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RESEARCH ARTICLE

IOT based Home Automation System through Adaptive Decision Making Fuzzy Algorithm

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ABSTRACT:
Real time automation is increasingly gets popular due to its flexibility in utilizing open source tool and adapting the new node without any complexity in programming. This paper proposes the human machine interface through context aware and decision support system using distance based fuzzy algorithm which utilizes the user's domain knowledge to frame the rules. The developed system is based on Linux OS and the algorithm is developed in python and results were stored in internet by FHEM API, used in Raspberry Pi B+ kit which is an IoT application and the mobile SSH settings using Wi-Fi modem. Using this app we can access through home automation systems by connecting IP address of the web server and also voice assisted module helps the patients to control the appliance through voice control. Effective algorithmic decision making and voice assisted automation produces the better result in automating the things in real world.

KEYWORDS: Real time automation, human machine interface, decision support system, FHEM API, Raspberry Pi B+, voice control.

INTRODUCTION:
Automation in real world plays a vital role in day to day life in various sectors such as industrial automation which leads to quality mass production by robots, mobility, and home automation. Drastic developments of low power sensor node which also adds catalyst in development of automation. A "smart home" typically is a domestic environment that has been partially automated. Home automation includes centralized control for lighting air conditioning, appliance management, and others. Home automation aims to enhance the comfort, energy consumption efficiency and security in domestic scenarios. This leads to the better energy saving by controlling equipment in remote place[1].

The establishment of low cost sensor network[2,3] and reliability factor in transferring of data in real time with multipath routing protocol and adaptation of new node without much complexity in network made effectiveness in home automation[4]. Raspberry Pi is a mini on board computer is suitable for home automation in case ease of programming and in order to implement any communication algorithm in real world better computing environment[5,6].

The developed embedded system incorporates the user profile information as decision support system which is used to control the home appliances using mobile or PC and through voice for the visually impaired people using IOT. Raspberry pi set of technologies with user profile algorithm now exist that combine the power of PC, communication and multimedia technologies of web and portability of mobile device using FHEM web server. Voice recognition kit module uses voice feedback as an acknowledgement for both voice controlled automation and automation through mobile. This will be of great help for the visually impaired user to ascertain the status of the device on issue of the command signal or the

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command word. Visually impaired people mainly rely on voice commands, voice menu or voice feedbacks for any control operation. When voice control is used, the user should be able to select a particular device and should be able to disable it.

BACKGROUND:

A home automation system is a means that allow users to control electric appliances of varying kind. Many existing, well-established home automation systems are based on wired communication. This does not pose a problem until the system is planned well in advance and installed during the physical construction of the building. But for already existing buildings the implementation cost goes very high. In contrast, Wireless systems can be of great help for automation systems. With the advancement of wireless technologies such as Wi-Fi, cloud networks in the recent past, wireless systems are used every day and everywhere. There were different people will be available in a home and individual user will have his own taste.

For example "Suppose Dave goes home after work and sits in the living room, the TV is turned on automatically playing his favorite TV program at that time. The ambient light and temperature are adjusted by controlling the home facilities according to his preference. His smart phone reminds him his traveling plans, recommends a route, and notify fuel quantify. When time reaches 11:00 pm, Dave is suggested to prepare to go to bed, and the home facilities are turned off when Dave leaves". Dave and Abord[7] suggested a common focus shared by researchers in mobile, ubiquitous and wearable computing is the attempt to break away from the traditional desktop computing paradigm. Implementation of intelligent computing environment with changing context of user needs made the solutions to provide a flexible context-aware infrastructure and several applications that take advantage of context-awareness to allow freedom from traditional desktop computing.

This investigation mostly deals with how to help the occupants in the home and suggest solving the technical issue by implementing an context aware algorithm which varies depends upon the user requirement and comfort. G. D. Abowd[8] provides a solution to break away from the traditional desktop computing paradigm and also context-aware infrastructure will be the key to several applications. Yulia Evchina[9] discussed about the formation management system with usage of Semantic Web technologies (ontologies and queries), which takes into account personal user needs in the system and current situation in the environment and reduces information load to the user by providing personal data.

