Smart Home System using IoT and AI

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ABSTRACT

The world is moving forward at a fast pace, and the credit goes to ever growing technology. In recent year, the Internet of Things (IoT) has drawn significant research attention by researchers worldwide. IoT is considered as a part of the Internet of the future and will comprise billions of intelligent communicating 'things' and thus, IOT is a hot topic or one can say a trend in the field of Electrical Engineering and Computer Science (EECS). The future of the Internet will consist of heterogeneously connected devices that will further extend the borders of the world with physical entities and virtual components in various fields. The Internet of Things (IoT) will empower the connected things with new capabilities. In the current context of smart homes, specifically in the urban areas, the scenario is that the demand for modern systems with better features is ever increasing and all major companies are trying to address the same demand. In this paper, the applications of IoTin Smart Home System are systematically analyzed. Firstly, definition of IoT and the technical ecosystem of IoT is introduced; secondly, current implementations of IoTin this field of Smart Homes are discussed; thirdly, some issues related to the application in field of location determination are explored and how AI might be a solution to the refinement of determining location is lightly touched upon; finally, the major applications of a Smart Home System and the scope of such system and current limitations which need addressing by the research community are briefly explained in the paper.

***Keywords**: Artificial Intelligence, Automation, Child Security, Home Automation,HVAC, Internet of Things, Location Tracking, Locking System.*

I. INTRODUCTION

Smart home technology, also often referred to as home automation or domotics (from Latin "domus" meaning home), provides homeowners security, convenience and energy efficiency by allowing them to control smart devices, often by a smart home app on their smartphone or other networked device. Smart home systems and devices often operate together, sharing consumer usage data among themselves and automating actions based on the homeowners' preferences.Imagine a future where interfaces are personalized to your needs. A future where you actually converse with home appliances rather than poking the switches on the board. The Paper focuses on using currently developed technologies to design a Smart Home System.

1.1 What is Internet of Things (IoT)?

Kevin Ashton coinedIoTin 1999, and he referred it as uniquely identifiable interoperable connected objects with radio-frequency identification technology.The emerging wireless sensory technologies have extended the sensory capabilities of devices and therefore the original concept of IoT hence is extending to ambient intelligence and autonomous control.

A number of technologies are involved in IoT, such as wireless sensor networks, barcodes, intelligent sensing, RFID, NFC, low energy systems, cloud computing. Evolutions of these technologies bring new frontiers to IoT. It describes the next generation of Internet, where the physical things could be accessed and identified through the Internet. [1]

Depending on various implementations, IoTcan be defined in various manners. However, it is implied that objects in an IoT can be identified uniquely in the virtual representations.

1.2 IoT Technical Ecosystem:

The IOT Ecosystem comprises of processors (Arm Cortex-M, Arc, and Quark etc.), operating systems (uCLinux, Embedded Linux, Android Auto, Ubuntu, and TinyOS.) devices and aggregators (Access points, routers, ZETA platforms etc.), Infrastructures (Cisco lox (fog)) and platforms (Beagle Bone, Raspberry PI, Arduino etc.)

It also consists of two essential members Interoperability and IOT Protocols. Interoperability term comprises of Open Interconnect Consortium whose mission is to develop technology standards and certification for devices involved in the IoT; APIs such as IOBridge, COSM etc.; Reference Implementations (Intuity) and Integration Frameworks which include Apple HOME KIT, Temboo, CROWNSet, WeMO and many more. Bluetooth, Cellular, DDS, DSRC, HTTP, Ethernet, Zwave, NFC, SATCOM etc. are some examples of IOT Protocols. [2]

II. LITERATURE SURVEY

The work on this aspect of Smart Home technology started way back in late 20th Century when Bill Gates published design of homes where Lighting, music changed according to a person's taste. Since those days, this field has seen various innovations and designs which can be said as progress towards smarter homes. Currently few technologies like Amazon's Alexa and Google Home can be said as Smart Home System. Another important research breakthrough is that of Duet, a multi-modal location tracking system which is useful in the design of Smart Home Systems. Duet is a wireless wall-hanging sensor which has ability to track location more accurately than current systems.Duet leverages device-free localization to track people's movements in the home even when they carry no personal devices on them. It then uses device-based localization to tagusers' trajectorieswiththeiridentitiesbasedontheusers' intermittent interactions withtheirphones [3].

