

A NEW IMPLEMENTATION OF AUTOMATED SMART HOME CONTROL SYSTEM BY USING LABVIEW 2014 TOOL

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ABSTRACT

Smart Home Control Systems also known as Home Automation, is the act of controlling basic home functions through computer networks, both locally, remotely or even fully automated without the need of human intervention. In this paper authors implemented a home based control system using Lab View 2014 tool. As every system requires a framework for it to be built on, LabView is the program of choice for the designing and implementation of the Smart Home Control System as it is capable of handling data input, processing and data output from various types of signals and hardware. The completed system can also be hooked up to various I/O devices that are supported and tested by LabView. In overall this paper provided the hardware integration of smart home system.

Keywords: *Control System, Automated, LabView, Smart Home, Network*

I INTRODUCTION

Data Acquisition and Control concept refers to hardware and software solutions that are capable of receiving input, making calculated measurements and transform them into actions which control external processes [1]. Data acquisition is the step where factors such as voltage, current, temperature, pressure or sound is measured with a computer. Sensors pick up the analogue signal, sends them to the DAQ (Data Acquisition) device where it is pre-processed and converted into digital signals to be read by the computer. One characteristic of the system used further on in this project is split up into more than one modules, each having their specific function. In this specific project, there are 4 modules, each serving its own purpose. Generally the modules are split into 2 groups, one being the module accepting inputs and the other, processing inputs and converting them into useful processes that is required by the user. Having the modules separate also means that the modules handling the processes can stay active even though the module to accept inputs are turned off when not in use. This translates into a higher efficiency as less resources are required. Besides that, simple modules for receiving inputs allow

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for easy distribution of the module on smaller and less powerful devices. This also leads to another advantage, where the modules do not have to be located on the same computer to be used. Modules can be easily connected through the internet where users are able to control the whole system remotely. National Instruments is an organisation providing technology-based solutions for innovation and enhancing productivity. NI has helped engineers and scientists remove complexity from their tasks, enabling them to carry out their tasks exceeding expectations. Their solutions are implemented in a wide variety of industries, from consumer electronics to particle physics, NI has the right hardware and software platform to improve the pre-existing solutions.

1.1 LABVIEW

LabVIEW or Laboratory Virtual Instrument Engineering Workbench, is a graphical programming environment for visualizing, creating and coding engineering systems. Standing out from traditional text based programming such as C, C++ and Java, the ability of being able to use graphics in creating solutions that are understandable and easy to interpret by engineers have made LabVIEW become the top choice for engineers trying to transform their ideas into reality. Being targeted at engineers, LabVIEW includes equipment and functions commonly used in engineering labs. Engineers can then create a virtualized version of their systems before diving deep into the physical system. In addition to the graphical user interface, the ability to drag-and-drop “Virtual Instruments” (VI) into the programming interface greatly speeds up progress and keeps the programming code clear and concise. By abstracting all the complicated low-level processing and removing the need of combining different products to achieve the final solution, users are able to complete a whole system just by mastering LabVIEW and deploying the system without worrying about compatibility issues that may arise with current text-based programming paradigms. With LabVIEW, users are able to use a multitude of measurement and control hardware across different brands with seamless integration. Lastly, LabVIEW also provides all internet communication protocols which makes it the right tool for prototyping and deployment of Internet-of-Things systems. A solid implementation of the common TCP/IP protocol ensures good connectivity between systems and also ease of use for the end users.