The traditional IF-Then Fuzzy logic for making the solution to service adaption is independent to individual person profile. There were various computing algorithm in order to develop the context aware decision support system. For developing the computing algorithm Fuzzy Multi-Attribute Decision Making (FMADM) Multi-Attribute Utility Theory (MAUT), probability-based model, Adaptive Neuro-Fuzzy Inference System (ANFIS), Rough-Fuzzy method, and fuzzy computing gives better results in framing the context rules. Each one has its own strength in handling the context data in providing the context service.

FMADM[10] and MAUT[11] are light weight and simple in logic but can't be useful in computing the complex data set. Probability-based model[12], ANFIS[13] and Rough-Fuzzy method[14] employs fuzzy to handle complexity of context. Fuzzy computing[15] enables the system learning ability to expect the user requirement and provide intelligent services. For the above methods the database is developed based upon fuzzy methods and service is provided to user needs.

PROPOSED SYSTEM:

Fig.1 shows the block diagram of developed model. The proposed design consists of raspberry pi kit which acts as a computing device in prediction of user service needs based upon user id. The context data is prepared based upon the sensor data s and different modes of operation is indexed in it. Each and every user in home will have his own id and his own interest in switching if devices in home environment. Sensor nodes of home network will acquire the real time data which is shown in Table 1.

Table 1: Context Items

C1: Brightness (B)	L-Low M-Medium H-High	**C4: Temperature (T)**	C-Chill A-Ambient H-Hot
C2: Human (HU)	Y-Yes N-No	**C5: Humidity (HD)**	L-Low H-High
C3: Weather (W)	S-Sunny R-Rainy C-Cloudy	**C6: Time (TM)**	M-Morning A-Afternoon E-Evening

Every user id will be generating with its own rules and context aware fuzzy logic algorithm is used to make decision of appropriate decision based upon user id. Since different heterogeneous data types were involved in context data, so the algorithm should we designed in consideration with computing environment. For rule generation predominant factor controlling the environment should be considered.

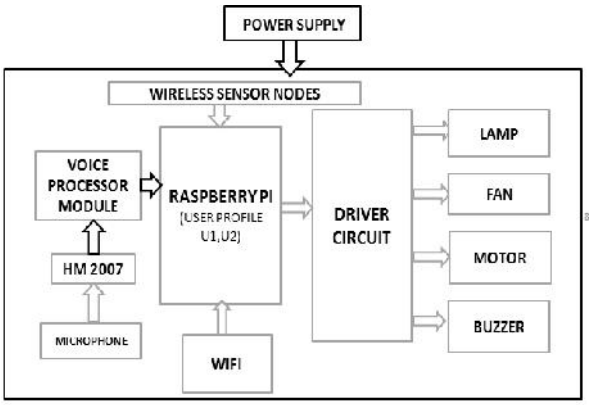

Fig. 1: Block Diagram of Proposed System

Here design is made based upon the sensor data acquired from different nodes and user id, the algorithm compute the data to control the lights and fan speed of air conditioner. The algorithm is simulated in the MATLAB environment and results for speed control of Fan with respect to rule matching algorithm is shown in Fig. 2 which indicates that the running time of algorithm increases with increases in number of rules and context items and it is roughly a linear curve. It is evident the algorithm is truly not time consuming.

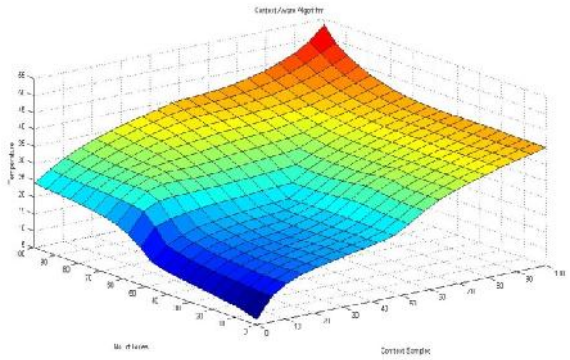

Fig 2: Algorithm Simulated Results

The predefined rules were framed with respect to context items such as if humans were present and temperature is hot then the output should lights on and increase the speed of the fan but if the additional data such as if it is at night time lights should be turned off so that that rule should be updated in real time data to day environments. So the daily analysis is made to system to adjust to the user requirement. The predefined rules were listed in Table 2.

