs is a promising technique since it allows combining and evaluating diverse parameters in an efficient manner. Fuzzy logic and genetic algorithm are very promising approach because the execution requirements can be easily supported by sensor nodes improving the overall network performance. In order to increase event detection and further decrease the number of false alarms, the temporal properties of the monitored events have to be involved in decision making causing the number of decision supporting rules to increase. Focusing on the aim to increase accuracy and decrease false alarms, method for determining confidence of fire, including temporal semantic, are presented in this paper. The method is based on previous and current temperature sensor readings inside the defined time interval, while the second one introduces two linguistic variables: temperature and rate of temperature change that encapsulate time variable. Both approaches are first modeled and tested in MATLAB. The simulation results show that confidence of determining fire confidence is higher if the temporal distance between the sensor readings is shorter and vice versa.

References

1. Qiu, T., Feng, L., Xia, F., Wu, G. and Zhou, Y.: A Packet Buffer Evaluation Method Exploiting Queueing Theory for Wireless Sensor Networks, ComSIS Vol. 8, No. 4, pp. 1027-1049, DOI: 10.2298/CSIS110227057Q, Special Issue, October (2011)
2. Ali, F.: A Middleware to Connect Software Applications with Sensor Web. *The International Journal of Technology, Knowledge and Society*, 6(5), 27-35, (2010)
3. Liu, P., Zhang, S., Qiu, J., Shen, X. and Zhang, J.: A Redistribution Method to Conserve Data in Isolated Energy-harvesting WSN, ComSIS Vol. 8, No. 4, pp. 1009-1025, DOI: 10.2298/CSIS110420066L, Special Issue, October (2011)
4. Kapitanova, K., *et al.*: Using fuzzy logic for robust event detection in wireless sensor networks. Ad Hoc Netw., (2011)
5. Kumar Das, S., Kumar, A., Das, B., Burnwal, A.P., Ethics of Reducing Power Consumption in Wireless Sensor Networks using Soft Computing Techniques. *International Journal of Advanced Computer Research*, 3(1-8), (2013)
6. Ross, T.J.: Fuzzy Logic with Engineering Application, 3rd Edition. Wiley (2010)
7. Kapitanova, K., Son, S. H., Kang, K. D.: Event Detection in Wireless Sensor Networks -Can Fuzzy Values Be Accurate?, Ad Hoc Networks, 49, 168-184, (2010)
8. Rezaee, B.: Rule base simplification by using a similarity measure of fuzzy sets. *Journal of Intelligent & Fuzzy Systems* 23, 193-201 DOI:10.3233/IFS-2012-0509 IOS Press, (2012)
9. Bolourchi, P.: Intelligent Decision Making Based on Fuzzy Logic System in Remote Wireless Communication, Master Thesis, Eastern Mediterranean University, Gazimağusa, North Cyprus, (2012)
10. S. C. Folea and G. Mois, "A Low-Power Wireless Sensor for Online Ambient Monitoring," IEEE Sensors Journal, vol. 15, no. 2, pp. 742-749, 2015.
11. P. Changhai, Q. Kun, and W. Chenyang, "Design and Application of a VOC- Monitoring System Based on a ZigBee Wireless Sensor Network," IEEE Sensors Journal, vol. 15, no. 4, pp. 2255-2268, 2015.
12. S. D. T. Kelly, N. K. Suryadevara, and S. C. Mukhopadhyay, "Towards the implementation of IoT for environmental condition monitoring in homes,"

IEEE Sensors Journal, vol. 13, no. 10, pp. 3846-3853, 2013.
13. N. K. Suryadevara, S. C. Mukhopadhyay, S. D. T. Kelly, and S. P. S. Gill, "WSN-Based Smart Sensors and Actuator for Power Management in Intelligent Buildings," IEEE/ASME Transactions on Mechatronics, vol. 20, no. 2, pp. 564-571, 2015.
14. S. Kraijak and P. Tuwanut, "A survey on internet of things architecture, protocols, possible applications, security, privacy, real-world implementation and future trends," in *IEEE 16th International Conference on Communication Technology (ICCT)*. IEEE, 2015, pp. 26-31.
15. T. Inaba, S. Sakamoto, V. Kolici, G. Mino, and L. Barolli, "A CAC Scheme Based on Fuzzy Logic for Cellular Networks Considering Security and Priority Parameters," *The 9-th International Conference on Broadband and Wireless Computing, Communication and Applications (BWCCA-2014)*, pp. 340-346, 2014.
16. K. Matsuo, D. Elmazi, Y. Liu, S. Sakamoto, G. Mino, and L. Barolli, "FACS-MP: A Fuzzy Admission Control System with Many Priorities for Wireless Cellular Networks and Its Performance Evaluation," *Journal of High Speed Networks*, vol. 21, no. 1, pp. 1-14, 2015.

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