1.2 FRONT PANEL

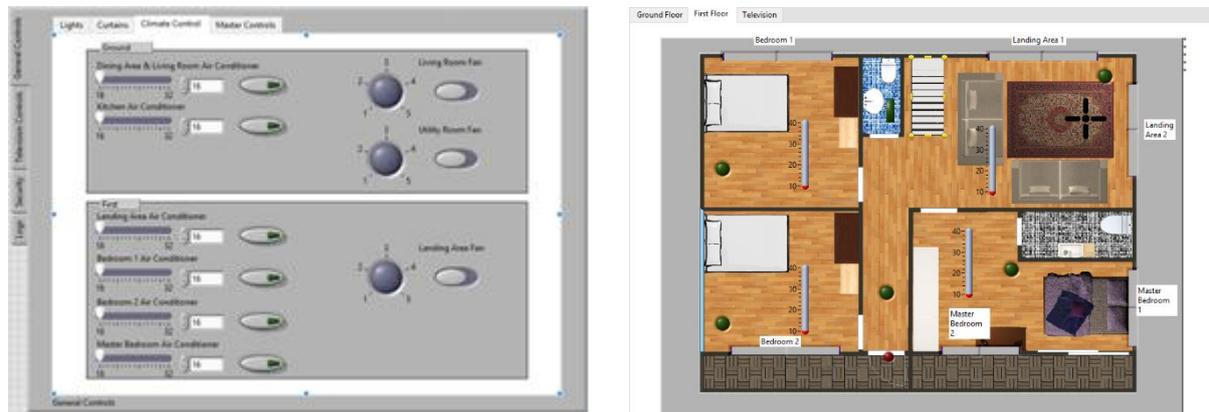


Figure 1. Front Controls and Control Indicators

The front panel of a VI is also the user interface or the VI. Using various controls and indicators, the front panel is built to allow input from users and also display of output processed by the VI. Controls that are present include toggle switches, push buttons, radio buttons, knobs, numeric input, text input; indicators include LED lights, numeric display, text display, graphs, animated pictures, and even ActiveX objects like Windows Media Player. Controls work as input devices, supplying data into the block diagram of the VI. After processing by the programming done in the block diagram, the indicators become output devices that display the outcome of the operations done in the block diagram and shown in “Fig.1” [2].

II. TCP/IP IN LABVIEW

TCP/IP stands for Transmission Control Protocol/Internet Protocol. It is a basic communication protocol used in the Internet. It can also be used in a local area networks as long as the devices support this protocol. It allows devices to send and retrieve data from other devices that also implement TCP/IP protocols. TCP/IP can be split into two layers, with TCP being the higher layer and IP being the lower layer. The Transmission Control Protocol is responsible of packing data into small packets to allow data transfer through the network. Internet Protocol layer however, is responsible of handling addressing of each packet. Each router on the network will check the address with a list of automatically updated tables and determine the direction of which the packet is to be forwarded to and shown in “Fig.2”. Each packet does not have to follow a same route to the destination, but each packet will be transferred sequentially [3].

