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C.R.A.M.E.(COMPUTERISED RECOGNITION FOR AUTOMATED MODIFICATION OF ENVIRONMENT)

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Abstract—There is a burst in advanced remote controlled features in the homes of today but often these features cost a fortune for homeowners who are crawling through their life trying to make end's meet. CRAME is an application of existing technology that can be implemented to our houses to shorten the gap between manually controlled houses and remote controlled luxury of the future. Smart homes are a very lucrative and futuristic concept that intrigues the user at first glance. Concepts have existed since 1990's with cinematic focus amongst other ways to creatively fasten the process but have not been successful or completely utilised upto it's maximum potential. Our effort is to devise such a method using RFID and OS based home automation using Wi – Fi to control electricity with RFID to track movements amongst other methods to sort the clusters of day to day life along with providing a better class of home to fit a futuristic/ luxurious household experience for the users.

Keywords—Smart Home, Smart home appliances, Smart home technology, RFID, Operating System, Biometrics, Security system , Opto – Eelctronics, Electricity conservation , Smart Band.

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I. INTRODUCTION

Home automation or **smart home** is the residential extension of building automation and involves the control and automation of lighting, heating (such as smart thermostats), ventilation, air conditioning (HVAC), and security, as well as home appliances such as washer/dryers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring. Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, mobile phone software, tablet computer or a web interface, often but not always via internet cloud services [1].

Smart homes have been a very fascinating part of the human mind since the evolution of the idea of futuristic societies. You have in one way or the other thought of owning or living in one as is portrayed in movies, journals, TV shows, philosophical books etc.

In recent times there have been a vast plethora of companies that have tried automating homes and have been successful. However, these attempts have automated parts of the home and not the entire household to the expectation of the customers based on all promising concepts of home automation. Thanks to modern technology we have various applications of existing technology that we can apply to the smart home concept that may possibly take us a long way in the direction of a completely automated or “Smart” house of the future.

II. PREVIOUS WORK

Smart homes have been a very lucrative market since the 1990’s. People have such a tedious/hectic lifestyle that even the slightest modification that reduces their workload is a very welcome change.

There isGoogle Home [1] / Amazon Echo [2] – that have connected basic electronics such as Iphone Docks, speakers, lights, entertainment system etc. but have a hard time pulling off the functions in their demos with ease. These two installations from the world’s leading technology giants are the most famous voice assistants being integrated into home automation. Voice control though a very lucrative addition to controlling the features of the home is primitive and has

trouble performing tasks for multiple users apart from being limited by the number of connected appliances.

The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data [3]. IOT is a concept that has been commonly used in the marketplace via companies to release their Smart Home OS in the market such as OpenHAB[4] , CastleOS[5] , LoxoneOS[6] and Google's latest attempt at IOT named Google Things. IOT is an attempt at home automation via communication amongst devices. However, it does not actually control anything that is not software – based unless it is connected using an expensive method.

ZigBee[19] and Z-Wave[21] are smart home wireless protocols that connect to a full host of wireless devices available at competitiveprices. The communication protocols between these devices hinges on a connection between a central gateway and the slave devices. A mobile app based interface sends in a command to the gateway via internet and the command finds the fastest way to the slave devices using a Zig-Zag means of travel (thus, the name). It's complex connection to the slave devices and communication medium that leads to state – of - the – art programming which usually makes it expensive.

The above mentioned methods of Smart Home development and implementation are presently in the market but are either expensive or not completely operational as desired. This paper works on the aspect of developing a Smart Home module that is both simple and cost – effective.

III. PROJECT OVERVIEW

This paper focuses on the combination of biometrics/RFID/OS based home entertainment and automation to provide a luxurious and comfortable setup to help the user navigate through the household with ease, saving his time and if possible conserving electricity by judicious and necessary use of electricity.

The CRAME system is based on the understanding that the world needs to take a worthwhile step towards energy conservation combined with an automated/controlled navigation of daily household for leisure living using technology. With lifestyle progressing into the 21st century it has become a tedious task to do everything theold - fashioned way.

