Survey Paper on Event Detection Techniques in Wireless Sensor Network for Disaster Recovery

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Abstract

Wireless Sensor network is having tremendous growth in current world due to low cost sensor and well planned techniques. Wireless sensor networks (WSNs) are large networks made of a large number of sensor nodes with power to sense the environment and communicate it with administrator. This technology can be used to detect the particular event which can be helpful to manage the disaster. Until now various techniques of event detection have come forward and effectively contributed to manage the disaster. In this survey paper, we present Wireless sensor network architecture, we study various techniques used for Event Detection in WSN like Support Vector Machine a, Feed forward neural network, and machine learning techniques. Also, we introduced the open issues and challenges faced in various techniques and how machine learning technique with the help of neural network effectively addresses to it. Finally, several open research questions of wireless sensor networks and event detection are suggested and put forward.

1. Introduction

Whenever and wherever there is catastrophe or disaster occurs, we have to save lives and reduce the danger by using engineering principles.WSN helps in tremendous manner to overcome from the drastic effects of catastrophe. Disaster management plays vital role in handling such situation.WSN helps disaster management in effective way. Event detection can be done in wireless sensor network by using large number of small sensing motes. These small nodes can sense various environmental conditions like temperature, humidity, moisture and smoke. These nodes are backed up by small microcontroller and radio transceiver. This setup collects data by sensing environment condition and passes the collected data to another node in the network. This way all data from sensor network is getting collected in the sink. Administrator can keep eye on sink and make smart decision on it. The paper is organized as follows. In the section 2, we will briefly summarize the system architecture for sensor networks. We then set our work apart from prior surveys on sensor networks. Section 3 summarizes Event detection techniques. In section 4 we study event detection by feed forward neural network. In section 5, we describe other Event detection technique by using distributed fuzzy engine. In section 6 we describe event detection in disaster management by using machine learning technique. Finally, section 7 concludes the Ease of Use paper with a comparative summary of the surveyed approaches and points out open research problems.

2. System Architecture

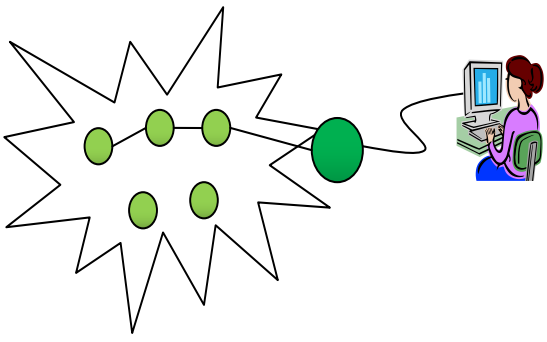

Fig 1: Wireless Sensor Network

A wireless sensor network (WSN) consists of sensors which are autonomous. These wireless sensors monitor the environmental condition such as temperature, humidity and smoke. They simultaneously pass their data to another node and then to main node called as gateway node. This all work is bi directional. Sink or

gateway node can also pass the data to each node by following same route...In early days various applications are invented to serve military and help them, wireless sensor network also immerges to help military. The WSN is built of nodes. From By today there networks are used for various purposes like disaster recovery, medical science, event detection etc. Every node in wireless sensor network is connected to the one or more nodes in that network...Each node is having a typical setup which consists of a small microcontroller and a radio transceiver. It is placed on the chip with one sensor which can sense the nearby environment conditions. A radio transceiver is there with antenna so that it can communicate with other node in the network. A battery is situated with every setup. These wireless sensors are available in the market in various sizes. A size like a shoe till a size like small dust particle. These sensors sometimes are called as motes. Cost of each sensor depends on the its complexity. Still the sensors are now available at low cost. Generally star topology is used in WSN, but it may depend upon external parameters to mesh or some other topology.

3. Event Detection Techniques

There are various event detection techniques. Detection of fire in early stage reduces the rate of damage and loss of life. For detection of fire, there should be combination of sensors and algorithm needed for detection some AI techniques are used to detect the event. Earlier they have made some assumptions which might be improper. So a new method is proposed Feed forward neural network. In this method there are optimal sensor combinations for accurate residential fire detection. Results are investigated by bayes classifier. FFNN feed forward neural network is type of neural network in which each layer is fed by its back layer. It has one input layer and one output layer and one or more hidden layer. This artificial neural network consists of mathematical model. It is composed of group of artificial neurons and they are used to process the information. The fuzzier converts a crisp value into degrees of membership by applying the corresponding membership functions. A membership function determines the certainty with which a crisp value is associated with a specific linguistic value. Figure 2 shows an example of a temperature membership function. According to this membership function a temperature of -2. Is classified as 20% Freezing and 80% Cold. The membership functions can have different shapes. Some of the most frequently used shapes include triangular, trapezoidal, and Gaussian shaped.