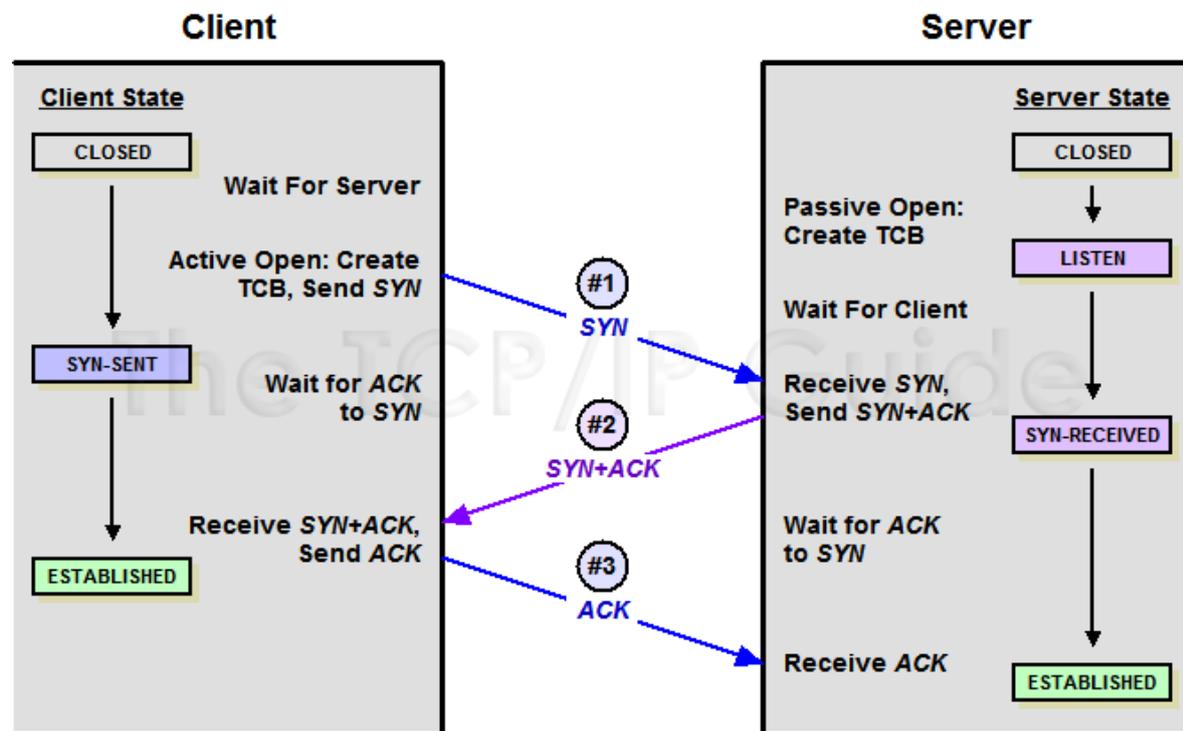


Figure 2: TCP/IP 3-way Handshake

The above figure shows a three-way handshake used in initiating TCP/IP connections, a SYN (synchronize) packet is sent to the server, it returns another SYN accompanied by the ACK (acknowledgement) packet. The client will then send another ACK packet completing the process of establishing connection between the client and the server. In LabVIEW the TCP/IP is implemented using various TCP/IP functions found in the TCP/IP palette. It is located in Functions -> Data Communications -> Protocols -> TCP Palette in the block diagram of LabVIEW. The TCP/IP functions in LabVIEW include TCP Listen, TCP Open Connection, TCP Read, TCP Write, TCP Close Connection and more. This allows TCP/IP communication between separate VI instances and over networks. TCP Open Connection function opens a TCP Connection with the address and remote port provided to the function. It will try to establish connection to the server within the time set in "timeout" and provides a connection ID to be used by other TCP functions such as TCP Write and TCP Read. The error out of the function will output error codes to help diagnose problems with the connection.

III. SMART HOME FEATURES

3.1 ALARM SYSTEM WITH LOGGING FEATURE

The alarm system implemented with the Smart Home control enables not only an alert to be triggered when an attempted break-in occurs, but also log the details of the alert on a log.txt file to be reviewed by the home owner. Login events (successful or failure) will also be included in the log files and displayed in the same manner. Many have faced the problem where the alarm is active, but nobody is there to react or take preventive

measures to stop future thieves from fulfilling their wishes. The records on login details are used to deter outsiders from trying to brute force the authentication system shown in “Fig.3”. Therefore the logging feature implemented is to supplement the pre-existing alarm system to further improve safety of the home.

