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Project Research Article

Smart Home Automation using ARM11

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Abstract

The Smart Home Automation System is a mobile web based application that allows users to monitor and control home/office using their mobile device. This system is established for all the home/office users after gaining access form administrator. This system includes the remote control and monitoring of home appliances and security through a live video feed, providing security and energy management. Once all appliances of Home or office are automated and connected, it becomes important to consider issues of security, authentication and access control. Through this literature review, scope of project and user requirements can be retrieved whether how big the project is. The use of methodology helps to produce a better quality product, in terms of documentation standards, acceptability to the user, maintainability and consistency of software. Waterfall model has been chosen as a methodology for this project and will be implemented along the system development process to ensure the objectives of the project can be fulfilled. With the latest and powerful technology, the system is not only expected to be workable, but also highly efficient in terms of execution speed and response time. The Intelligent Home automation System will contribute effort to users.

Keywords: *Smart Home Automation System, Mobile web based application, Waterfall model, Monitoring of home appliances, Security through live feed.*

1. Introduction

This project 'Smart Home Automation 'is based on an Arm 11 processor at its heart supported by 512mb ram and running at 700 MHz, (over clocked at 1 GHz) without voiding the warranty of the board, The project will be based on image processing and networking platform , A fixed camera placed on the front door of the house will stream live video to the user , and take a click of every person coming in front of your doorstep and after Face recognition process, if it's the family member or user himself , it won't issue an alert , but if a stranger is there , it will raise an alert and display the live clicked picture on the user's smart phone ,and the user is prompt an option to open the door lock at his will right from his smart phone. The user can also control host of customizable things from his smart phone ,like security ,surveillance, lighting , Energy Management, Access control, Entertainment, Interfaces all possible by the GPIO ports of the Raspberry Pi board. There is an increasing need for Home security and automation due to increased rate of thefts and threats. And the benefits of automation are obvious. It is like the home of the future where food is cooked itself, clothes washed themselves and Lights came on after dusk.

The need of surveillance and monitoring is essential in today's lifestyle. Energy management provides increased cut down on costs on energy ; In few years, saving will be as much as the funding needed to set up such an autonomous system.

The increasing ubiquity of heterogeneous computing devices such as laptop computers, mobiles etc. shows that users prefer a ubiquitous access of a system rather than to be uncomfortably forced to go physically to the nearest control point. Remote control saves time and everybody is aware of this, it also provides increased security and flexibility. For example, if the user receives a SMS saying that there was an intrusion, he/she can connect to the internet and watch the video cameras inside the house to see what is happening, another example could be the possibility to turn on the heaters from the distance using a mobile, laptop or PDA so as soon as the user reaches the house it will be hot already, this could be really useful especially in cold countries. As a matter of fact security will always be a main priority in all families, and prevention is better than cure. By receiving alerts in a portable device user is informed of all possible issues occurring in the house and it gives the possibility to deal with it using different ways of control like instant messaging, since many users are already familiar with the concepts and user interfaces of instant messaging. Good scalability properties, independence of location or geographical distance, and high flexibility due to the different existing protocols make remote-controlling House Automation Systems suitable for most user needs.

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2. Concept Review

A. Proposed system

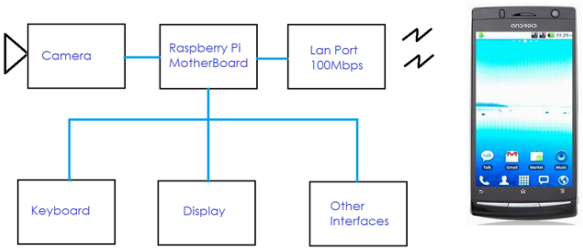

Fig. 1 Architecture of Home Automation System

(Fig.1) shows the block diagram of main functioning system. The raw data input is fed through a camera to the Raspberry pi and the main board processes the information, performs all logical functions, and through the LAN port sends the information through internet to the user's mobile device. The mobile device is joined to the internet by a service provider internet plan.

The interfaces to the main mother board are a keyboard to feed information and passwords if any and a display device to show the needed information to the user. The other devices that are connected to the motherboard are the appliances through driver boards which will be connected to the Raspberry pi Motherboard through the GPIO ports.

The Main core concept of this project is to provide overall control of an automated home to user via a handheld mobile device. The system provides the user with control over Home door locks, Home video surveillance, and appliance status and on and off control, Media volume controls, other customizable interfaces. For this system we are using a Raspberry pi, which is powered by ARM11 processor, and 512MB ram running the Raspbian Linux open license OS.

There is a CMOS camera sensor which will send the data of the person standing in front of it to the Raspberry Pi board using the CSI port , and there using OpenCV library, the data will be processed and compared to already fed templates to know if the person is a known or unknown person. If an unknown person, then an alert and a photo of the person will be sent to the admin users Mobile phones, and if the person standing in front of the camera is a known person, then the system will prompt the users device either he wants to unlock the main door. Then there is another module to this project where the home appliances, surveillance, energy management, lighting, and security can be remotely controlled through the Mobile phone and this will be done through LAN port and the Raspberry board provides GPIO's (General purpose Input and Outputs) which is a major benefit of the board , by which all devices will be controlled.

