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FIRE DETECTION AND MONITORING: A COMPREHENSSIVE SURVEY

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ABSTRACT

IoT provides mechanism to integrate various diverse components (Sensors) to work in synchronised way. A system of smart interconnected components can be used to monitor the abnormal situation where existing resources or infrastructure fails. This paper is intended to study to study the techniques and framework used to analyse the disasters such as floods, fire, earth quakes etc. the prime objective of this study is to examine the techniques associated with fire detection in considerably larger premises like forest. Fire detection system along with heat sensors are employed in this case. This work provides the comparative analysis of each technique to determine better approach that can be enhanced on the parameters of energy conservation and fault tolerance in future work.

KEYWORDS

IoT, Sensors, Disaster, Fault tolerance, fire alarm system

1. INTRODUCTION

Internet of Things(IoT) is the network of physical devices including sensors, actuators, software and network connectivity. (Thomas et al. 2016)IoT allow the object to be sensed and controlled remotely. It allows direct integration of physical world into the computer system causing enhanced performance in terms of accuracy. The cyber physical system is created using the application of IoT.

The evaluation of Internet of Things greatly facilitates the diagnosis process of abnormal situations. (Anon n.d.)suggests monitoring of records associated with patients is becoming possible with the utilization of IoT. In order to accomplish this task, (Abdelwahab et al. 2015)(Xu et al. 2014)small IP based wireless sensor (Proximity sensors) is attached with the patient body. (Guo et al. 2016)proposes sensor based sensing application that helps in monitoring the psychological parameter like heart rate and blood pressure remotely and frequently. The record so obtained can be stored over the cloud so that patient record can be retrieved as and when required. The proposed work studies the applications of the IoT in the field of health care along with management policies used to enhance security of records stored within cloud.

In addition application of IoT can be used to monitor disaster management. (Gubbi et al. n.d.; Shinde et al. 2017)In order to accomplish this sensors are in place for gathering the information about the smoke and heat. A fire alarm system has number of equipments working together to detect abnormalities and warn people through audio and visual mechanisms as they detect smoke, fire and other critical situations. these fire alarm systems can also be

activated manually. Alarms used within the fire alarm systems can be motorized bells or wall mounted horns. Frequency of alarms can be altered depending upon the area in which these systems are installed.

IoT serves automatic extraction of information in the absence of infrastructure facilities or areas where human interaction is minimal. Parameter extraction through IoT is described as under

1.1 COLLECTION OF INFORMATION THROUGH THE APPLICATIONS OF IOT

The parameters collection is integral part of abnormal situation detection. Collection of parameters is organised in the form of tabular structure. (Li et al. n.d.; Vaishali & Kalaivani n.d.)as more and more data is collected Big Data is formed, it is organised to form dataset. Parameter collection process involves sensors placed on different parts of the body of humans or at extraction points in case of physical premsis. As the persons moves or perform distinct activities, sensor produces information which is recorded in memory. Overall organization of internet of things in parameters collection is organised as follows

PARAMETER COLLECTION "PLACEMENT OF SENSORS" ALONG WITH SENSOR PLACEMENT		
Settings of Sensor	Description	Utilization Example
Human Body	Devices attached inside or outside human body	Devices used to maintain well being of humans. Applications include disease management, increased productivity etc.
Home based environment	Homes and Building where people live in	Sensors used in security systems
Business Store	Places where customers engage in transactions	Stores, Banks, maul etc involving large number of people.
Offices	Place where intellectuals interact with each other for business	Management of energy and security enhancement services in buildings
Organization like factories, industries etc.	Mostly used in production	Places where repetitive work is done like in hospitals, inventory systems.
Sites where actual work is done	User specific customer environment	Oil Mining and construction environment
Cars and other moving vehicles	System which work inside moving vehicles	Vehicles including cars, jeeps etc used to monitor consumption of fuel.
Urban Environment	Cities	Smart Cities
Miscellaneous	Between Urban and rural area	Including rail tracks , roads etc. used to detect blockage if any

Table 1: Parameter Collection settings Source "www.internetsociety.com"

Collection of parameters collected through the above listed source form dataset. For detection of disease related to Activities, dataset from UCI website can be drawn. The parameter collection process is listed in following diagram