Each and every user can able to update the rule due to different changing environmental factor. The analysis is made and recorded for 100 days, the bar chart for the number of rules and rule update is described in Fig 3.

Table 2: Predefined Rules

ID	Rules (Condition and Decision Attributes
Rule1	(C2 is True)^(C1 is Low)=>Lights ON
Rule2	(C2 is True)^(C1is High)=>Lights OFF
Rule3	(C2 is True)^(C4 is Hot)=>Increase Fan Speed
Rule4	(C2 is True)^(C4 is Chill)=>Decrease the Fan Speed
Rule5	(C2 is True)^(C6 is Afternoon)=>Increase Fan Speed
Rule6	(C2 is False)=>Lights OFF

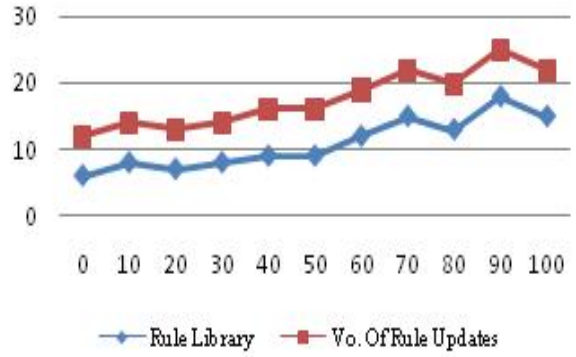

Fig 3: No. of Rule and vs. Rule Update

DESIGN IMPLEMENTATION:

In the proposed system the commercially available low cost sensor were used and wifi network is employed for the connection between electronic devices and master device. In the prototype system the communication is between is by following ways.

i) Sensors were connected to the controller which is integrated with the WIFI adaptor.
ii) Wifi is connected to the master Raspberry Pi.network .
iii) Based on the all the sensor node data and user id, the computing device with run the algorithm written in Python programming language.
iv) Decision is made according to it to control the light and fan speed of the home.

The user can monitor the operation of the home system through Mobile SSH setting and web page is developed to monitor and control of the home devices. FHEM (TM) is a GPL'd Perl server for house automation. It is used to automate some common tasks in the household like switching lamps / shutters / heating / etc. and to log events like temperature /humidity / power consumption.

The program runs as a server and can control it via web or smart phone frontends, telnet or TCP/IP directly. n order to use FHEM you'll need a 24/7 server (Fritz! Box, NAS, RPi, PC, Mac Mini, etc) with a Perl interpreter and some attached hardware like the CUL, FHZ1300PC, etc. to access the actors and sensors. The designed hardware model is simulated in Proteus software and shown in Fig. 4.

