Home Automation Using Complex Event Processing

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Abstract- Complex event processing (CEP) is an important technology for the real time application. CEP process the occurring information which is called as events. CEP applications are very much success, which has been applied in different field like finance, manufacturing. It provide us a real time system so we can change our business logic in real time. As we are taking decision in real time so this is required that we test our system properly so no issues could be found further. Testing is very much required for any type of system. We as a human being can't fully rally on the developed system. A smart Home is an integration of home system which has smart technologies installed, It allows us to control electronic devices install in the home through a single input, through a single command, or through a single click. This Smart Home development uses different kinds of sensors. It makes use of data collected and provided by various sources which is further analyzed to take the desired action. The management of this large amount of data is a herculean challenge for Smart Homes or rather we can say this is a complex task. This paper uses the Event Processing Language to formulate the queries and uses the ESPER engine to detect complex event out of the incoming stream of events.

Keywords- Complex Event Processing, Home System, Smart Home, Complex Task

1. Introduction

Complex Event processing is a technology which can process the data and provide response in real time. It is basically processing of real time data (streaming data) to detect relevant information from the data received from many sources. CEP engine extract event pattern on continuous incoming streams of data and gives immediate response that is required. CEP is a technology in which real time data is analyzed, processed and decision is taken on previous (past) data and it also predict what will be the future event. Smart home is an integration of home system with advance technology installed in it. It allows us to control the many electronic devices installed at home through a single input, through a single command, or through a single click. This Smart Home development uses different kinds of sensors. It makes use of data collected and provided by various sources which is further analyzed to take the desired action. The management of this large amount of data is a herculean challenge for Smart Homes or rather we can say this is a COMPLEX TASK. Therefore, to handle this Complex task, a technology that can efficiently process the data and give timely response is required named as CEP – Complex Event Processing. It can manage events flexibly and efficiently.

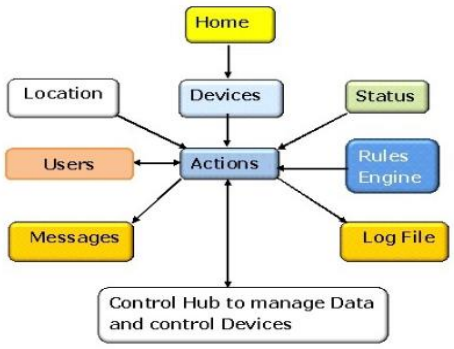

Fig 1. Conceptual Smart Home Model

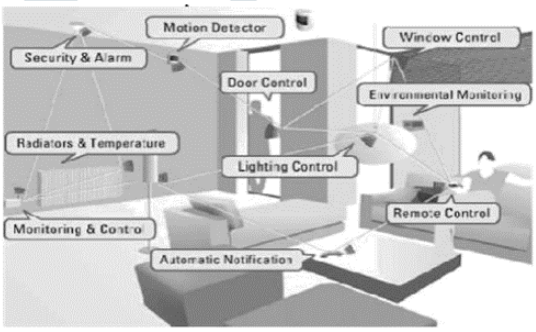

Fig 2. Smart Home Technology Automation

Above fig depicts that how a home can be made to behave in smart way. The various home appliances (which can be connected over the network) like air conditioning and heating control, the remote control, the security and alarm system, motion detector and the usage of digital contents to provide convenient services to the users. With the use of these devices, smart home system alerts the user whenever an unexpected event occurs from the detected data.

1.1 Applications of CEP

1. Fraud detection in credit card transaction
2. Algorithmic stock trading
3. Smart home
4. Real time profit and loss analysis

2. Background

CEP approach is proposed for monitoring and controlling a smart home. The continuous stream of events from the environment is collected by various sensors or devices, deployed in a home which are then analyzed so that appropriate actions can be taken. Uncertainty handling is required to enhance the processing of numerous events and queries. Proper rule sets are defined to detect relevant and meaningful patterns on incoming stream of data. By using CEP approach, every task can be atomized in order to provide a good response in a Smart Home system. A case study of resident access control of Access Control Service is done in [15] to verify proposed CEP-based architecture. When an access event happens, an event processing engine can be used to identify the

access type by differentiating the resident's RFID Reader ID. All scenarios required for the management about the resident's access are stored as queries, so that all access event streams of the residence can be processed in real time and the outcome of the processing can be sent to the control centre for appropriate actions. Safety in homes can be ensured by object tracking and intrusion detection in a wireless sensor network environment as proposed in [14]. It proposes the detection of an intruder by using semantic query processing. ESPER, an open source CEP engine was used to formulate queries and implement the system of intruder detection. Information from PIR sensor, RFID reader and camera were also used to address the security issues. The result from this application is used for assessment of situation awareness, threats and response generation. Temperature and humidity need to be controlled if one builds a smart home. This can be done by integrating CEP with the RFID and WSN systems as highlighted in [2]. CEP constantly monitors and streams the large amount of data transmitted by the RFID. An event queue is used to process the events received from the sensors sequentially, thus improving system response. A good food storage system can also be designed using this technology. Different types of food require different temperature for their proper storage. To make sure that the food is properly stored, the system can identify the type of food by using RFID, and the temperature around the food can be sensed by the wireless sensor, upon receiving these data from the sensors, and accordingly the temperature around the food can be controlled.