B. Waterfall Methodology

We are using Waterfall Methodology for development of our project. The waterfall model is a sequential design process, used in software development processes, in which progress is seen as flowing steadily downwards (like a waterfall) through the phases of Conception, Initiation, Analysis, Design, Construction, Testing, Production/Implementation and Maintenance.

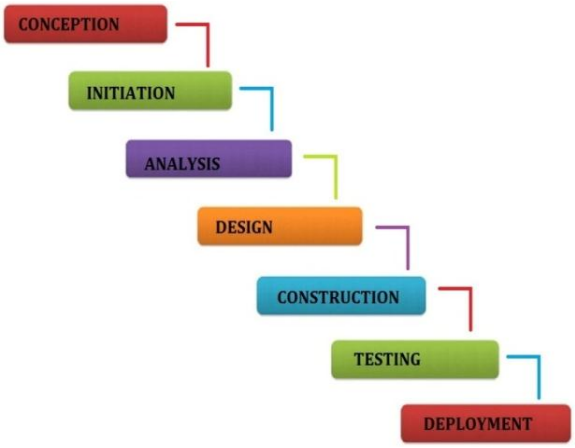

Fig. 2 Methodology

The waterfall development model originates in the manufacturing and construction industries; highly structured physical environments in which after-the-fact changes are prohibitively costly, if not impossible. Since no formal software development methodologies existed at the time, this hardware-oriented model was simply adapted for software development.

C. Face recognition

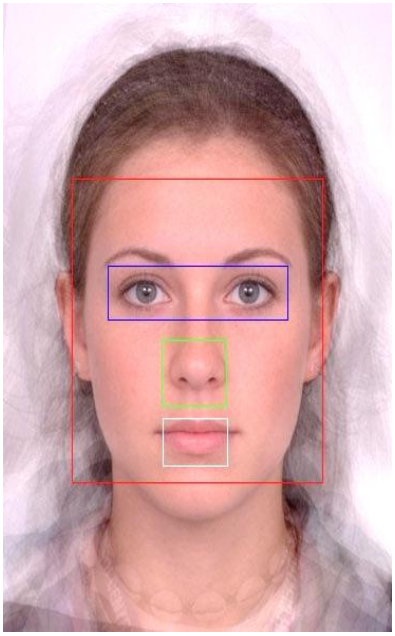

Fig. 3 Example of Face Recognition

Face Recognition is used in our project for identifying a person and providing authority to the right ones.

Face recognition is an easy task for humans. Experiments have shown that even one to three day old babies are able to distinguish between known

faces. So how hard could it be for a computer? It turns out we know little about human recognition to date. Are inner features (eyes, nose, mouth) or outer features (head shape, hairline) used for a successful face recognition? How do we analyze an image and how does the brain registration of the marker points is complicated, even with state of the art algorithms. Some of the latest work on geometric face recognition was carried out. A 22-dimensional feature vector was used and experiments on large datasets have shown, that geometrical features alone my not carry enough information for face recognition.

The Eigen faces method described in, took a holistic approach to face recognition: A facial image is a point from a high-dimensional image space and a lower-dimensional representation is found, where classification becomes easy. The lower-dimensional subspace is found with Principal Component Analysis, which identifies the axes with maximum variance. While this kind of transformation is optimal from a reconstruction standpoint, it doesn't take any class labels into account. Imagine a situation where the variance is generated from external sources, let it be light. The axes with maximum variance do not necessarily contain any discriminative information at all, hence a classification becomes impossible. So a class-specific projection with a Linear Discriminant Analysis was applied to face recognition. The basic idea is to minimize the variance within a class, while maximizing the variance between the classes at the same time.

It was shown by David Hubel and Torstein Wiesel, that our brain has specialized nerve cells responding to specific local features of a scene, such as lines, edges, angles or movement. Since we don't see the world as scattered pieces, our visual cortex must somehow combine the different sources of information into useful patterns. Automatic face recognition is all about extracting those meaningful features from an image, putting them into a useful representation and performing some kind of classification on them.

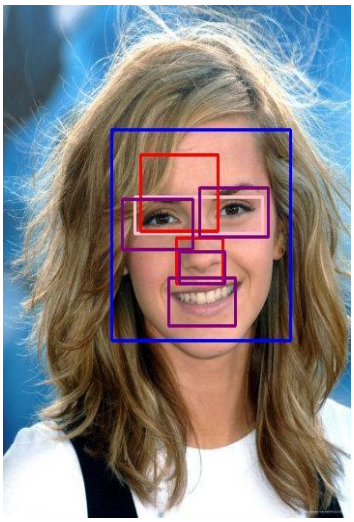

Fig. 3.1 Example of Face Recognition

Face recognition based on the geometric features of a face is probably the most intuitive approach to face recognition. One of the first automated face recognition systems was described and marker points (position of eyes, ears, nose ...) were used to build a feature vector (distance between the points, angle between them...).