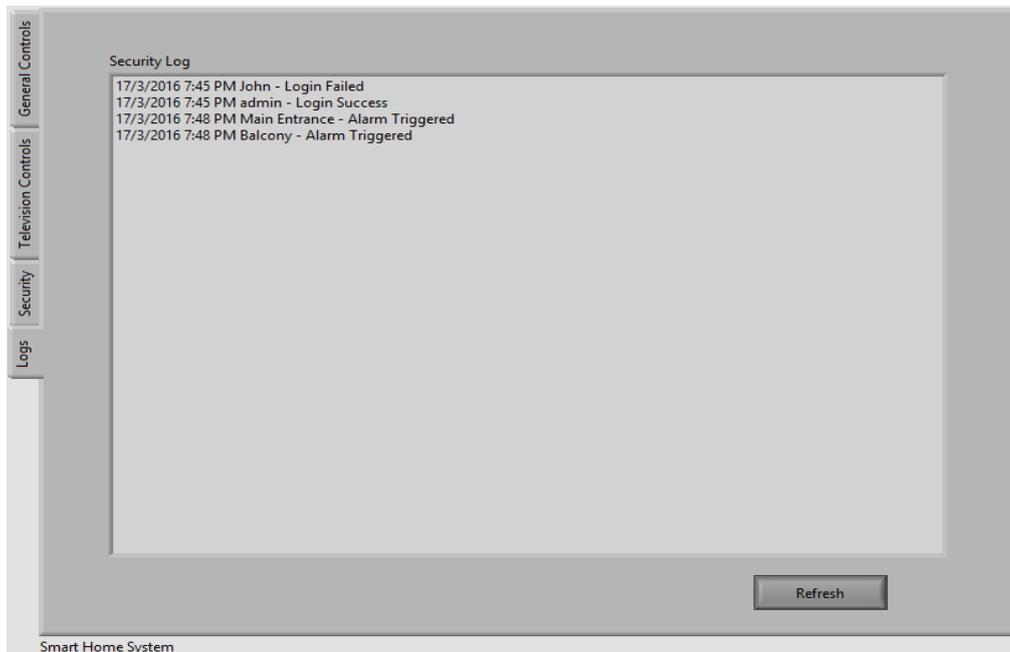


Figure 3. Security Logs

One major point in Smart Homes is the ability to save electricity and improve the quality of life. With motion sensing light controls built in to the washroom lights, the lights will only turn on when someone is using the washroom also shown in “Fig.4”. This is also very useful when a person is rushing to use the washroom, they do not have to worry about turning on the lights and forgetting to turn them off afterwards.



Figure 4. Automatic Lights

The TV Child Lock implemented with the TV controls are to prevent children from randomly pressing buttons on the controls and thus causing the channel, volume or other settings to change while the user is enjoying his/her favorite TV show and shown in “Fig.5”. The child lock will disable all buttons on the TV Control panel but still allow other controls of the home to be modified, it only affects TV Controls.

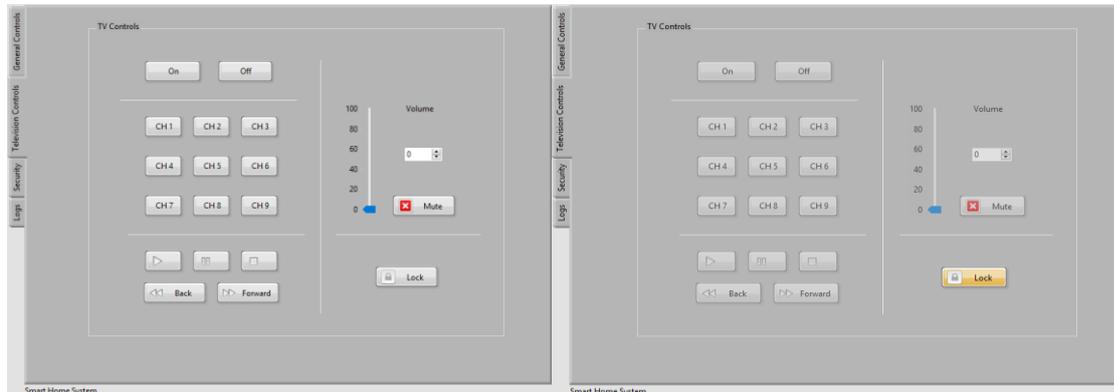


Figure 5. TV Unlocked and Locked

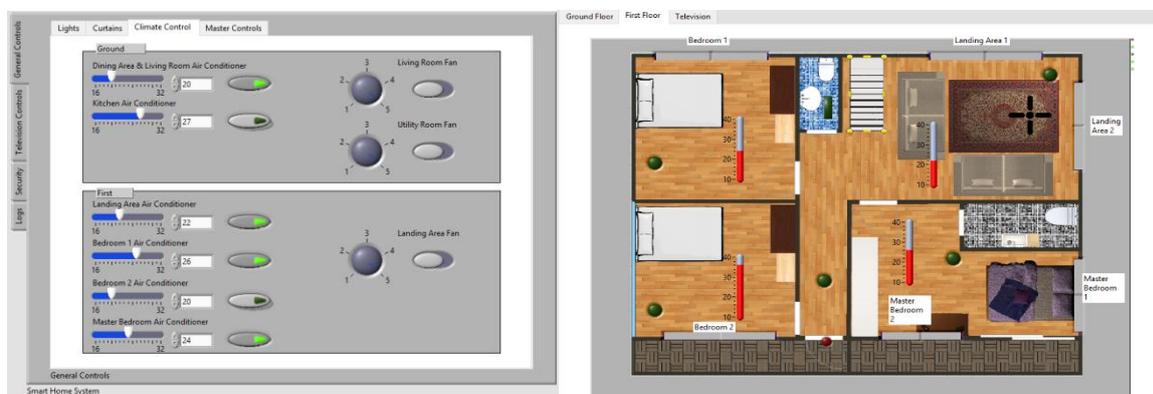


Figure 6. Air Cond Controls and Indicators

The air conditioning for the smart home is set up so that the temperature of the smart home stays at the temperature set without going down further like traditional air conditioning systems. This is convenient to home users not having to manually turn the air conditioning on or off based on the ambient temperature and also saves electricity in the long run shown in the above “Fig.6”. The air conditioning will turn on as the temperature exceeds the threshold set, and will turn off as the desired temperature is reached.

