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Fault Detection and Reporting System for Devices Used in Homes and Corporate Offices

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Abstract

In today's electronic world, humans are dependent on electronic devices. These electronic devices are having greater impact if some of those does not work correctly at required situations. The number of devices being used in homes and corporate offices is quite big. If same amount of devices fails, then it causes high amount of wastage of time and cost required for maintenance of such faulty devices or to replace those devices. Therefore, there is a need arises to maintain the devices into proper working states. To know status of all devices, they need to be observed. It is possible to detect faults by comparing the behavior of the device against a reference. Here, we use sensor data analysis to identify faulty devices using clustering techniques for selecting the action against a fault or failure.

Keywords: *Clustering, device failure detection, fault detection, sensors, sensor data analysis*

INTRODUCTION

In today's generation, almost every individual is familiar and more dependent on electronic devices in his daily routines. These electronic devices are having many advantages also having same amount of disadvantages. Imagine what if these devices could not work on the situations when it needed the most. Lots of devices fails due to lack of maintenance on time, poor quality materials used in production, or due to some external reasons. When such devices fails, in the traditional way of maintenance, a service agent follows his diagnosis routine for identifying the problems which caused failure in device. But sometimes it takes more time to identify the problem. In some situations the device need to replace with the new device. To avoid such a lack of maintenance on time, the daily working of devices need to be monitored.

For monitoring such devices, different types of sensors can be used. A sensor measures a physical quantity and converts it into a signal and then it is converted to data. Sensors are able to collect the real time data by measuring the environment parameters around devices. With this feature of a sensors, devices are observed. The proposed system uses an array of sensors collecting data and transmission over cloud-based computing and storage resource.

The device manufacturers provide an additional information about the working of devices and parameters required for proper working of devices, and real time sensor values from sensors are pre-processed at server side. The preprocessing of data helps to remove unnecessary values from the collected data. Then this preprocessed data is used for analysis purpose. The analysis of sensor's data and manufacturer's data is done at server. For this analysis of such data, algorithms are implemented on server with a Graphical User Interface (GUI) application.

The analysis of real time sensor data and manufacturer's data is analyzed by using the clustering techniques. From using clustering for analysis, we are able to distinguish between correct and incorrect data from large amounts of sensor data which is continuously retrieved from sensors to cloud storage.

We are using GUI application for visualizing the analysis of sensor data. The purpose of analysis in this system is to identify the incorrect parameter values and check that the device is working properly or not. We usually have access to the analysis results on our mobile phones or computers via apps or browsers by getting access to server. By this, we can get the correct information about fault in devices. According to which the user can then perform an action and solve the issues in faulty devices.

Fault in device is sometimes minor or major. If the fault in minor it does not put the device into dead state, but if the fault is major then there is risk of device failure and device going into dead state. According to its impact on device, we categories the fault into different categories. If the fault is minor we only notify the end users about the fault. If fault is major, then end users has to take prior action. The adjustments or actions that the user has to make are sent via the system. To send action and fault information to end users, we are using SMS integration service on the server. The SMS contains the required action and fault information. We only send the Error Code to show type of fault. In such way we are trying to eliminate the rate of device failures.

The present proposed work includes: The proposed system works for identification and diagnosis of faults in the devices. To identify the faults, we need to work with the real time data provided by the sensors. This system is having four phases. Each phase is having its separate purpose in proposed system.

- Real time sensor data collection.
- Data Pre-processing (sensor data + manufacturer's data).
- Data analysis using clustering technique.
- Fault reporting and action selection.

RELATED WORK

Jorge C Seabra et al., proposed an intelligent, low cost system, which monitors the behavior of electrical magnitudes of domestic appliances in real time [1]. The system is able to analyze the collected data, detect possible faults, and report this situation to the user. This system is designed to adopt old generation electronics. Also the necessary interventions are given in form of TV displays, etc. Fault detection and diagnosis systems available in real-time and on-line add ease of management to domestic appliances. Fault detection is done through information registration, recognition, and indication of anomalies in the systems behavior.