The recognition was performed by calculating the Euclidean distance between feature vectors of a probe and reference image. Such a method is robust against changes in illumination by its nature.

Recently various methods for a local feature extraction emerged. To avoid the high-dimensionality of the input data only local regions of an image are described, the extracted features are (hopefully) more robust against partial occlusion, illumination and small sample size. Algorithms used for a local feature extraction are Gabor Wavelets, Discrete Cosinus Transform and Local Binary Patterns. It's still an open research question what's the best way to preserve spatial information when applying a local feature extraction, because spatial information is potentially useful information.

3. Overall Description

A. Product Description

There is an increasing need for Home security and automation due to increased rate of thefts and threats. And the benefits of automation are obvious. It is like the home of the future where food is cooked itself, clothes are washed itself and Lights came on after dusk. The need of surveillance and monitoring is essential in today's lifestyle. Energy management provides increased cut down on costs on energy in few years, saving as much as the funding needed to set up such an autonomous system.

The increasing ubiquity of heterogeneous computing devices such as laptop computers, palms, mobiles etc. shows that users prefer a ubiquitous access of a system rather than to be uncomfortably forced to go physically to the nearest control point. Remote control saves time and everybody is aware of this, it also provides increased security and flexibility. For example, if the user receives a SMS saying that there was an intrusion, he/she can connect to the internet and watch the video cameras inside the house to see what happens, another example could be the possibility to turn on the heaters from the distance using a mobile, laptop or PDA so as soon as the user reaches the house it will be hot already, this could be really useful especially in cold countries. As a matter of fact security will always be a main priority in all families, and prevention is better than cure. By receiving alerts in a portable device user is informed of all possible issues occurring in the house and it gives the possibility to deal with it using different ways of control like instant messaging, since many users are already familiar with the concepts and user interfaces of instant messaging. Good scalability properties, independence of location or geographical distance, and

high flexibility due to the different existing protocols make remote-controlling HASs suitable for most user needs.

B. System Functionalities

- Home Security using active Face Recognition with visitor alert and door locks control feature.
- Live streaming mode
- Appliance control mode
- Entertainment control mode
- Security feedback feature

C. Operating Environment

- Hardware Requirements

Server :
Raspberry pi B+ board overclocked to turbo mode
5 Megapixel Cmos camera.
Sonic range finder.
Illumination device (LED array)

Host device:
An android device with minimum of 512 Megabytes of RAM and a 1 GHZ processor.
100mb of free space.

- Software Requirements

Server :
Raspbian linux open OS.
Open cv

Host device:
Minimum required Operating System – Android Gingerbread 2.3.2

D. Algorithm

Face recognizing security feature.

Step1.1. System detects a person by sonic range detector
Step1.2. Board activates illuminator for better lighting conditions, favorable for better accuracy of face recognition.

Step2. System takes a photograph of the person 4 to 5 seconds after the sonic range finder is triggered. Meanwhile illuminator is on.

Step3. System starts active video Face recognition.

Step4. If person id matches a valid users template through face recognition it displays the person's name on user's android device with his photo and prompts an option to open the locks of the house door

Step5. If it does not matches the trained database for a valid user, the photo taken of the user is displayed on the android device.

Appliance control

Step1.The main board gets status of the the appliances through the GPIO port

Step2. Display the power status of each appliance either on or off , on the users android device.

Step3. If user togles the power status of any device on his device , toggle the power from the main board GPIO pins which drive relays , ultimately driving the appliance (load) on or off

Step4. Again display power status of each appliance, this time with feedback of the swittched on device.
Media control.

Step1. Display media controls (volume +, volume-, >>, << .) on android device

Step2. If user presses any buttons on the android device, contorl the media server as per the user request , either th volume or the track.

Conclusion

This project is highly customizable and very useful tool in present times. The development of this project will be done as the Raspberry pi offers customizable GPIO ports which help in easy programming and interface with the outside world, which can be addressed as inputs or outputs and can be controlled easily through only a one to two line code in python.

Future Scope

There is a great deal of future scope to this project because of rapid evolving technologies and the fact that this architecture or software structure can run on any ubiquitous computer, with a small amount of computing power. User has the freedom of customizing the system according to his/her will. And the environments of the home, can also be customized according to the users will . Therefore here we see a highly customizable aspect of this project providing a very rich future scope. The computing platform used is also highly experimented upon and there is high scope of future development in the RISC platform of computing architecture.

Predicting the future of just about anything is very risky business. Home automation is an industry that largely started with X10 devices in 1980. Today, we believe the future of home automation will very much ride the digital age and develop along with the computer and networking systems in the years to

come. Initially it appeared, companies such as Microsoft and Exceptional Innovation with their Life/ware software were positioning the Windows Media Center PC as the heart and soul of a complete solution for home automation relying on web services to seamlessly interface with lighting controls, climate controls, security panels, and IP surveillance cameras to compliment the digital media management capabilities of Windows Media Center.

However, Exceptional Innovation stopped selling their systems for residential installations, and Microsoft Media Center capabilities have disappeared in the Windows 8 OS.

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