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Adaptive Home System Using Wireless Sensor Network And Multi Agent System

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ABSTRACT
Smart Home is an emerging technology growing continuously which includes number of new technologies which helps to improve human's quality of living. This paper proposes an adaptive home system for optimum utilization of power, through Artificial Intelligence and Wireless Sensor network. Artificial Intelligence is a technology for developing adaptive system that can perceive the enviornmrnt, learn from the environment and can make decision using Rule based system.Zigbee is a wireless sensor network used to efficiently deliver solution for an energy management and efficiency for adaptive home. An algorithm used in adaptive home system is based on software agent approach that reduce the energy consumption at home by considering the user's occupancy, temperature and user's preferences as input to the system.

Keywords **–** Adaptive Home, Artificial Intelligence, Raspberry Pi, Rule Based System, TARANG Zigbee Module.

I. Introduction

Energy is consumed every day at home as we perform simple tasks, such as watching television, washing dishes and heating and cooling home spaces during season of extreme weather conditions, using appliances, or turning on lights. Also in wiring system, the equipment will be connected into main power supply directly and many types of wires that people may want to install in wall which increases the cost of a home. Energy saving can be realized by initiating an intelligent system that can detect occupant presence or absence, and adjust the environment accordingly. For example, automatic light switching on or off when a person enters or leaves a room. Customer satisfaction can be achieved by determining the occupant's comfort level, while customer awareness can be home is a living environment that consists of sensors, actuators, networks and middleware that collect information about the home to provide comfortable living for the occupants. A smart home has the technological capability to adjust itself in certain circumstances to make the home more comfortable for its occupants while sharing a common interface accomplished by real-time monitoring that allows users to see the level and cost of energy they consume on a daily basis.

The wireless technology has some amazing achievements in the home automation using ZigBee. The wireless sensor network reduces the cost of the system unit as well as it is much easier to install. The wireless sensor devices have the capability to self-organize into the so-called WSN. Their ability to sense diverse variables of interest, such as the temperature, humidity, pressure, airflow, occupancy, sunlight and other, could greatly improve the limitations of the existing and future energy management systems. Wireless sensor networks are used to monitor psychical parameters such as light and temperature, as well as the presence of users in the home by using infrared sensors in each room. An algorithm is composed of three types of agents. The first type is the personal agent that tracks an individual's location and learns his/her preferences within the environment. The second type is the local agent that is responsible for a particular zone in the home. The third agent is the central agent that is responsible for decision making and interface with external and internal services.

II. Proposed System and Methodology

Basically, a Smart Home refers to a home with intelligent to control, monitoring and automate the home system. The Intelligent System proposed is based on the rule-based expert system and unsupervised learning techniques where the problem is how to adapt to new knowledge without destroying the existing knowledge. The core controller unit is equipped with distributed sensors i.e., intelligent agents, which use the rule-based expert system and artificial intelligence concepts to learn and adapt.

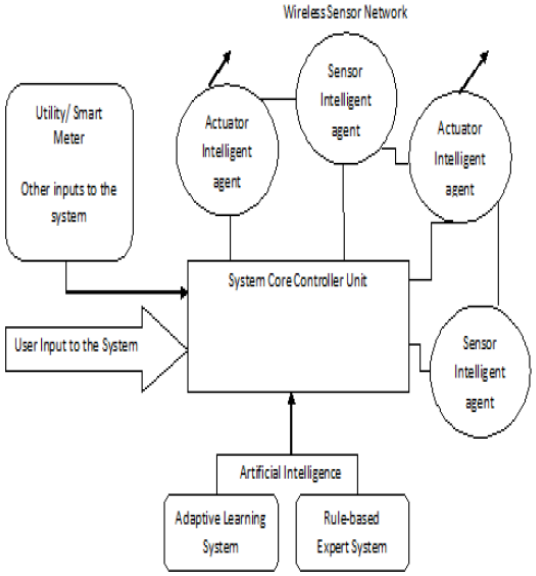

figure 1.Diagram of Intelligent Home System

The proposed system enables the comfort zone adjustment, i.e., the control of heating/cooling of individual rooms and/or of the entire house; and is capable of processing inputs to and from the EGU i.e. Utility/Smart Meter to the core controller unit. The main goal of the Adaptive Learning System is to adapt to the occupant's pattern and schedule changes by providing comfort, while not ignoring the energy conservation aspect.

2.1 Raspberry Pi

ARM board provides high speed, better accuracy, good flexibility and low cost solution for development of embedded system. Using ARM board as development platform speed up the process of development. Raspberry pi Model is currently most popular ARM board. The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word- processing and games. It also plays high-definition video. It has a Broadcom BCM2835 system on a chip SoC, which includes an ARM1176JZF-S 700 MHz processor,VideoCore IV GPU, and is shipped with 512MB of RAM .It does not include a built-in hard disk instead it uses an SD card for booting and long-term storage. It comes with two USB ports, RJ45 Ethernet port, HDMI port and RCA output on board. The Figure 2 shown below provides the glimpse of features of Raspberry pi model.

figure 2.Raspberry Pi

2.1.1Features of Raspberry Pi

1. The Raspberry Pi is a small device coming in at 85.60mm x 53.98mm x 17mm and weighing only 45g.
2. The 3.5mm analog audio jack allows connecting headphones and speakers to the Raspberry Pi. This is especially useful for audio and media player based projects.
3. The Raspberry Pi comes equipped with two of them, allows hooking up a keyboard and mouse and a micro USB port for powering your device.
4. The High Definition Multi-media Interface (HDMI) port allows the Raspberry Pi to be hooked up to high-definition televisions and monitors that support the technology. This provides an additional option to the composite RCA port for video and additionally supports audio.
5. The Ethernet port is the Raspberry Pi's main gateway to communicating with other devices and the Internet.

