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Context and Fuzzy Inference System for Home Customization

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Abstract: ***Embedded System is often used to handle the real time system. Embedded system handles different hardware. Now a days, Micro-controllers based embedded system are common in use. Embedded system technology can use to develop the Smart home which is sub domain of Internet of Things (IoT). Smart home is necessity of today's fast life style. To handle the home in smarter way there are different sensors and actuators are deployed in home which are used to learn the home, surrounding environment as well as human behavior. Many systems are developed previously but fails to handle multiple incoming context and in making the decision. In this paper, proposed system uses Fuzzy Inference System (FIS) for decision making which improves the performance of the system. Prototype system is developed using smart phone, low cost sensors as well as electronic devices. Raspberry –pi 3 plays important role in this system. FIS system is overall used to handle incoming context from sensor as well as for the decision making which gives the accurate response to particular devices which are connected to this system. In this way this system helps to customize the home.***

Keywords: Embedded system, FIS, Internet of things, Sensors, Smart home, Raspberry pi

1. Introduction

The meaning of embedded is connection of two different thing and embedded system in which the software is embedded into the hardware. Embedded system having advantage like they consume low power, improve the performance of the system as well as they are customizable easily. By Looking to these advantages, one can use this embedded system to develop the smart home.

Internet of thing growing tremendously. Billions of object are now connected to each other and communicate via network. Atomization of industry, city, agriculture, hospital is going on. Smart vehicle, smart home are the small domain of the IoT which provides the usefulness, alertness to human being and people can live there life more comfortably.

Human brain works faster than the computers. The reason capability of brain is powerful than that of the computers. Computer only know the binary system. To develop the smart home, many systems are developed previously using different technique. To develop smart home is same like developing one brain control system where response should be more faster. Fuzzy logic is same as human brain which as approximate rather than exact means true and false. For human interaction analysis , different sensor are deployed on in home which are low in cost. They are used to take context of surrounding ,user , user historical data all are useful to develop the smart home. These all are sensed by the sensor used for the further process. This system is develop to automatically close or open the door, light, fan as well as water motor . For this deferent types of sensors are available they are interfaced with the raspberry pi micro controller. [1].

In this paper, propose the system which is developed by using the fuzzy inference system for atomization of the home where rules are generated using if then else logic. The flow of the paper will be like this ,related works shows that previous system which use the different technique for atomization of home followed y the prerequisites to understand the system ,next is proposed system block diagram and fuzzy Inference system will work for smart home atomization is given and finally the brief conclusion

2. Related Work

Fuzzy controller is used to develop the system which gives the measures in the approximate format such as if we take example of temperature then in control system the values are only to such as cold and hot but in the fuzzy system the intermediate value also consider such as cold, colder, hot ,extreme hot etc.

In [2] fuzzy logic technique is used, which handles the temperature of home. Fuzzy sets are created at different membership factions. This system gives the information about how the fuzzy system works to control the temperature.

In[3] different sensors are deployed and there data is classified in and given to the FIS system to handle the data and produce the response which handles the actuator. In this for deffuzification the centroid method is used. In this system fuzzy set is on humidity and temperature. This system improves the performance as well as keep the stability of system. In [4] lighting control system is developed using fuzzy logic. Light amount is captured from the environment and the different level of brightness is set. And according to that brightness the illumination of light is change with less consumption of power. In [5] propose the system door access control on private room. This system also use the fuzzy logic for decision making. Membership function is developed on the heat of body and activity is characterise according to the low, high and average etc. Fuzzy Inference rules are generated by aggregating these two fuzzy membership function. This system works properly.

In [6] fuzzy system is used to analyse the human behaviour. In this way the fuzzy system is used in many previously for specific propose such as automation in lighting, door lock , temperature handling etc.

3. Proposed System Configuration and algorithm

3.1 Related Study

Fuzzy Logic: Fuzzy logic is some what closer to human reasoning. So it is useful to develop customize the home. Fuzzy logic used in many fields such as expert system logic control, rule based system. Fuzzy logic gives the output in approximate form rather than exact form.

Fuzzy Set: Fuzzy set are not same as crisp set. According to the example the fuzzy set are defined. Consider the example of age. Fuzzy set will be Infunt, Young, Adult,Seniour etc . and each set consist of different range of age for 0 to 4 age people come in infunt, 5 to 17 age people comes in young set 18 to 58 age people comes in adult and above 58 will comes in senior. So for each set the threshold is defined. This is called as fuzzy set. In fuzzy knowledge based system these sets are stored.

Fuzzification: It is the process of converting crisp set into the linguistic variable. For example if my age is 22 then 22 is converted into the adult.