III. PROPOSED SYSTEM

3.1 Use of AI in Detecting Person:

Fig 3.1: Process Diagram of Proposed Solution.

Since most of the location tracking systems use the signals received from device to determine location of the device and then tag the location of the device as the location of device owner, the accuracy of person detection is ambiguous. The reason being, it is not mandatory that the device is always used by the owner. An example is when a child borrows his/her parent's phone to play games. In this example, the tracking systems will tag the child's location as the parent's location and this can bedetrimental to our System and therefore needs correction. Since most devices have a Front Camera today, we can perform a Face Detection [4], similarly some people have another device along with them, therefore there will be 2 signals from approximately same location, also pattern matching the usage of apps and arrive at an approximate identity of the user. Combining all this information and providing this to an Expert System developed for this purpose with appropriate Datasets of Personal Information, the Identity of the User of a device is more refined.

Table 3.1. A is FATHER of B and has given his phone to B so that B plays Games.

Below table compares the performance.

Type of Detection	Result	Reason
Normal	Location marked as A's Location	A is the owner of the phone.
Refined using AI	Location marked as B's Location	Games being played, face similar to B detected

As we can see, the marking set by Normal Method is totally wrong and the correct marking is set by the refinement done using AI.

Using the collected data, we have accurate location of all inhabitants and by applying this data we design the system with following applications:

3.2 Lighting and HVAC Control:

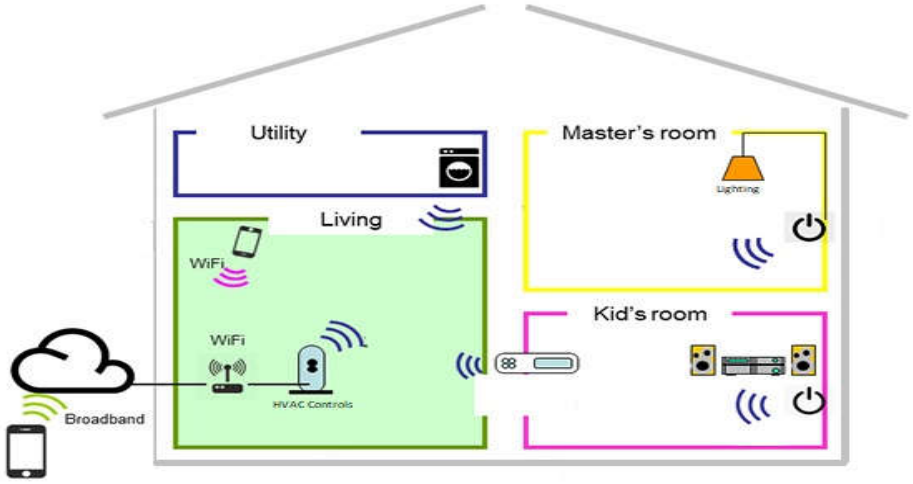

Fig 3.2: How HVAC & Lighting is controlled in Smart Home System.

Since, we have the location data, when a particular person enters into a room, the Central System sends a ping to the device of the person and after receiving the ping, the person can control the Lighting and Heat, Ventilation & Air Conditioning (HVAC) of that room. Also, as soon as a person enters a room, his/her preferred settings for the Lighting & HVAC are

enabled in the room so that the person can have the best experience. Also, according to the Sunlight intensity, the intensity of the lighting inside gets adjusted automatically, resulting in energy saving.

Thus, with the help of IOT, the entire Lighting System and Heat, Ventilation & Air Conditioning Systems of the home can be controlled using Mobile App (i.e. Wireless Control).