Pravesh Kumar Tejan et al., intends to detail how to make the sensor system, low maintenance and self-healing [2]. All the civilized communities across the universe are spending a lot on the maintenance since it affects the physical, mental and spiritual wellbeing. This maintenance can be divided into two phases. First phase is observing and reporting. The better the observation and reporting, the better and faster are the chances of a quality resolution of the issues. It is noted by psychologists that human mind find it

difficult to take effort and record community issues. Also studies has proved that machine or devices behave much better in both these phases of maintenance, and if these phases are combined into single coordinated and combined ecosystem, the sensor machines can play a pivotal role in community maintenance.

Junghee Lee et al., proposed a self-diagnosis technique for faulty node identification in large-scale IoT systems [3]. The technique is based on lightweight processor-level architectural support to minimize the performance overhead. It is demonstrated by experiments that the proposed methodology can detect 92.66% of failures, regardless of when the external monitoring program is connected. A faulty device identification technique which is based on very lightweight processor-level architectural support.

Timo Niemirepo et al., proposed a method DICE, to detect and identify faulty IoT devices with context extraction [4]. DICE identified faulty devices successfully with an average of 94.9% precision and 92.5% recall. Our system took an average 3 minutes to detect faults and average 28 minutes to identify faulty devices.

Gaoming Shi et al., carried out various types of analysis method on the NFF household appliances: first, visual inspection, function test and electrical parameter tests for confirming the NFF phenomenon; second, reproduce the fault phenomenon through various stresses, such as thermal stress, humidity stress, electrical stress [5]. In the continuous development of reliability engineering technologies, the no fault found (NFF) phenomenon remains a big obstacle that troubles various manufacturers. Especially, in the household appliance industry, NFF accounts for about 30–70% of the returned faulty products. With in-depth analysis on the failure modes and mechanisms, a few solutions to the NFF problems are also suggested, which can reduce substantially the NFF rate by approximately 50%.

Diane J Cook et al., presented the MavHome smart home architecture, which allows a home to act as an intelligent agent [6]. As part of the MavHome architecture, several prediction algorithms are introduced that play critical roles in an adaptive and automated environment such as MavHome.

B Abinaya et al., implemented Smart Street Lights that operates according to the outer weather conditions [7]. The system is mainly designed to ensure safety and to prevent energy wastage. This system cuts down the cost of conventional system by 50−60% which improves the economy of the country and saves a huge amount of investment as it can be utilized in useful ideas.

Tanaya Tavade et al., proposed a data logger system which will act like a fault diagnostic system for mechanical engine and log the data on the web server for remote access [8]. This is implemented using the Controlled Area Network (CAN) protocol for communication and Raspberry Pi which is a card size computer which acts like an Internet of things (IOT) device. The development and design of data logger system depends on the application on which it will work. The fault diagnostics system is done in two methods online and offline detection (Fig. 1).