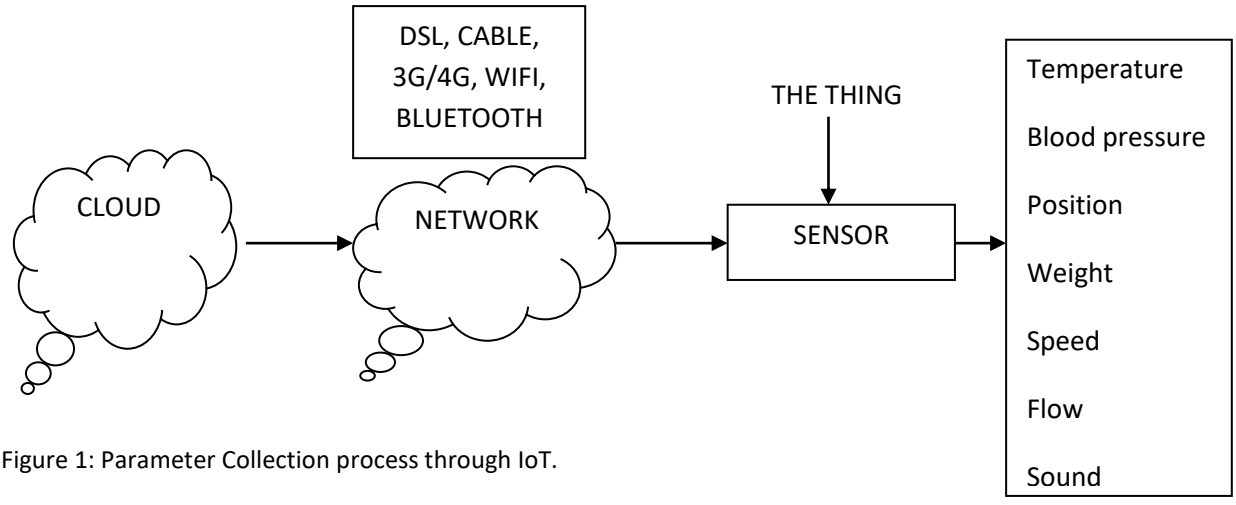

Figure 1: Parameter Collection process through IoT.

1.2 USE OF INFORMATION COLLECTED IN THE IOT ENABLED SYSTEMS

Collected information through sensors is used within the fire or other disaster management system for predicting abnormalities. There exist components associated with such a system. These components includes

1.2.1 Microcontrollers

Microcontroller act as a interface between the sensors and alarm system. Microcontroller receives the data from the sensors and converts them into critical and non-critical information. in other words information is partitioned into to categories. First category indicates that smoke or fire intensity levels are beyond the threshold value causing the alarm to blow and second situation indicates the normal in range smoke and fire values.

1.2.2 Temperature Sensors

Temperature sensors are primary components within the fire management systems. The task of of temperature sensor is to examine and monitor the temperature of the physical environment presented. The threshold value is merged within the fire management system. The microcontroller as and when gets the enhanced temperature value then alarm will be blown. The alarm system is greatly depending upon the correct working of temperature sensors.

1.2.3 Gas Sensors

Gas sensors used to detect the gas emission due to the application of fire within the prescribed premises. Gases like carbon dioxide, carbon monoxide etc. are detected along with the intensities associated with these gases. The emission of gases corresponding to comparison within the accompanied threshold which if exceeded alarm blows off.

1.2.4 Flame sensors

Flame sensor is used to detect the flames which are initiated as a result of fire that is caused within the considered premises. Flame sensor either gives the value as 0 or 1. In case flame within greater intensity value is detected, this sensor gives 1 otherwise this sensor gives 0.

The collected information through the IoT enabled system is fed into the fire or abnormality detection system. The microcontroller through the threshold value comparison detects the abnormality and sets the alarm to on or off state. The collected information accuracy is matter of concern since sensors within IoT enabled systems may gives wrong information due to faults or failures.

1.3 Description of fault and failures within the sensor leading to misleading information

Sensors are susplectible to noise and atmospheric effects causing misleading information. sensors faults and failures are listed as under

a. FAULT/DEFECTS

Faults are the mistakes resulting in incorrect results. Faults are interlinked hence faults in system may cause further failures to occur. Several faults caused by single error and identical faults caused by distinct errors .In the code faults are symbolised as problems.

b. FAILURE

In this required function is not performed within the specified performance requirement. Failure occurs when a software program ceases to deliver the expected service. The various levels of failures are identified by user such as catastrophic, which may be major or minor that depends upon their affects and results of the system like monetary value, human life and property lost. Several faults may be caused by a particular failure. Failures are considered as incorrect external events.

c. ERRORS

Errors are the differences between the compute, observed and the truly specified value. When some parts of the computer software products results in an undesired state then error occurs.

d. Mistakes

The software contains mistakes or logical mistakes in this case. These mistakes are also known as bugs. Mistakes can be intentional or unintentional in nature.

e. Process failures

When the program executes process is formed. Poor methodology is followed in case of process failure. Such problems occur during development time.

f. Real Time Anomalies

Real time applications are severely affected due to presence of faults. The target could be way of in case of present of defect within the system. Military software applications could be example of it.(Ogheneovo 2014)

These faults and failures are required to be tackled in order to develop a precision based fire detection system. Next section gives some in depth into the previous work which is done towards fire detection within the physical area considered.

