Study of Smart Home Automation in Customized Way by using Context and Rule-Based Services

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ABSTRACT
People get the easier life, security, alertness with help of smart home which is based on Internet-of-Thing . Using real time monitoring of home one can access electric devices, switches, and other connected devices with or without help of smart mobile devices. Different sensors deployed at home monitor and read sensed information. Embedded sensing technique and user's historical data in the home have to be used for rule based service customization. In order to handle incoming context form sensors and to give appropriate response accordingly, Fuzzy Inference System(FIS) can be used in decision making purpose for customization of services.

Keywords
Smart home, Internet-of-things, Context, Context awareness, rule-based services, decision making, fuzzy Inference System

1. INTRODUCTION
Internet of Things is emerging part of future internet in which communication occur within human to human(H-H), Human to machine, machine to machine , and machine to human. IoT is growing rapidly to all the domains such as home, city, industry etc. Along with growth of smart phone ,huge number of embedded devices, sensors, and actuators are deployed to provide the services for automation of system. In this era, to provide human comfort and luxurious life, the home automation is required. For home customization, security ,privacy, data leak threat attack should be taken in account.

To establish the service infrastructure that provide security feature. This is necessary to define the exact security feature for each component that make up service infrastructure.

Now a days it is possible to access home devices remotely so that they can be handled and configured by themselves in real time or with the help of data which produced by sensors deployed at home. According to the surrounding environment and users historical data and using dynamic context information the decision have to be taken for the corresponding output generation.

Different of sensory data is generated from multiple sensors by monitoring the system. According to incoming context the rules are set to each devices at each time to make decision is really challenging. To make a decision different machine learning algorithms are present. One of the key issue for smart home service system is how to process real-time data from IoT layer rapidly and supply intuitive service with precision and intelligence. Home automation using context aware system based on rules which using XML language to mapping element and services [16].Proposed system use various services and devices rapidly to realize the association of devices and services. This paper proposes a home automation based on rule based which identify event through real-time sensing and processing and supply services using fuzzy inference system which is very feasible and less time consuming model. The remaining paper can be sorted as: section 2 gives brief study on the techniques that have been previously used in same field like rule based services and home automation. In section 3 contribution of system we are proposing and finally in section 4 reviewed conclusion.

2. RELATED WORK
Context aware service can be considered as when you come home door get automatically open after that according to temperature the fan get started your favorite TV channel get on automatically. Context is a core element in IOT by which machine to machine communication is done easily. There are different type of context such as primary context and secondary context. Primary context are generated from the sensory data and secondary context are derived from the primary context. Different types of context can be taken in to account while developing your customized home such as user related context, physical ,environmental (temperature, humidity),location ,Network. Historical context also plays important role which can be used to analyse current and future coming context related to the user .Context aware system use context to provide relative information which depends upon the user related task. Table1 shows which type of context are used for Automation of system.

All these context generated is processed and converted into reliable format and stored. This stored information can be used for identify and match the incoming context. These context are consider as event .Event can be atomic event or complex event. To handle these events rule library ,event subscription library are present. This event matching method is used In[2] approach is used to represent events by expressive and semantic modeling language. Contents are represented using ontology model which are gathered from software and hardware resources .In[1] propose the fire alert system in which pattern matching events are queued and judgment is done that whether support real time sensing .This system handles more complex events and gives more accurate intelligence. According to user aspects and requirement the corresponding out put much be generated for which rules are assigned for handling home appliances. These rules are generated from the stored event which is historical data related to user. There are many rule based system proposed previously which are using the rule based services as follows:

In [3] the prototype smart home infrastructure is developed based on rule-based services, which employs a semantic distance based rule matching method .Context aware services

Table 1: Number of context are used for Automation of system

Types of Context	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
User	-	√	√	-	-	√	-	-	-	-	-	√	√
Physical	√	-	√	√	-	-	-	-	-	-	-	√	√
Sensed	-	-	-	-	-	√	-	-	-	-	√	-	-
Location	-	-		-	-	-	-	-	-	-	-	-	-
Identity	-	-	-	-	-	-	-	-	-	√	-	-	-
Temperature	-	-	-	-	-	-	-	-	-	-	-	-	-
Network	-	-	√	-	-	-	-	-	-	-	-	-	-
Historical	-	-	√	-	-	-	√	-	√	-	√	-	-
Time	-	-	√	-	-	-	-	-	-	-	-	-	-

√ is used to show that that type of context is used in that reference paper.