For patients and aged people, sanitation and medical safety is a primary concern, which can be easily and effectively taken care of using the CEP technology. As proposed in [1], sensors are attached to the patient's body which keeps track of the patient's environment and his location and also keeps count of values like the body temperature, blood pressure, heart rate, pulse rate, etc. and sends these data to the CEP engine at specified intervals. If it finds anything wrong at any point of time, then it sends an alert to the nearby hospital, personal doctors, close relatives, using the GPS, the data of which is stored in the database. Many a times, there is a necessity to add new rules to the CEP engine to represent some new threat etc. This can be done by using the Threshold learning algorithm which dynamically updates new rules using push based approach and hot code deployment. The system doesn't need to be stopped to do so which ensures that the system is always up and running. In the paper [6], the proposed method to reduce the threats of infection to a great extent is to attach sensors to the body of the HCWs so as to continuously track them and ensure that they comply with hygiene rules (for example, to check whether the workers clean their hands prior to entering a room where a patient is kept), and also remind them at suitable moments to take hygiene precautions, thus preventing spread of infections. Making use of the active CEP, any violation of rules and regulations is notified through an alarm. Few other domains where CEP is used are that of Real time detection of road traffic events. The idea suggested in [5] is to combine CEP with Its which can in real-time carry out detection of road traffic events thus ensuring road safety and also often reducing travel time. CEP allows adding new event detection techniques or to modify existing techniques in an easy and flexible way. Sensors such as VDS, TCS, CC and the APID algorithm and the EPL are used by ITS. Human Mobility Extraction based on Social Media is another application of CEP where mobile devices like smart phones have inbuilt sensors. This has been highlighted in the paper [9]. It helps in Personal mobility mining (i.e. timely extract personal mobility). As proposed in the paper the system consists of two different sides mobile and server one. The mobile side runs on the Smartphone, whereas the server side runs on a back-end machine and collects the information generated by the target Smartphone for further processing. The mobile client side consists of four different EPRs namely Tweet Adaptor EPR, Tweet Enricher EPR, Region Extractor EPR, and Route Composer EPRs that makes the personal route mining. In day to day life, network is risked by many threats. Some of the most dangerous ones include worms, virus and Trojan horses, etc. Hence there is an utmost need of a proper network security since some smart attackers and hackers can be successful at times to break the network security.

Network security is meant to protect the network from such people and make the network safe, reliable and usable. In the paper [4], CEP is suggested as an excellent system in order to detect anything wrong and malicious in the network, and also handle the anomalies timely. To analyses such threats with care and intelligently, these situations are handled using ESPER which acts here as a highly intelligent engine which derives intelligent data from raw input data which is then structured using Data Reader, Data Parser, Log evaluator. Massive amount of log data is to be processed by CEP engine. ESPER engine is used to extract useful data by pre-processing the large input.

The paper [3] proposes an unconventional approach of ensuring cyber security, using CEP. It proposes considering every information request and access as an event, and the use of complex event processing to check for any mischievous activity, thereby ensuring the security of the system. The use of digital signing to prevent unauthorized access of information by the attackers is proposed. As part of ensuring security, it is also proposed that, each user must automatically provide the digital signature after certain fixed intervals, to avoid any unauthenticated use of the network. The fact that CEP doesn't know what information is being shared, and is only interested in the events, makes it more secure and reliable.

3. Plan of Work

3.1 Technology and software requirement

For "Home Automation using CEP", we made use of certain software's.

- Net-beans IDE
- ESPER Libraries for JAVA [7]
- Linux/Windows Environment

The ESPER plugin is used along with Java to handle the event streams and detect patterns to form complex events and handle the complex events. The development has been done on Net-beans IDE, using Java as the programming language. The project also uses Swing library of Java for GUI. The J-Free Chart library is used to generate graph simultaneously as the temperature is received by the CEP engine.

4. Result and Discussion

Upon the completion of the project, we aim to develop software, which can provide home automation, and thus provide safety, security, comfort and convenience to the residents. We aim to develop a home automation system, which can monitor and control most of the events that happen inside and in the environment of the house, and can generate alerts to the residents, and all concerned persons, whenever necessary, thus ensuring the safety and security of the house. The fully developed system is expected to gather information about the events that are happening continuously, identify patterns among them, which may even go unnoticed to anyone living in the house. The home automation

system is also expected to do a lot of work for the residents, for example, the garage door control system, as described above, frees the owner from the job of opening and closing the garage doors and does it automatically. Similarly, the smart home system can free the owner from a lot of other such works, and thus make life simpler. The home automation system should run continuously without any interruptions, as it may miss some important events if it doesn't run properly, making it rather unreliable. Tables should be well designed so that we can derive conclusions by properly taking joins, and related database schema. After implementing the home automation system it was necessary for me to test our system properly so we can say that our system is perfectly working. For that I have done JUNIT testing for our developed system. Following are the screenshots of our result.