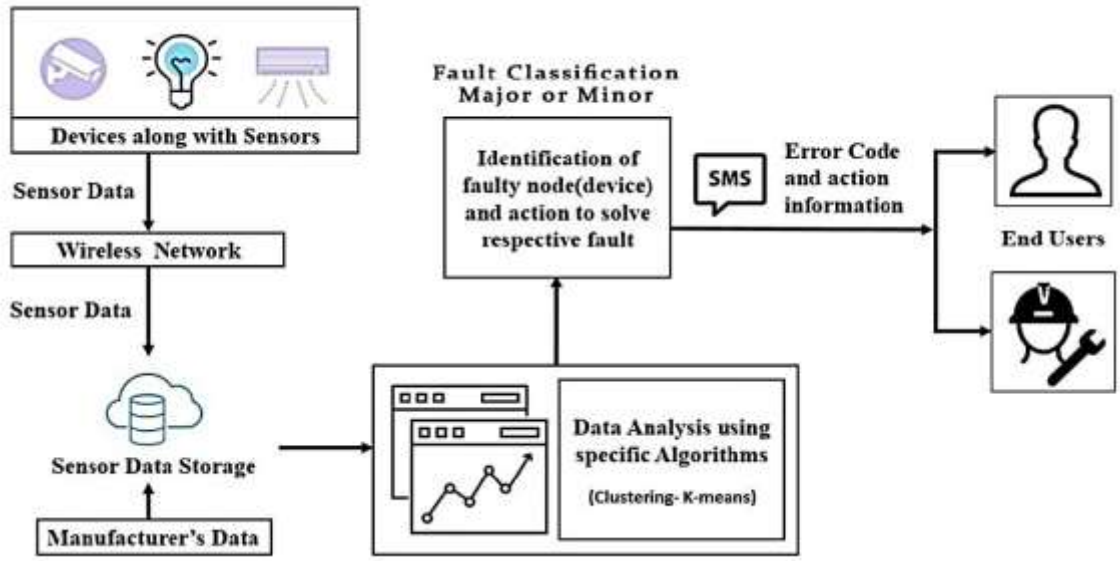

Figure 1: *Proposed system for fault identification.*

Jiwon Choi et al., presented an automatic method to detect and identify faulty IoT devices with context extraction. The presented system works in 2 phases [9]. In first phase, i.e., pre-computation phase, the system calculates the sensor correlation and the transition probability between sensor working states known as context. During second phase, i.e., real-time phase, the system finds a violation of sensor correlation and transition to detect and identify the faults in devices.

Chen Wang et al., proposed a solution by making use of IoT enabling technologies offered by SAP [10, 11]. This system first discovers the causal relationship of the physical devices by analyzing the device sensor data without the knowing the physical manufacturing process of the system. The health of devices is measured according to its previous working states.

METHODOLOGY

An Execution of Proposed System

The proposed system which identifies the faults in functional working of such devices which are used in homes as well as corporate office infrastructures. In this system, real time working of each device is monitored using sensors. Then collected sensor data is analyzed to get the fault information and then notify end users and service agents about the problems or factors which are affecting the working of devices.

Phase 1 (Real Time Sensor Data Collection)

In this phase, the system requires to collect the sensor data. This sensor data is useful to know the current status of the devices. The sensor data from different devices is continuously sent towards the cloud storage where this data is stored for further processing. The transfer of data is done with the help of wireless communication. The manufacturer's data is information about the parameters of particular devices. This manufacturer's data also stored at cloud storage. In proposed system, we are using a Raspberry PI board with GSM

Module (SIM 300). Also, the sensors such as temperature sensors, electrical power sensors, light intensity sensors also used.

Phase 2 (Data Pre-processing)

Data pre-processing of collected data is done in this phase. This pre-processing of

sensor data and manufacturer's data has to be done to get the correct parameter values of devices. This process is to remove the unnecessary data and make the dataset which is important for identification of faults in devices.

Phase 3 (Data Analysis using Clustering Technique)

Data analysis is a process for discovering useful information, informing conclusions, and supporting decision-making. The analysis of collected data is done by using clustering techniques. Mainly, we use K-means clustering technique because it is computationally faster for large amount of data. Also, it gives more accurate differences between data.

The analysis of collected data is to be done to get the detailed information about the sudden or improper changes in the data values provided by the sensors. This change in values of sensor data indicates some fault in the device. But to ensure the correct information about the fault, different algorithms are used. When the analysis is done then we get fault identity and decision or action needed to solve the problem of device. We are using a GUI to visualize the results and continuous analysis of devices.

Phase 4 (Fault Reporting and Action Selection)

Reporting of fault and decision selection is final phase in this system. Required action selection is done from results of analysis. The information about the required action is sent to end users in the form of text message. The message also having the fault information shown as error code. This type of fault is sometimes major or minor. The error code is generated according to fault and its impact on device. The text message is sent to the end users via a SMS interface.

EXPECTED RESULT

The objective of this paper is to identify faults that affects the proper working of IoT devices and diagnose faults with the help of sensor data analysis. This analysis uses machine learning algorithms for identifying faults. Afterwards the information about required actions that has to be taken to solve the problem are sent via SMS to end users.

CONCLUSION

In the proposed system, the focus is on to improve the efficiency and reduce regular maintenance needs of the devices. We are intended to observe devices which are most commonly used in domestic and corporate environments, such as Air conditioners, CCTV Cameras and Smart lighting systems, etc. This proposed systems major task is to identify the faults in the device with the help of sensor data analysis. The sensors attached with devices. Sensors get the real time parameters of the devices and send them to cloud storage, where this sensor data is to be stored. By using cloud storage it makes reliable to develop an application which is accessed from remote locations and used for analyzing of actual devices in real time. This application shows real time analysis and also alerts end users whenever requires. After analysis of sensor data is done, to identify faults and an action to recover device to proper working state is to send to the end users by using a message interface which is executed from application.

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