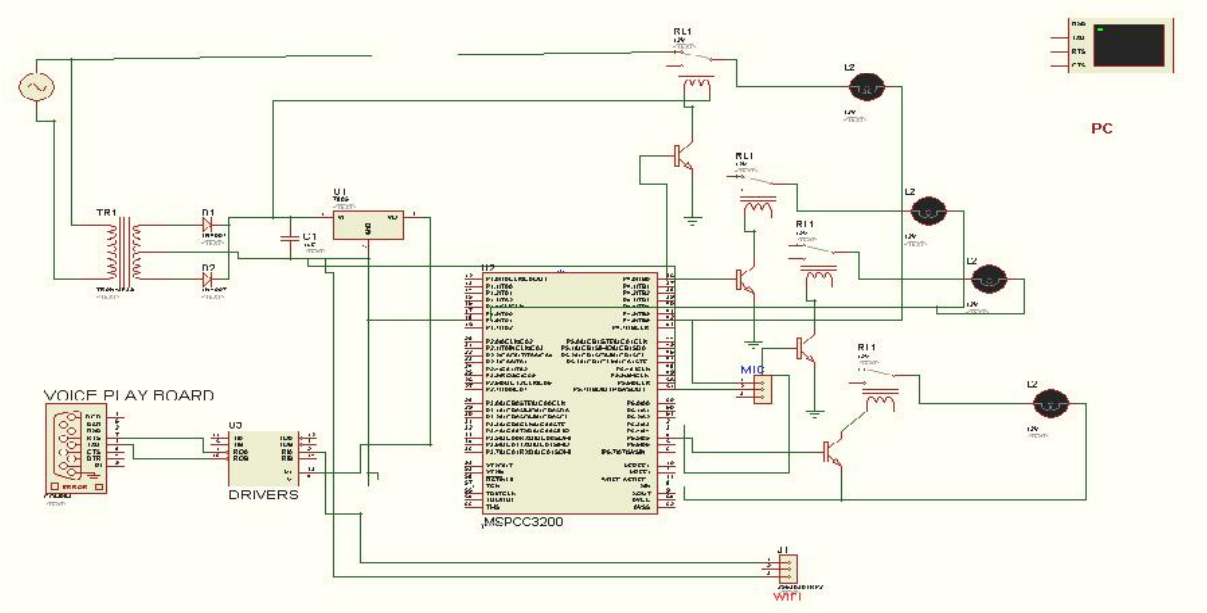

Fig.4 Simulated Hardware Model

In addition to it, the developed system has the added with the voice recognition module to acquire the command from the person with moving disabilities. The designed module and the mobile web server screen shot is shown in Fig. 5 and Fig. 6.

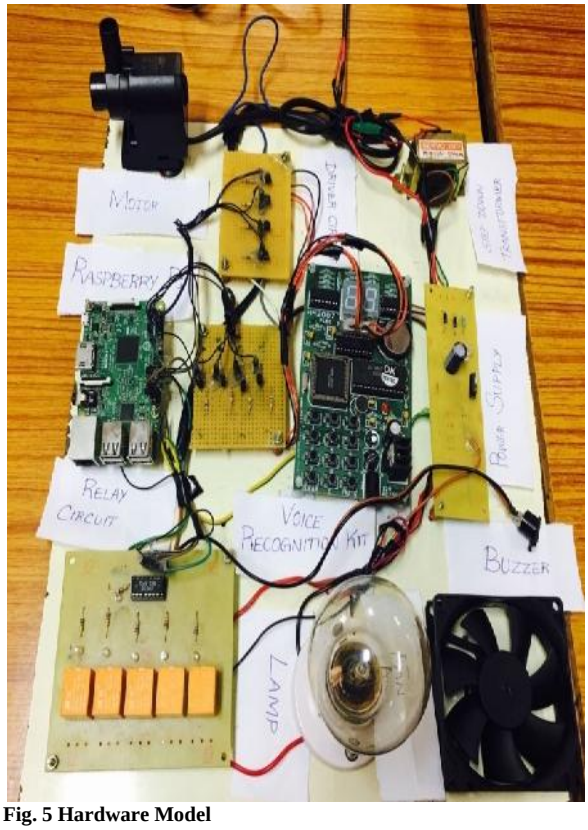

Fig. 5 Hardware Model

Fig. 6 Mobile Server Screenshot

CONCLUSION AND FUTURE SCOPE:

Thus the developed home automation model controls the light and fans speed of air conditioner according to the sensor nodes and user needs and rule updating techniques make it to as smart IOT device.

Even though there were certain limitation were available when more number of controlling parameter included and more number of user id, the system become complex to decide the appropriate decision. The priority in user access also be the limitation of the present system. Even though, this device is very easy to integrate into existing

applications and require only a small amount of expertise to install.

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