Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Fault Detection using Real Time Tracking of Electronic Appliances in Homes & Corporate Offices using Change Detection Algorithm

To cite this article: V R Nampelli and Dr Pratibha Yalagi 2021 *J. Phys.: Conf. Ser.* **1854** 012023

Fault Detection using Real Time Tracking of Electronic Appliances in Homes & Corporate Offices using Change Detection Algorithm

V R Nampelli[1] and Dr Pratibha Yalagi[2]

[1]PG Student, Department of Computer Science and Engineering, Walchand Institute of Technology, P.A.H. Solapur University, Solapur, Maharashtra, India

[2]Professor, Department of Computer Science and Engineering, Walchand Institute of Technology, P.A.H. Solapur University, Solapur, Maharashtra, India

[1]vi.nampalli@gmail.com, [2]pratibhayalagi@gmail.com

Abstract: In recent years, there is a remarkable rise in the use of electronic appliances in many homes and corporate offices. Such appliances include Air Conditioners, Smart Lights, Refrigerators, and CCTV Cameras, etc. To keep such appliances in a proper working condition, functional working of appliances needs to be checked. Changing the place of appliance, improper settings, cleaning of rooms, etc. lead appliances to failure. In proposed system sensors are used to track the functional working of appliances in real time or when there is a need arises to check working of the appliances before and after the maintenance is done. This sensor data is collected in database server. At database server, preprocessing of data is done to get accurate results. Then preprocessed sensor data are compared with the manufacturer's data (sensor data when the appliance is in ideal working conditions). For comparison of sensor data with the manufacturer's data, a Change Detection algorithm is used in the proposed system. The results of the Change Detection algorithm are shown in the form of graphs on the user interface at the server. This is accessed and analyzed using a mobile application in smartphones and a web browser in a desktop PC with, authorized login credentials provided to owners and technicians of appliances. This helps technician or the owner of appliance to identify the basic cause of appliance failure and do necessary repair whenever needed.

1. Introduction

Electronic devices fails due to lack of maintenance on time, poor quality materials used in production, or due to some external reasons. When a problem occurs in device working, a device technician follows his diagnosis routine for identifying the problems which caused failure of 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.

1.1 Objective

There are several common reasons devices can break down, and understanding why your devices may be failing is your first line of defence against the serious consequences of unplanned downtime. Most equipment requires regular maintenance for optimal performance. Tracking devices can help to keep maintenance schedules on track and devices operating at maximum operational efficiency. Preventive maintenance results in up to a 30% reduction in energy and maintenance costs and reductions in downtime by up to 75%. And also reduces the time required to identify the cause of device failures.

For this reason preventive maintenance is necessary and we are intended to achieve this using proposed system.

2. Literature Review

Reviews of the previous studies are considered important to understand the problem. In this regard, some of the relevant studies have been reviewed in the present study.

1 J C Seabra, M A Costa Jr., and M M Lucena [1] proposed an intelligent, low cost system, which monitors the behaviour of electrical magnitudes of domestic appliances in real time. The system is ready to analyse the collected data, detect possible faults, and report this issue to the user. An IoT device, designed to be adapted to unspecified generation consumer device, is a component of the proposed system. The entire system is ready to detect instant faults, as well as, predict the necessity for preventive maintenance. The computer programme makes use of digital TV, mobile devices, or conventional computers to warn householders about necessary interventions. Fault detection and diagnosis systems available in real-time and on-line add simple management to domestic appliances. Fault detection is finished through information registration, recognition, and indication of anomalies within the systems behaviour.

2. Pravesh Kumar Tejan, Shilpi Kain [2] intends to detail a way to make the sensor system, low maintenance and self-healing. All the civilized communities across the universe are spending lots on the upkeep since it affects the physical, mental and spiritual wellbeing. This maintenance will be divided into two phases. First phase is observing and reporting. The higher the observation and reporting, the higher and faster are the probabilities of a top quality resolution of the problems. It’s noted by psychologists that human mind find it difficult to require effort and record community issues. Also studies has proved that machine or devices behave far 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.

3. J Lee, M Debnath, A Patki, M Hasan [3] proposed a self-diagnosis technique for faulty node identification in large-scale IoT systems. The technique relies on lightweight processor-level architectural support to attenuate the performance overhead. It’s demonstrated by experiments that the proposed methodology can detect 92.66% of failures, irrespective of when the external program is connected. A faulty device identification technique which is predicated on very lightweight processor-level architectural support. A hardware-based monitoring agent is incorporated within a processor, and connected to a separate monitor program when an examination is required. By analysing information collected by the agent, the computer program determines whether the device under monitoring is functioning correctly, or not.