2. BACKGROUND ANALYSIS

The existing literature provides framework for tackling the issues associated with fire detection over the remote area using the application of sensors over the given premises

Wireless sensor based fire detection system proposed by (Reddy et al. 2011). In this literature nodes are distributed. Nodes with maximum energy are termed as monitoring nodes. The fire detection system detect the abnormal or intruder in terms of heat and flames. The fire detection system then gives the signal to the alarm system to show critical situations. Zigbee oriented fire monitoring system is used for the detection of abnormal situation within the area monitored.

Fire detection using ZigBee and GPRS system proposed by (Kiran et al. 2017). Forest fire detection using the zigbee and GPRS is handled through the said literature. Forest fire detection proposed through this literature includes algorithm detecting humidity and temperature change. The hardware circuitry of proposed solution is based on Arduino board with ATmega328 microcontroller, temperature sensor and humidity sensor along with ZigBee and GPRS modules.

Intelligent fire detection system is proposed by (Mobin et al. 2016). This literature presents a system in which dissipative fires as citrates, welding smoke etc is eliminated using fusion algorithm. During the fire hazard SFF notifies the fire service and oth- ers by text messages and telephone calls. Along with ringing fire alarm it announces the fire affected locations and severity. To pre- vent fire from spreading it breaks electric circuits of the affected area, releases the extinguishing gas pointing to the exact fire locations. This paper presents how this system is built, components, and connection diagram and implementation logic.

Room temperature control using IoT and MQTT proposed by (Kang et al. 2017). Amazon web service is considered for evaluation through message queue telemetry transportation. A broker is used in this case that sense the room temperature with the help of IoT. Threshold values are maintained which if violated alarm will blow. This alarm causes the monitoring of temperature within the room.

Fire detection system using the applications of IoT is proposed by (Shinde et al. 2017). This literature divides the entire fire detection system into three parts: first part involves detection of smoke. Second part involve detection and monitoring of flames and third part includes temperature monitoring. In case any of the above three cases are violated, alarm will be blown. An automatic wireless sensor network is considered in this case. The 'automatic' word in here signifies minimal human interaction. Once this system is in place, fire is detected and alarm is blown for safeguard of place and humans where it is installed.

2.1 Problems associated with existing literature

Most of the existing literature considered do not considered the fault tolerance and energy efficiency. Fault tolerance and energy efficiency are critical factors attached with sensors. In case sensor encountered misleading information is presented by it causing false alarms. Also sensors have limited energy associated with it. Conserving energy could also be a future concern.

3. Comparison of various techniques associated with fire detection

The comparative analysis of various fire detection system mechanism using the application of IoT is considered for evaluation through qualitative analysis as

Title	Technique	Sensors	Merit	Demerit
Efficient Cluster head selection for WSN(Raj 2012)	High energy node selection for cluster head to conserve energy and reduce packet drop	Advanced and normal nodes considered as sensors	Packet drop ration in transfer of packets reduces greatly	Fault tolerance is not considered
IoT Middleware: A Survey on Issues and Enabling Technologies (Ngu et al. 2016)	Survey of techniques used within IoT for performance enhancement	--------	Comprehensive mechanism for comparison of techniques is presented. Applications of IoT in thr field of forest fire detection is presented	Fault tolerance and energy efficiency is missing
Fire Monitoring System for Fire Detection Using ZigBee and GPRS System(Kiran et al. 2017)	Zigbee and GPRS	Fire, Flame and smoke sensors	GPRS enabled mechanism is presented providing on the go information to the user about abnormal situations.	Fault tolerance and energy efficiency is missing.
An Intelligent Fire Detection and Mitigation System Safe from Fire (SFF)(Mobin et al. 2016)	Self controlled fire extinguisher mechanism	Actuators, Fire, smoke and flame sensors	The suggested mechanism not only monitor the fire but also suggest the mechanism to control the abnormal situation	Fault tolerance and energy efficiency if missing in this literature

Table 1: Fire detection and monitoring system: Qualitative analysis

4. Conclusion and future scope

Fire detection and monitoring systems presented in existing literature do not considered energy efficiency and fault tolerance for precision based abnormality detection. This means faulty sensors could cause misleading or false alarms and severe or critical situation may be left unhandled. The hexagonal view of area is also not considered hence all the area is not successfully monitored. In order to tackle the issue hexagonal view of area along energy efficiency mechanism can be incorporated within fire detection while considering large area like forest.

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