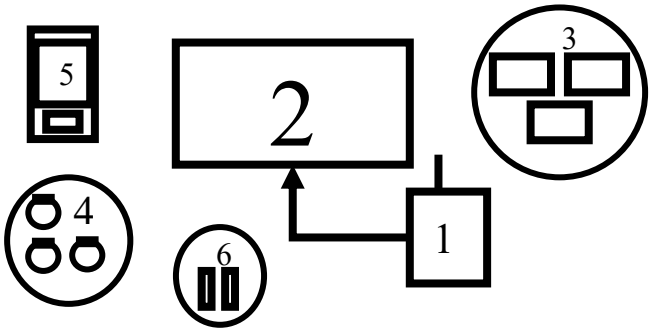

Figure 1. Block diagram with some of the smart home applications components

The above block diagram gives a basic layout of the setup of the CRAME system. The different parts of the system have functions as follows :-

1. The main console unit that includes the cloud server, encrypted Wi-Fi router, main control unit and the CPU - controls all major appliances in the house.
2. The display screens present in different parts of the house as per the user's preference.
3. A set of issued tablets/compacts PC's as per the customer's demand based on number of users present in the house.
4. Smart bands which act as triggers for various functions of the system.
5. Security system based on biometrics placed at a defined entry point of the house that compiles RFID identity and tags necessary devices to the users.
6. Sensors placed at checkpoints in the house that could co-relate to locate a person and switcheselectronics according to user specification for conserving electricity.

IV. HARDWARE

The complete apparatus as shown in Figure 1 has a detailed description of it's working as follows:-

1. Console–The main console is based off of Radio Frequency transmission in an encrypted wi-fi medium. It has a two-fold application -

A. The encrypted Wi-Fi connects with all the different parts of the smart home portal enabling the control of the environment.

B. The console when plugged into a display enables an Operating System for the user to interact with to control the applicationsof the console remotely, as well as use it for entertainment purposes.For more details look at Section V.

C. All personal devices such as smartphones, laptops, tablets etc. are synced to the console either through the encrypted wi-fi network or via a dock. This sync transfers sensitive data as requested across the console after required security parameters have been verified. Immediate content such as calls or messages from the phone can be displayed if requested across all tablets/ primary/ secondary screen.

2. Primary Display –The console is directly connected to the primary display in the house. An optional feature which allows the user to enjoy entertainment services using smart home features and keeping an eye on the functioning capacity of all the components of the CRAME Smart Home.

3. NetworkTablets–Personal encoded Tablets are issued to all the defined users registered in the system. They are directly connected to the console using the encrypted Wi-Fi system. The tablets are profile encrypted that can only be activated by tapping the RFID chip on the wristbands (Section IV 4) to the NFC sensor located at the base of the Tablet. The tablets are remotely synced with the profile data and can synchronously shift data from one Tablet to another depending on user utilization, It has the console's OS running that enables user interaction with the smart home features and access the OS's various features as well.

4. Smart Bands –The smart bands are made are of a polymer wrist strap housing a central removable/replaceable capsule that holds the rechargeable battery, RFID chip and biomedical sensors.

The Bands are also enabled with smart tracking and based on user preference it can set home features according to user's convenience when coupled with the user's input into the software. For eg.. When the person is asleep, the band detects the person's sleep cycle and reduces energy intake of the heavy electricity usage appliances such as fridge, water heater etc or if there is nobody at home the appliances go into energy saving mode automatically.

5. Biometric System – The biometric console is placed primarily outside the external point of entry viz. the main door or the back door. It can be switched to other places based on user

preferences. The biometric system has a Bioelectric impedance backed fingerprint sensor and facial recognition features that generate a unique ID which is fed into the system and imprinted into a new chip that can be placed into the Smart Band. The Biometric system is crucial to identifying and recognizing both permanent users and guests.

6. Door Sensors – The sensors are based on ultra high frequency RF detectors which toggle the electric appliances such as Lights, fans etc. connected to the sensor when the band passes through. This triggers the RFID notification of the band passing through the sensor which switches on the designated equipment linked to the sensor and deletes the band from it's directory when it passes once again.