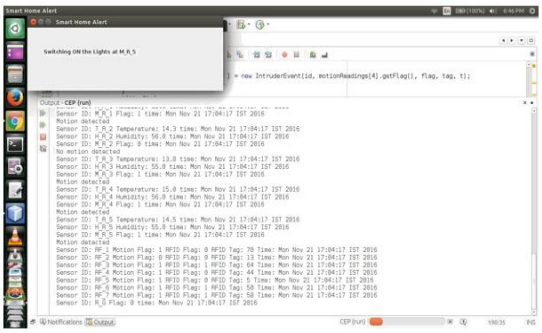

Fig 3. Switching ON the Lights at M-R-5 (Motion Sensor at Room 5)

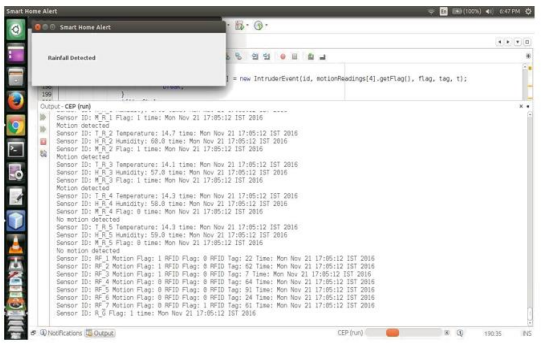

Fig 4. Rainfall Detected

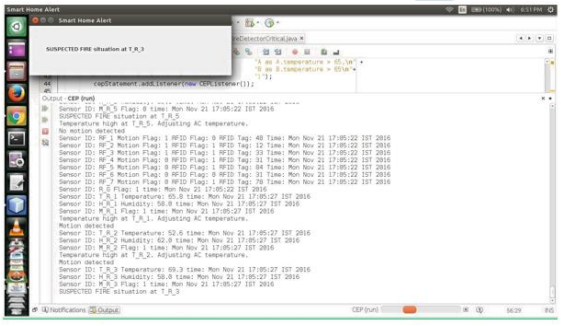

Fig 5. SUSPECTED FIRE situation at T-R-3 (Temperature Sensor at Room 3)

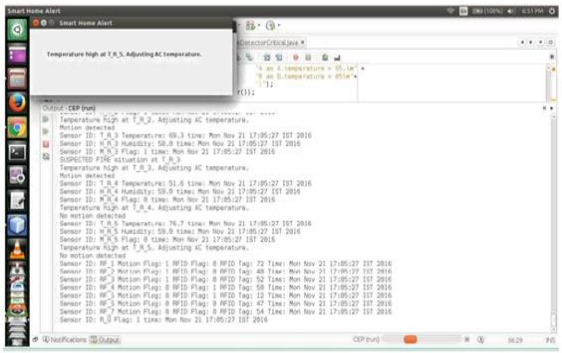

Fig 6. Temperature high at T-R-5 (Temperature at Room 5). Adjusting AC temperature.

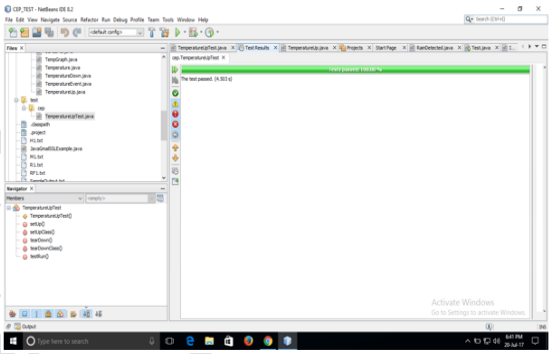

Fig 7. JUNIT Testing: Test cases successfully pass.

5. Conclusion And Future Work

This paper, if properly extended can be used to give rise to Smart Colonies/Apartments. For this purpose, the individual Smart Homes can share some data among each other, so that in case of any dangerous situation for example – fire, intrusion, etc. , the neighbors can be reported timely to take necessary actions. This is of utmost importance in case the inmates of the house are not aware or are not present in the house. This way security level of the apartments or some areas prone to crime can be increased to a whole new level. This project can also be extended to create Smart Office, where the data set to be handled is more complex. Home Automation Technology can be implemented in many other fields as well, and with advent of even more advanced technology, can turn out to be Bliss In Disguise. We can also perform different other testing technique to make our system more robust.

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