\- is used to show that absence of that type of context in the reference system

and rough set theory method is used for rule generation. Rule-Based Engine is used to grasp the context in [4] which is very effective and also improve organization business performan

Table 2: pros and limitation of different decision making techniques

Sr. No.	Algorithm	Pros	Limitation
[5]	SCADA system, MPL-ANN,IED	*Quick recovery from fault	*Continuous learning is not present *No support for real time environment
[6]	KNN, Bayes classifier	Average time is required to recognize daily activity	Not stronger for complex context Cant access system remotely
[7]	ANN, K-means clustering	Improve the feasibility of the system in terms of decision making	Can not handle system manually Less secure
[8]	SVM, Decision Tree	handle intrusion detect	Multiple class reorganization problem
[9]	KNN	Overlapped context handling	*Training data set is required *Handling context is challenging

Multiple context are coming at a time, due to which the applied rules for the appliances get over lapped at that time. To generate required output is difficult. To overcome these difficulty, there are different decision making algorithms are present to produce required output. Decision making is one of the important parts of the rule based system due to which the corresponding respond gets generated and handle the incoming event. Different types of machine learning algorithms are present for categories the coming context. Artificial Neural Network is used to design the smart home [5].Incoming context are generated by users and sensor data are feed forwarded to network and processor choose output from network which has more confidence and response is given . This system reduces power consumption and also support to the authentication of user.K-nearest neighbor and bayes classifier is used to recognize activities of daily life confidence value is fused and decisions are made using max rule is proposed in[6].To control the home devices ,adaptive neural fuzzy inference system is used to make a decision and for gathering a data is handled using k-means clustering algorithm are proposed in[7].This system improves learning ability of home .In the ANFIS system If-then logic is used to make a decision tree for solving milt-class problem[8]Decision tree model in this system consist of series of class of SVM. This system is used to detect the intrusion.KNN is used in[9] to handle the overlapped heterogeneous context.

After this decision making according to the generated result the corresponding devices change there status. In many previous home automation system ,results are notified to the users via massaging or by sending the emails. Due to which one can handle there home remotely so to handle home remotely notification system can be used. From the incoming context decisions are made and result is notified to the user and user can take action if he is not present in home. In [16]Machine learning algorithms are used to adequately manage incoming notification. User can handle generated notification. In the real situation uncertain events can occur

such as intruder attack, gas leaking, fire etc at that for security the notification is send to the particular user is proposed in[14] so this notifications can be used to alert the user in this way device to user and user to device communication can be take place. This investigation provides the context aware system and rule based services use for home customization.

3. PROPOSED WORK

Smart home is one of the real time application, in which sensors are deployed. To handle these sensors data microcontroller can be used for this real time application. In early days there are some microcontrollers was present such as pick and arm but they require the assembly language for the development of system and it is time consuming. In these days new microcontroller is come which is raspberry pi which is much easy to use to. It gives interfaces to connect different sensors to it as well different Raspberry pi-drives are present for the interfaces. Different types of sensors are present to catch the user activity but many of them gives the data in analog form. This form is converted into digital value by using ADC. And finally the output of that is given to raspberry pi.

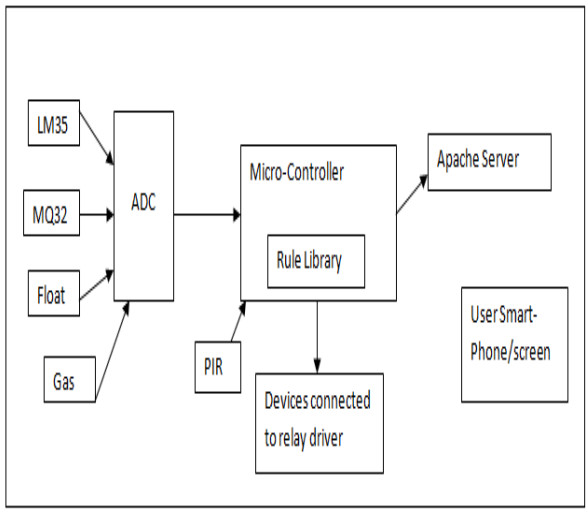

Fig 1: System Architecture

This system analyze the user behavior for the one week and at that time the all the sensor data which is generated is stored in the database same on microcontroller. With the help of this data the rules are generated using fuzzy Inference system. According to users preference and collected data the rules are set using fuzzification model. For example if temperature sensed by the sensor is up to 30 C then we set the rule as temperature is medium and also save the timing at that temperature.

After the collection of data from the sensors the rules are developed by aggregating the different context according to the time and that are also stored in rule library on raspberry pi. After this step the decisions are made automatically for the coming context using the rules set which is called as defuzzification. Out put generated from defuzzification produce the action to handle the devices .The status of all the sensors and the interfaces to handle the actions also be displayed on web pages. If there is any changes to the user behavior or environment user can update the rule as well as delete the rule.

Let $C_i \varepsilon$ C where C is set of context. In this system the context used is time, user identity ,location ,temperature, motion, gas etc .which is collected from sensor deployed in the home . In this system user is login from his mobile application, and according to the time T_i duration ,for each incoming context C the set rules are applied and if it is matched the corresponding action is takes place and which is displayed on the application of user.

So input to the fuzzification is incoming context from the sensor, this context are forwarded to the fuzzy inference system. Fuzzy inference system consist of rule library where rules are stored which are generated from user. Rules are applied in the deffuzification phase and output is action means status of the device is changed according to the rule, which are notified to the user. Rules are generated using if then else logic which require less amount of time than other process developed previously.

Use case diagram for this system is as shown in figure 2,There are different processes showed. User can register to the system i.e. authentication has given to login to the system and after that, he can set and update the rules. On the other hand, the raspberry pi performs to get data from sensor, applies rules as well as gives feedback.