3.3 Child Security:

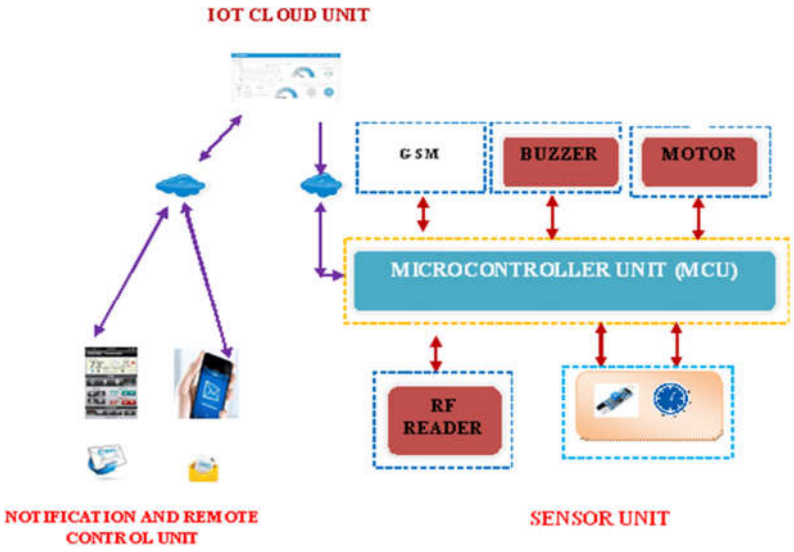

Fig 3.3:Child Security Mechanism.

Another important feature of Smart Home System is Child Security Mechanism. Since, we have accurate information of the inhabitants, using the Mobile App, the parent can select the child and also select all the appliances/regions which are a threat to the Child.

There is again some previous work in this particular application but it is never implemented as a part of Home System along with other applications. One of the work we refer to design our Child Security module is the one presented in International Multidisciplinary Conference on Computer and Energy Science (SpliTech).[5]

When the Child is near one of these appliances or in the forbidden region, the Sensors sense it and send a signal via the microcontroller and a warning is displayed on the App Screen and also the Buzzer Alarm is triggered.

If the Child is near an electrical appliance which was marked as threat in the app, along with the Buzzer and message, the electrical supply to the threat is disconnected for the reason of safety. Thus, the child is safe from electrical shocks and other hazards.

3.4 Locking System:

One of the major features of any decent System is its security features and for a home, security is of utmost importance, therefore, a decent locking system is required. Since, we already have access to accurate location of all the members in the house, we can use this data to design a very efficient system for Home Security.

For such a Home Security module, one of the important requirement is that of Smart Doors. Normal Doors cannot be controlled using the Internet and therefore, we need Smart Doors to implement a Locking System using IOT. There are very good research work in this particular field, the most efficient one being implementation of the Smart Door using Raspberry Pi [6]

The Locking System works as follows: Suppose A, X & B are inhabitants in the home. A selects that X is allowed to access his room but B is not allowed to access his room. Now, when X is near the door of A's room, the door is sent a signal of Positive response and therefore, the door is unlocked and A is sent a notification. When B is near the room, the door receives negative signal response and therefore, the door is locked and B sees a message that "Sorry, you cannot access".

IV. SCOPE

In the modern era, technology is making rapid strides towards innovations and there is always scope for improvements in the system. This section of the paper discusses the scope in further enhancement of the system and its sub modules.

One of the scope is in further refinement of the location determination of the individuals in the house by using Meta-heuristic prediction algorithms. This algorithm is used for the purpose of prediction in various manners. [7] The System can benefit from a better prediction as the system is heavily dependent on the location of the inhabitants.
This brings us to another scope of improvement in this system, i.e. reducing dependency on the location of the inhabitants. As we can see, the system needs the locations to function efficiently. There can be other methods for efficient functioning of the system which we leave for further research purposes.

V. LIMITATIONS

Since, the entire proposed Automation System is based on IoT, Internet Connectivity is a major requirement and all the appliances need to be connected for efficient working of the system. In areas with poor connectivity, this system will require a different connection medium to function.As the system is Internet dependent, there is a large risk of someone accessing the System remotely i.e. hacking the system and thus getting access to personal information. So, therefore, the system has limitations in terms of security in current scenario.

VI. CONCLUSION

With the boom of the emerging IoT technologies, the concept of Smart Home Systems will soon be inexorably developing on a huge scale. This emerging paradigm will affect us by embedding intelligence into the objects around us. In this paper we discussed the vision of Smart Home System, elaborated on the existing work in this field and presented a well-defined architecture for its deployment. Then we highlighted various applications like Appliance Control, Child Security, and Locking System, few of the related security threats and further scope of improvements in the system.

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