4. Feed Forward Neural Network

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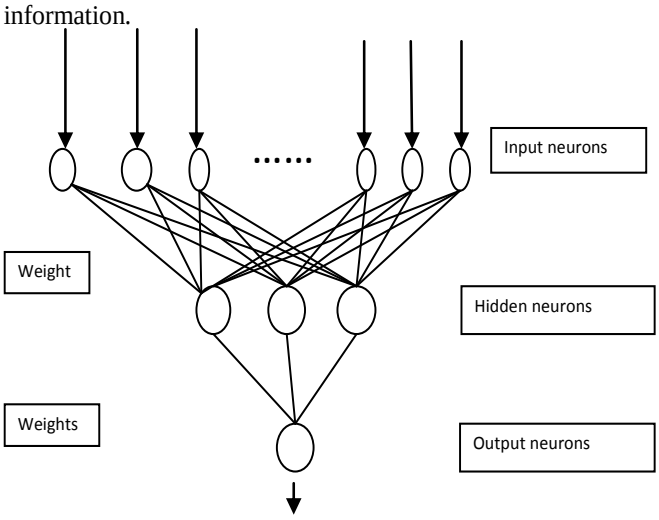

Fig 2: Overview of FFNN

In this network the main challenge is to find weight. We have to find appropriate weight. One process is there called as learning which is used to find weight. Algorithm used to calculate weight is Gradient Descent GD approach. [2]

Naïve Bayes Classifiers

Bayes' theorem is used to find the probability of each instance belonging to a special class. It is called Naïve because of emphasizing on independency of the assumptions. To find the probability of belongingness of each instant to a specific class, Eq. 1 is as follows.

$$p(c|E) = \frac{p(E|c)p(c)}{p(E)}$$

(1)

Comparison between FFNN and naïve bayes classifiers

In Feed Forward neural network we can easily do the programming with sensor nodes. Parallel capability is the advantages of feed forward neural network. At first we will put three neurons in the input layer. In the hidden layer we will put two neurons. And output neuron will be one. The weights can be found by the GD learning algorithm. Fig 2. Parallel capability is the advantages of feed forward neural network which means parameters used in Eq. 2 can be calculated independently and in parallel. This network can be easily programmed into sensor nodes using Eq. 1.

Evaluating this mathematical formula in form of a business rule is computationally very cheap and appropriate for resource constraint sensor nodes. This equation can be extended to more neurons and layers but the idea is the same. Eq. 2 formulates the network in a form of mathematical model. One should note that each neuron passes the sum of product (SOP) of the previous layer. In some networks SOP is given to a non-linear function such as tangent and transformation is a nonlinear one that makes Eq. 2 little variation.

$$\text{Output}=\left[W_{3,1}\times\sum_{j=1}^{3}(W_{1,j}\times I_j\right]+\left[W_{3,2}\times\sum_{j=1}^{3}W_{2,j}\times I_j\right] \quad (2)$$

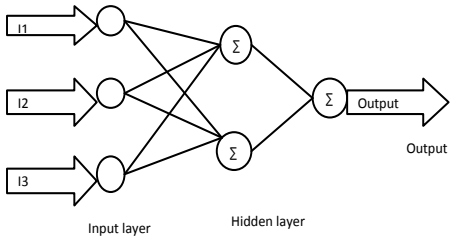

Fig. 2: FFNN having input of three neurons and output of 1 neuron.

One neuron in output layer along with their corresponding weights. Naïve Bayes classifier is also easy to implement. The most time-consuming part is how to compute p(E | c) in Eq. 1. This probability calculation is important to make the classifier more accurate. We can divide data into some intervals and count the data frequency within that interval. The new instances are also partitioned to the same intervals for finding the probability of each feature to be in that class. To clarify the method, suppose we have the following data for ten samples in two classes A, B .

A = [8, 7, 2, 4, 6, 9, 8, 9, 1, 3]

B = [1, 1, 1, 3, 3, 5, 8, 4, 2, 2]

Then we divide these data into two halves. Two halves were chosen to simplify the example however the number of halves are arbitrary. Therefore, those numbers less than five are allocated in the first interval, i.e. first half, and the rest in the second half.[1]

FFNN's Computation Complexity

Training phase is the most expensive part of FFNN.

If FFNN is once trained and then programmed then complexity of FFNN is negligible.

$$O_{FFNN} = O(m \times n \times p)$$

5. Distributed Fuzzy Logic

Event detection is key process in wireless sensor network applications. Though it has not given any special attention in the field of wireless sensor network. The majority of current event description approaches rely on using precise values to specify event thresholds. However values cannot be handled properly. Now here fuzzy values are handled instead of crisp values which improve the accurateness of event detection more significantly. We also show that our fuzzy logic approach provides higher detection precision than a couple of well established classification algorithms. A disadvantage of using fuzzy logic is the exponentially growing size of the rule-base. To address this issue we have developed a number of techniques that help reduce the size of the rule-base by more than 70% while preserving the level of event detection accuracy.[4]