Inference Engine: This converts fuzzy input to fuzzy output.

3.2 Configuration of sensors with controller

The architecture of proposed system is as shown in figure 1: There are different low cost sensors are connected to the raspberry pi which is heart of the entire system. Anolog to digital convertor is used to convert the sensor data to digital format, 4 relay drivers are used to connect to the devices. In this system sensors used namely, LM35 for temperature, MQ32 for Gass , LDR for light detection, PIR for person detection and float sensor for handling the water level in the tank. For relay driver, fan, light, dc motar and buzzer is connected output of the status of home is displayed on the smart phone mobile application.

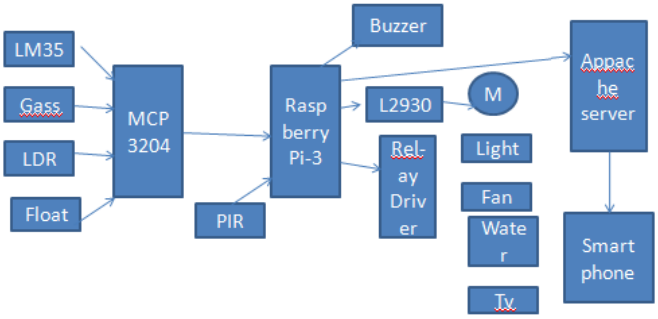

Fig1: : System Architecture

3.3 Rule based system for decision making

For the customization of the home, In this paper the rules are generated from the incoming data from sensors. For the generation of the rule, first of all the learning of the home is done for few weeks and week days and week end days behavior of the user is analyzed . According to that , different range are set for different device according to time and fuzzy membership function is prepared. Consider the example like temperature of the surrounding, fuzzy set will be like cold ,medium, hot, extreme hot. Following table represents fuzzy set and the ranges of each set for the temperature.

Table 1: Membership function for temperature.

S. No	Fuzzy set for temperature	Range in degree
1.	Cold	0 to 20
2.	Medium	21 to 30
3.	Hot	31 to 35
4.	Extreme Hot	36 and above

Next for controlling water level of tank different ranges and fuzzy sets are made as shown in table 2 according to the height of the tank.

Table 2: Membership function for water level

S.No	Fuzzy set	range
1.	Low Level	0 to < height/2
2.	Medium Level	height/2
3.	Full	height/2>to height

For controlling the fan and light, time and person detection sensor are used. Rules are set and stored in the file .So the knowledge based system consist of membership function as well as the rule file. As shown in figure.2. Input from sensor is given to the fuzzifier. Fuzzifer convert the data into membership function. Then it check where the 30 is present it is medium. Inference engine applies the rule which are present in the knowledge based system. And whatever the output is there is given to relay driver which will on or off the device. Rules are present in knowledge based system that are as shown in table 3.

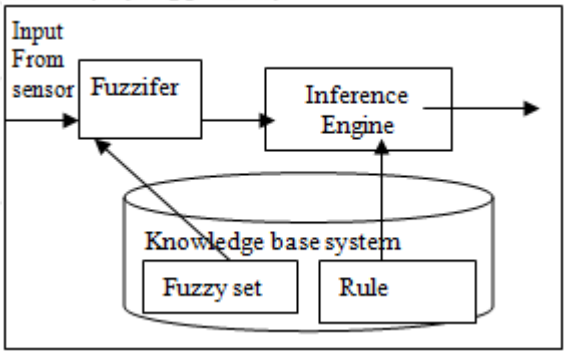

Figure 2: Fuzzy Inference System for decision making

Table 3: Rules set in knowledge based system

S.No	Rules
1.	temperature is hot and person found then fan is turn on
2.	temperature is hot and person not fond then fan is turn off.
3.	time is evening and person found then light is turn on
4.	time is evening and person not found light is turn off.
5.	Gass is found turn on buzzer.
6.	water level is low turn on water motar.

Above shows some example of rules that are stored in knowledge based system. Different context are coming from

different sensor. They are given to the fazzifier. Fuzzy set defines the fuzzy membership function. After that aggregation of context (data from sensor) is made. This is given to the fuzzy inference system. What ever rule is match the out put of that rule is given to the relay driver. In this way the fuzzy logic works and with help of this system the home atomization is done.

4. Conclusion

IoT is developing tremendously in each field. Use of IoT in our home gives us security, alertness also it saves the electricity also . Saving electricity is the need of todays time. As proposed in this paper, Fuzzy inference system works fast for making the decision and gives the response quickly. With help of different low cost sensors and controller as well as fuzzy inference system makes easy to customize the home. Future work will be related to handle the sensor data parallel as well as how the multithreading will works to handle the data.

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