2.2 Wireless Sensor Network

Wireless sensor networks (WSNs) have a tremendous potential to improve the efficiency of many systems, for instance, in building automation and process control.WSN are used in many different applications, such as medicine, transportation and urban monitoring, traffic control, military, environment and habitat monitoring, energy management, smart homes, automatic meter readings, industrial applications, telemedicine, etc. ZigBee is a new global standard for wireless connectivity, focusing on standardizing and enabling interoperability of products. ZigBee is a communications standard that provides a short range cost effective networking capability.

figure 3.TARANG Zigbee Module

In this project Tarang module is used as Zigbee Module. Tarang wireless modules based on Freescale MC1321X SIP,are low to medium power devices.It is suitable for adding wireless capability to any product with serial data interface.the modules require minimal power and provide reliable delivery of data between devices.The I/O interfaces provide with the modules help to directly fit into many industral application.The modules operate within the ISM 2.4GHz band with IEEE802.15.4 baseband.

2.3 Artificial Intelligence

Artificial intelligence is a science with defined objectives of making machines perform things which would require intelligence if performed by humans, which implies capability of performing some forms of cognitive tasking. It is collection of powerful programming techniques studying the nature of home automation. There exist a number of AI tools that make home automation system more sophisticated and that are Rule Based. A rule-based expert system consists of if-then rules that is conditions and actions and can have multiple conditions to represent the knowledge needed to solve a problem in a particular domain of study.
The term Rule in AI ,which is most commonly used type of knowledge representation, can be defined as an IF-THEN structure that relates given information or facts in the IF part to some action in THEN part. A rule provides some description of how to solve problem. Rules are relatively easy to create and understand.

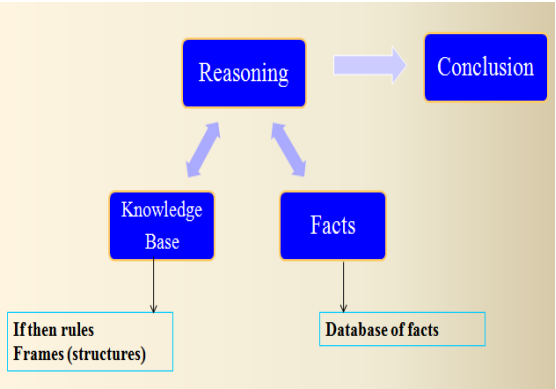

figure 4.Rule Based System

If x1, x2… xn represent the conditions for a particular problem; and y1, y2… yn represent the actions to be taken if a particular condition(s) are true, in a rule-based expert system, rules can be expressed as shown in examples below:
To keep the indoor temperature of the space between 10°C and 12°C:
If (space indoor temperature <= 10)
then
Turn on the heater to warm the space
else
If (space indoor temperature > 12)
then
Turn off the heater in the space

III. Proposed Algorithm

A algorithm consist of Reinforcement Learning and Agent based technique. A multiagent system (MAS) is a system composed of several agents, capable of speedy mutual interaction between them. .An Agent is a system situated within an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to affect what it senses in the future.

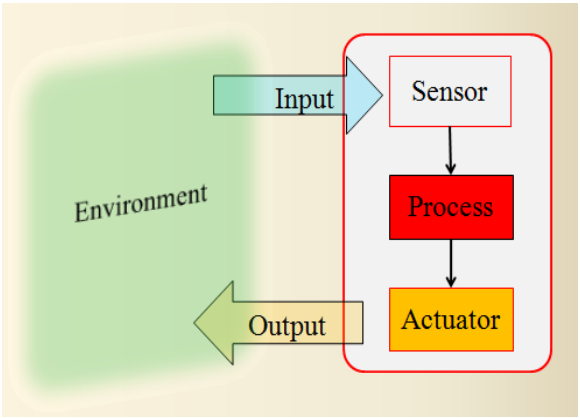

figure 5.Agent Interacting With Enviornment

The multi-agent system works as middleware between the input from the wireless sensor network and policy management and the

building management system that act on the environment. The system is composed of three types of agents. The first type is the personal agent that tracks an individual's location and learns his/her preferences within the environment. The second type is the local agent that is responsible for a particular zone in the home. The third agent is the central agent that is responsible for decision making and interface with external and internal services. The multi-agent systems with social behavior work in two ways: achieve its goal, and response to the changes that happen in the environment. The agents in the multi-agent system work to achieve energy saving, and in the same time consider the occupants appearance in the home and their preferences regarding the indoor temperature. To adapt to the occupants and meet the goals of comfort and efficiency, an intelligent environment should be able to acquire and apply the knowledge about its occupants. These capabilities are based upon the effective prediction algorithms. Prediction is based on observations, experience, and scientific reasoning. Given the smart-home device usage pattern data, we can use this data to train the prediction algorithm to forecast the future action that a home inhabitant might perform.

IV. Conclusion

The adaptive home system provides domestic environment that improves the quality of the resident's life by facilitating a flexible, comfortable, healthy, and safe environment. This system helps to provide user-friendly system which is easy to integrate in home and save more money. Wireless Sensor network and Artificial Intelligence are very useful and applicable technology for Home automation. A multiagent system helps to communicate each other and provides flexibility to learn and adapt new knowledge without destroying the existing knowledge and does not require constant programming.

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