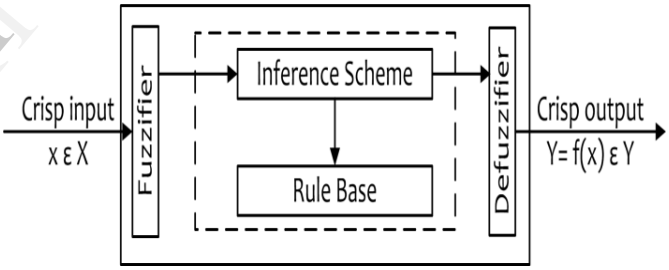

Fig 3: Distributed fuzzy logic

The fuzzier converts a crisp value into degrees of membership by applying the corresponding membership functions. A membership function determines the certainty with which a crisp value is associated with a specific linguistic value. Figure 2 shows an example of a temperature membership function. According to this membership function a temperature of -2. is classified as 20% Freezing and 80% Cold. The membership functions can have different shapes. Some of the most frequently used shapes include triangular, trapezoidal, and Gaussian shaped.

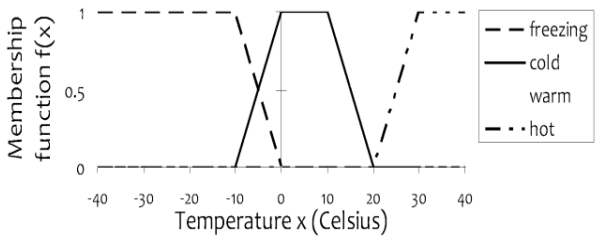

Fig 4: Event detection by distributed fuzzy logic

6. Machine learning Technique

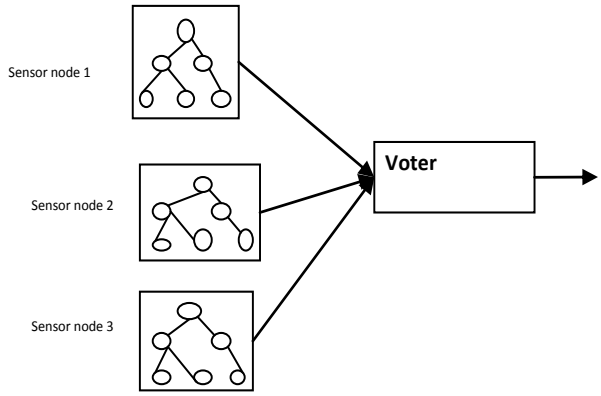

Fig 5: Election process on Machine learning technique

A *Reputation-based Voting*

In reputation based technique each node will make its own decision based on own computation power. Then we have to use voting techniques. There are various voting techniques, One is reputation based voting. It is based on finding the reputation of each node and choosing the reputation of highest node and make decision. Local decision tree classifiers should be used to calculate reputation but using reputation technique. At first we will assume that each node is detecting its event properly and communicate data with neighbor nodes. Each sensor node then calculates Detection Value (DV) by its own detected event. And send that detected value to the all neighbor nodes. Detection value is then collected by all neighboring nodes and that value is stored in separate table known as neighbor detection value table(NDVT).In the second step each sensor node should compare its detection value with neighbors detection value and do the judgment and Calculate the difference between own and neighbors detected value. If that difference is less than threshold value, which is standard value provided, result will be positive. Otherwise, result will be negative. At last NDVT is sent to the voter. To reach a consensus among different opinions. The main challenge in this reputation based techniques is how to assign global reputation value to each node. So we assign two reputation techniques to calculate global reputation value of each node too. [1]

B *Reputation Technique 1*

In the first technique it will check the reputation locally. the other sensor nodes in the perspective of event detection. Positive and negative votes given by neighbor sensor decides the local reputation value of the sensor. Then weight of the sensor is multiplied by its average reputation value using to get global reputation value. W is the global reputation value is calculated as a result.

$$W_i = R_i \times A_{cci} \quad (3)$$

Where R is the reputation value corresponding to sensor node i, A is the local reputation value of sensor node i from other sensor nodes perspective, and is the same output.

7. Open Issues

Though wireless sensor network and event detection has demand on the pick, the development regarding that has not given any attention.Use of Artificial intelligence and neural techniques will help the sensor to make smart decision instead of traditional method of detection of event that creates unnecessary burden in the administrator. Still much more development is needed to make sensor think and make smart and wise decision to cure and prevent disaster.

Event Detection Techniques	Sensitivity	Specificity	Accuracy	Net Detection Value
Feed Forward Neural Network	high	low	medium	high
Distributed Fuzzy Engine	low	high	low	low
Machine learning Technique	high	low	high	high

Conclusion

In this paper, all important aspects of event detection in wireless sensor network is described including sensor nodes, wireless sensor network architecture, Various techniques of detection of event like machine learning techniques, Event detection by support vector machine and event detection by distributed fuzzy logic. However, The support vector machine and distributed fuzzy logic methods are having many pitfalls as compares to the AI technique Feed forward neural network. For fast and accurate detection of disastrous events using WSNs, Machine learning techniques are used for accurate event detection. Distributed event detection is considered in

machine learning technique. This paper surveyed some of the research Techniques in event detection of Wireless sensor network. Comparison between the different methods of event detection is done in this paper. Finally some of the open issues are discussed regarding event detection in this paper.

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