4. T Niemirepo, M Sihvonen, V Jordan, J Heinilä [4] proposed a way DICE, to detect and identify faulty IoT devices with context extraction. This technique works in two phases. In an exceedingly precipitation phase, the system precomputes sensor correlation and therefore the transition probability between sensor states called context. During a real-time phase, the system finds a violation of sensor correlation and transition to detect and identify the faults. In detection, analysis of the sensor is finished data to seek out any missing or newly reacting IoT devices that are deviating from already grouped correlated sensors, and state transition to search out the presence of an abnormal sequence. DICE identified faulty devices successfully with a mean of 94.9% precision and 92.5% recall. Our system took an average 3 minutes to detect faults and average 28 minutes to spot faulty devices.

5. G Shi, G Yuan, X Chen, Z Xie, C Chen [5] carried out various sorts 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, like thermal stress, humidity stress, electrical stress. Within the continuous development of reliability engineering technologies, the no fault found (NFF) phenomenon remains an enormous obstacle that troubles various manufacturers. Especially within the home appliance industry, NFF accounts for about 30–70% of the returned faulty products. With in-depth analysis on the failure modes and mechanisms, some solutions to the NFF problems are suggested, which reduce substantially the NFF rate by approximately 50%.

3. Data Collection

Data collection is an important task to find out solutions for any given problems. We can get solutions to relevant problems in the data collection process and determine results.

3.1 *Manufacturer's Data*

To perform the analysis of given sensor data, we have collected the device manufacturer's data from current device used for the proposed system. This data includes ideal working condition information of a device used in the proposed system.

3.2 Temperature Sensor Data

Device's temperature data is important part of the proposed system. In the proposed system we collected device temperature information using an ADT7410 sensor with Microchip MCP9808 on a Raspberry Pi 3B+ kit. This temperature sensor information is passed to cloud database where we are analysing the collected sensor data with manufacturer's data.

4. Methodology

In the proposed system, the fault is said to be change in functioning of a particular device. We identify this change in functioning using the proposed change detection algorithm. According to results from the change detection algorithm we are notifying end users about the status of device.
The proposed system works in 3 phases as given below.

4.1 Data Collection

In the proposed system, Real time sensor data is transferred to cloud storage using a wireless network. The cloud storage is also having the manufacturer's data which shows the ideal working conditions i.e. temperature information of a particular device used in proposed system.

4.2 Change Detection Algorithm

We present an efficient change detection algorithm to identify change in device temperature. We monitoring device temperature for particular time durations to find out whether if there is any problem with the actual temperature of device. Here we check the difference between the previous temperature and current temperature values. According to this difference values we classify these values into a particular status of device. If the difference is minimum then we mark it as minor or regular change, if this difference is large then we monitor it again for particular duration before reporting it to the end users. If the difference is still increasing and temperature values are not matching with the temperature given in the manufacturer's data then we report the status of device to the end user. If the temperature is constant for particular of time duration we say device status as normal.

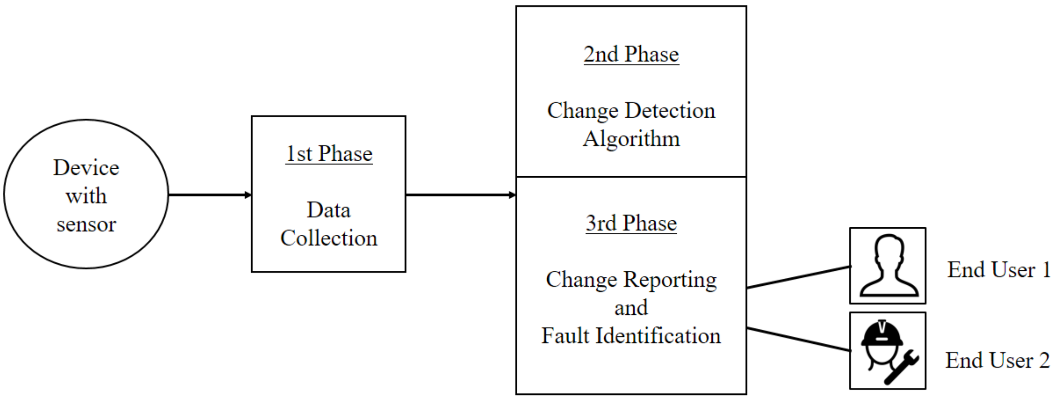

Fig 1: Proposed System Basic Structure

4.3 Change Reporting and Fault identification

From the results of change detection algorithm, the user interface module from server sends a notification to end user. This notification contains the current status of device and difference values. End user is able to check this temperature information and device status using a portal given to them which is accessed using authorized login. According to this temperature information end user can identify the cause of improper working of device.

5. Results and Discussion

5.1 Data Collection

We tested the proposed system with the local manufacturer's refrigerator and its temperature information required for ideal working. Plastic box cased Raspberry Pi kit with an ADT7410 sensor with Microchip MCP9808 with a battery attached and a Wi-Fi connectivity to kit put inside a vegetable storage area of refrigerator. All sensors naturally support operating near 0C, usually their range is between -20C and +70C without any concern. Raspberry Pi 3B+ kit uses CYW43455 for Wi-Fi and Bluetooth and it can operate from -30C to +85C and its optimal performance is between -20C and +75C. Here we used refrigerator temperature information for reference as given in following Table 1.