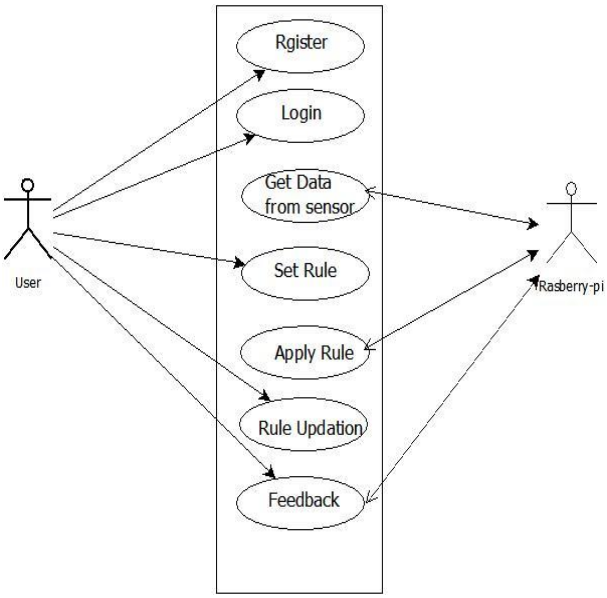

Fig 2: Use case Diagram

4. CONCLUSION

Internet of Things has many applications in different areas. loT has been already designed for industrial WSN. It has been developed for Smart Homes System. As proposed in proposed work using sensor data and users actions rules are generated using fuzzification and corresponding output means action is replied using difazzification model. Proposed system is feasible the new rules as well as updating of existing rules. With the help of FIS system, the rule generated in particular time are required less time as compare to other system .In this way home customization is made according to user behavior and status of all the electric devices and emergency situations occur in home are notified to the user. Future work will be focused on sensing technique, decision support and in central the rule generation for customization of system.

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6. REFERENCES

[1] Quanlong Li, Yan Jin, Thing He, Hanchuan Xu, "Smart Home Service Based on Event Matching.",*10th International conference on fuzzy system and knowledge discovery,* 2013.

[2] Fano Ramparany ,Yazid Benazzauz, Marta Bel Martin, "Agenda driven home automation –Towards High level context aware systems", *Symposia and wokshop on ubiquitous ,Autonomic* ,2009.

[3] Z.Meng and J.Lu,"A Rule-based service customization Strategy for Smart Home Context-Aware Automation",,*IEEE transaction on mobile computing.*PP-201490,2015.

[4] ShobhitShukla,K.Sornalakshmi,"Internet-of_Things:Rule Based Event Management",Paper ID:SUB153249, Vol:4,April 2015.

[5] DiogoL.E,Nina, "Hybrid Support System for Decision Making Based on MLP-ANN ,IED and SCADA for Distribution Transformers" *.15th International conference on Computer Modeling And Simulation* ,2013.

[6] Muhammad Fahim, Muhammad Hameed, Sungyoung Lee."A Multi-Strategy Bayesian Model for Sensor Fusion in Smart Environments", *5th International Conference On ICCIT,* February 2011.

[7] Wanglei, SHAD Pingfam,"Intelligent Control in Smart Home Based on Adaptive Neuro Fuzzy Inference System",2015

[8] Snehal A.Mulay,P.R.Devale,G.V.Garje."Intrusion Detection System Using Support Vector Machine and Decision Tree.",*International Journal of Computer Appliances.VOL :3,NO:3,*June 2010.

[9] Labiba Gillani Ehad ,Syed Fahad Jahir,"Feature Selection and Data Balancing for activity recognition in Smart Homes",*IEEE ICC 2015,SAC-Communication for E-Health,*2015.

[10] Yo-Ping Huang and Po-Nan Cheng,"Using Fuzzy Inference Method to Automatically Detect and Identify Intruders from the Security System",*IEEE international Conference onNetworking ,sensing and control,*2004.

[11] SlavicaJonic,DejanPopjan ,"Three Machine Learning Techniques for Automatic Determination of Rule to Control Locomotion." *IEEE transaction on Bio-medical Engineering.VOL:46,No:3,*March 1999.

[12] Vijay Sivaramany, Hassan HabibiGharakheiliy, ArunVishwanath_, RoksanaBoreli, Olivier Mehani "Network Level Security and Privacy Control for Smart Home IoT Devices.",*2015 eighth international Workshop on selected Topics in Mobileand wireless Computing,*2015.

[13] Gerfried Cebrat,"Secure Web Based Home Automation" , *2nd International Conference on Information and Communication Technology,*2014.

[14] Biyi Xiaot, Leiting Chent, Ming Liut, VueCaot, Yong Yang,, "Design and Implementation of Rulebased Uncertainty Reasing in Smart Home,"*Proceedings of lCCT,*20 I5.

[15] Charith Perera,Chi Hardoldli u,"The Emerging Internet of Things Market Place From an Industrial Prespective :A Survye".

[16] Falvio Corno ,Luigi De Russis,,"A context and user aware smart home Notification system ",2015.