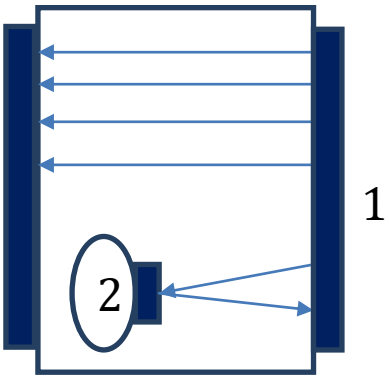

Figure 1 - RFID functioning

Figure 2 shows the working of RFID and the intent of using it in the control of electronics in the different zones of the house. The RFID sensor substitutes the use of switches, but doesn't essentially replace them, it acts as a fail-safe to the human error factor. The switches will still be available and once the user leaves the zone, the electronics will be switched off irrespective of the switch configurations.

The RFID sensor (1) has a transmitter and receiver on both sides of the door. When there is no RFID tag in between the door, the RF wave travels unhindered between the sensors (as shown in Figure 2). But when there is a tag in between or in this case, a smart band (2) – the difference in RF pattern is registered as a custom RF wave by the microprocessor in the sensor which is associated with a user's presence in the room/zone. This difference switches on the electronics and switches them off once the user leaves. When requested by the master console in a brief

ping, this user information is sent via the encrypted Wi-Fi router and is displayed within the interface as to the concerned user's location.

7. Junction Box –The opto-electronics enabled junction boxhouses the electronic switches to control the heavy appliances of the house such as fridge, air conditioners, water heaters, heaters etc. It acts as an auxiliary switch that adds to the functionality of the door sensors. The door sensors can control lights and fans dependent on the presence of a user inside the room. However, such high consumption electronics are far more sensitive/expensive and consume more electricity. Thus, they need to be treated with care.

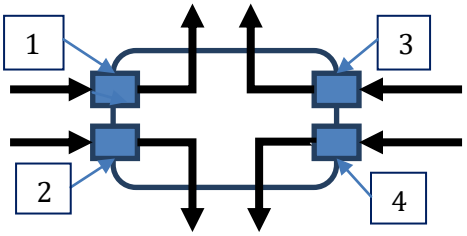

Figure 2 - Overview of Junction Box

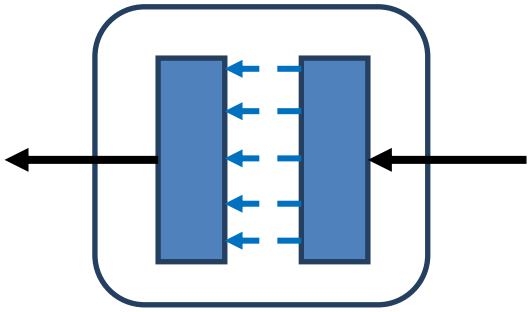

Figure 3 - Working of Junction Box nodes

The junction box is to be placed with the main electrical switchboard with wires for all the critical appliances passing through the various inputs as per configuration (Figure 3). These nodes are controlled by the digital switches operated by the console, taking in inputs via the digital interface as per user requirements.

Figure 3 shows the overview of the junction box that is placed in conjunction with the house's main electrical unit. The wires for the critical appliances pass through the nodes (1,2,3,4). Figure

4 shows the working of the node. The nodes are based off of opto – electronic isolation thus preventing any heavy electrical damage or current leakage. When the user sends a command via digital interface to the junction box, the appliance is turned off. There also is however a fail-safe to automatically turn off all appliances as soon as the RFID sensor at the door recognizes the house is empty.

This fail-safe can only be overridden when the user specifically requests the working of the appliances, even when he/she is not at home.

8.Secondary Displays – Secondary displays are put in places as requested by user such as kitchen, bedroom, bathroom mirrors etc. Content from various personal devicessuch as phones, laptops etc.as well as the network tablets can be displayed on the secondary devices when requested.

9. Miscellaneous– There are other small and insignificant enhancements in the design, some of which are as follows:

a) Water Control: The door sensors at the bathroom act as switches not only to the lights in the washroom but also valves to the taps which are sensor controlled.

b) Location pinging: When requested the door sensors and the console ping the location of a user based on the smart band being tagged at the moment in and out of areas in the house.

c) Secondary Consoles: An enhancement that maybe used in case the surface area for the house is bigger than a safe limit for operation as speed getsaffected with distances. These secondary consoles will have their own extended encrypted wi-fi modules shared from the master console to enhance the speed of functioning in the house. These secondary consoles will be connected to a master console that will have control over the junction box, secondary console andthe biometric system.

d) Smart metering – The console that has master rights over the junction box and can be used to control the timings/ amount of energy the appliance consumes throughout the given designated time.

e) Luminous controlled lighting – As per user requirement luminous controlled light bulbs/tube lightsare installed which the user can dim/brighten based on his/her requirement via the digital console that is linked to the junction box as well.

f) Wireless Earpiece – All audio in the system (Calls, voice commands etc.) are transmitted/received through the earpieces tagged to individuals similar to the smart band encryption.