Table 1. Domestic refrigerator storage temperatures

Compartment	Fresh food storage compartment	Chill compartment	Cellar compartment
Definition	Compartment intended for the storage of unfrozen food at the temperature specified	Compartment intended specifically for the storage of highly perishable foodstuff in which the above-specified storage temperature can be maintained	Compartment intended for storage of particular foods and beverages at a temperature warmer than that of the fresh food compartment
Temperature range	0 to 8 °C (mean ≤ 4 °C)	−2 to +3 °C	+8 to +14 °C

With the above given manufacturer's data, real time temperature data is transferred to cloud storage for which we have used a server storage space with 30 Gb storage capacity.

5.2 Change Detection and Device Status Reporting

In proposed system, we monitored temperature data of refrigerator for a particular time duration. We have tested the system to check status of a device according to various time slots of a day and by powering off the device and again by powering on for particular time durations. In this particular time durations we recorded different temperature values which are shown as below.

Table 2. Time slot of 25 minutes

Time (Hours)	Temperature (° C)
6.55 PM	4.12
6.58 PM	4.11
7.01 PM	4.06
7.04 PM	4.01
7.09 PM	3.97
7.14 PM	3.92
7.19 PM	3.89

Table 3. Time slot of 2 Hours

Time (Hours)	Temperature (° C)
5.05 PM	3.02
5.25 PM	3.31
5.45 PM	3.19
6.05 PM	2.88
6.25 PM	2.90
6.45 PM	2.94
7.05 PM	2.92

In above 2 situations, (refer table 2 and 3), we observed that the device is working according to the manufacturer's ideal conditions (refer table 1). In this situation we showed the device status as normal.

If the device's temperature is not according to the manufacturer's details then we have observed the device for more given time duration and reported the status and difference values to the end user through a user interface situated at server side.

6. Conclusion

With the proposed system, the end user is able to identify the real time device status and do necessary actions if required by observing the temperature information history of a particular device if any problem arises in the device. End user access this device status analysis report from any remote location. If the problem– is small then he can provide the required solutions details to the owners of the device without visiting location of device. We tested the proposed system with one device only but in future we are intended to connect more devices with the system and monitored whenever needed. This will help in maintenance of devices and check multiple devices status. If we are having multiple electronic devices in corporate offices and homes then the proposed system is useful in monitoring such devices.

7. References

[1] Jorge C. Seabra, Mário A. Costa Jr., and Mateus M. Lucena, “IoT based Intelligent System for Fault Detection and Diagnosis in Domestic Appliances,” in IEEE (2016).

[2] Pravesh Kumar, Shilpi Kain, “Smart community maintenance ecosystem with self-reporting and self-diagnostic IoT sensors”.

[3] Junghee Lee, Monobrata Debnath, Amit Patki, Mostafa Hasan, Chrysostomos Nicopoulos , “Hardware-based Online Self-diagnosis for Faulty Device Identification in Large-scale IoT Systems” in IEEE (2018).

[4] Timo Niemirepo, Markus Sihvonen, Vesa Jordan, Juhani Heinilä, “Service Platform for Automated IoT Service Provisioning” in ICIMS (2015).

[5] Gaoming Shi, Guanghua Yuan, Xuanlong Chen, Zhenfeng Xie, Cheng Chen, “Case study of no fault founds in household appliances”, in ICEPT (2018).

[6] Jiwon Choi, Hayoung Jeoung, Jihun Kim, Youngjoo Ko, Wonup Jung, Hanjun Kim and Jong Kim, “Detecting and Identifying Faulty IoT Devices in Smart Home with Context Extraction”, in IEEE (2018).

[7] Aliya Shaikh, Manasi Thapar, Divya Koli, Harshali Rambade, “IOT Based Smart Electric Pole”, in ICECA (2018).

[8] Tanaya Tavade, Paresh Nasikkar, “Raspberry Pi: Data Logging IOT device”, in ICPEDC (2017).

[9] B. Abinaya, S. Gurupriya, M. Pooja, “IoT based smart and adaptive lighting in street lights”, in ICCCT (2017).

[10] Zhiwei Gao, Carlo Cecati, Steven X. Ding, “A Survey of Fault Diagnosis and Fault Tolerant Techniques Part II: Fault Diagnosis with Knowledge-Based and Hybrid/Active Approaches”, in IEEE (2015).

[11] P. Saraswathi, M. Prabha, M. Seema, “GSM Based Smart Surveillance System Using CCTV”, in IJARCSSE (2016).

[12] Chen Wang, Hoang Tam Vo, Peng Ni, “An IoT Application for Fault Diagnosis and Prediction”, in IEEE (2015)

[13] M. Sathishkumar, S.Rajini, “Smart Surveillance System Using PIR Sensor Network and GSM”, in IJARCET (2015).