V. SOFTWARE DESIGN

The hardware is the most essential and crucial part of the apparatus with the software playing an equally critical part in it's functioning. The software is primarily intended to guide the user experience allowing for a better understanding of the interface as well as accessing the entertainment features along with controlling the various segments of the CRAME system's different components. The software is installed into the Main Console that is connected to the primary screen, all user profile data is stored in the hard disk via the cloud and can be accessed via any device directly connected to the encrypted wi-fi router for seamlessly transferring data from one place to the other. The digital interface has the following features:

- The software connects to the online database for storing the biometric profiles of all the users with administrative privileges or for temporary guest users.
- It stores online data/ personality profile of the people who are tagged in as the primary and guest users entering the house along with the specific code of all the smart bands/earpieces tagged to the users in the house at the moment.
- The software has different segments which thread together a casual digitalinterface for all its audiences. It has an Internet browser for surfing the web, Software such as Polaris/Microsoft Word to edit and read important documents etc.
- An online database is present to all users contains a vast volume of movies/ TV shows/ songs/ videos for entertainment or educational purposes etc.
- The main console will further be connected to online video streaming sites such as Netflix/ YouTube etc.
- The main console also will have a direct connection to the cable network based on user's choice.

- User logged individual profiles keep information separate and secure from other users who are using their devices in the house.
- Users can remotely access the digital interface by using applications in the play store or apple store to give commends to the console to perform tasks before the user has actually reached home, for e.g.. pre-heating water, cooling the room to optimal temperature etc. Thus, saving time and effort.

VI.Results

CRAME comes from a thought of combining various smart home components which are present in various differentiated aspects of the market but have not been brought together under a single unified umbrella.

All parts of the CRAME smart home have been shown to be excellent sections of various parts of the market such as RFID which is used for secure payment/logging entry and exit from places. It has been used for ages and has great potential in being used as a real time tracking feature for users and controlling electricity output in houses. Fingerprint biometric system has been an age old security measure in most parts of the world but coupling it with Bioelectrical impedance analysis to authenticate and weed out any impersonators can be an effective part to strengthen security measures. Opto – electronics used in the junction box is a vastly used application for electric isolation in biomedical applications has the potential to give user some satisfaction that their invested fortune in a subtly lavish lifestyle is in safe hands.

CRAME uses a primitive version of wireless communication like Wi-Fi instead of Z-wave for a good reason. Z-Wave promises an improvised way of communication between the slave and master devices but limits the number of devices that can be connected and isa very expensive device which has caused inflated prices.

The ideology behind comes from the thought that energy conservation and technology of the future are some of the most sought after concepts in the present and future markets. Most electrical wastages happen either due to electrical faults that sometimes lead to vast property damages or due to human errors (leaving heavy usage appliances such as air-conditioners ,

heaters etc. on with nobody present at home or forgetting to switch them off.) Such mistakes happen and CRAME intends to reduce them while giving the allure of a futuristic home at your beck and call.

VII. FUTURE WORK AND CONCLUSION

The market has been chasing the concept of having totally automated homes which can be operated from the convenience of a handheld device. However, these conceptual smart homes tend to be very expensive and complex with an incomplete version of home automation being provided. From as far back as 1990, smart homes have been doing their rounds across the market promising the audience a "Home of the future" but haven't been successful.

In future developments, the CRAME system may get additional improvements such as a scanned digital version of the clothes to try on a digital copy of the user to show a perfect version of the user based on his/her choice, health dock to assess the user's medical condition with the consent of the doctor from the comfort of their house, nano – technology based strength – hardened doors for enhanced security, digital assistant to turn the digital interface more user – friendly, connecting to the vehicle (car, bike, van etc.) , smart band based distress signal transmission for emergency services etc.

CRAME is a theoretical module which hasn't been applied in the field yet. Based on preliminary tests the features as promised should be able to operate with ease. So, in the future we intend to make a working prototype before commercial production.

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