3.2 MASTER CONTROL

The master control panel is a set of settings used to control the settings of the whole smart home. Lights, curtains, air conditioning, fans are all controlled from the master control. With a precautionary measure, users are required to switch the radio control to “On” before the master control panel is activated. This smart home system is deployed on the assumption that the control panel and server is running on the same computer. The smart home system is also assumed to be running without any delay and reacts to requests instantly. The master control panel is a set of settings used to control the settings of the whole smart home. Lights, curtains, air conditioning, fans are all controlled from the master control. With a precautionary measure, users are required to switch the radio control to “On” before the master control panel is activated shown in “Fig.7”.

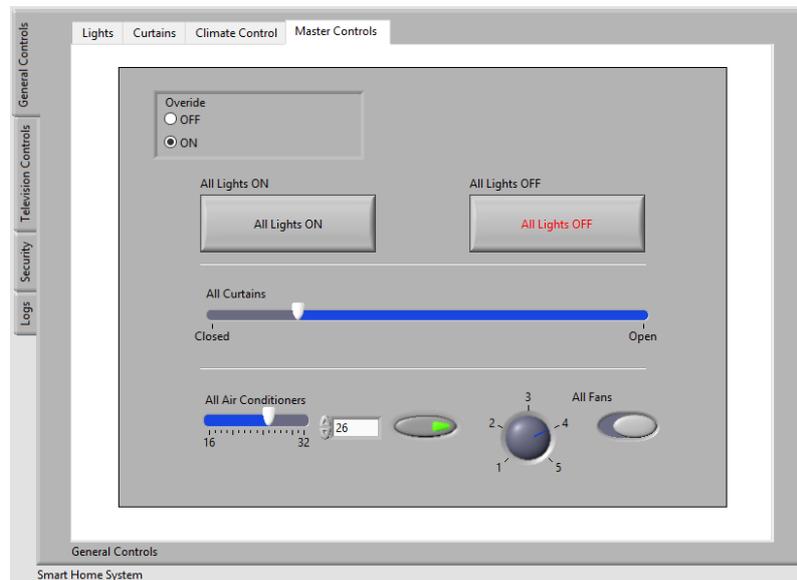


Figure 7. Master Control Panel

IV. LIMITATIONS

As perfect as the system may be, there are still limitations to every system. In the smart home system, the server must always be online for any appliance to work. If the power goes down, the home system would not work, most essentially the alarm system. Without power, the alarm is not able to trigger and log down any activity to the server log files. The system is not able to provide sound alerts due to a lack of codec support in the VI environment. The security is only limited to break-in attempts and not including windows and motion detectors. Besides that, most of the electrical appliances such as microwave, washer, dryer which require more complex controls instead of a basic on/off or value selector is not able to be implemented in this smart home system. The graphical user interface, while being clear and concise, fails to provide a programming interface that is compact and easily reused for different objects. Therefore the smart home system lacks automation in terms of timed light controls with light sensors, automatic fan controls and timed alarm systems.

V. FUTURE ENHANCEMENTS

In the future, the system can be improved by adding motion sensing equipment and cameras on the areas surrounding the premise. The cameras can then be run for a set period of time after motion is detected to record the face of the perpetrators. The files can also be saved in an archive, be viewed remotely and then be sent to the relevant authorities for further action. The automation of lights and fans can be applied with the use of light, humidity sensors. Instead of only using a time-based approach for the lights and fans, the data from the sensors can also be used to calculate if the device should be turned on. This will further improve eco-friendliness of the smart home. Air conditioning can also be turned off if there is nobody in the selected rooms.

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Next up, the smart home should also include outdoor devices such as mailboxes and sprinklers. The owner will then know when to pick up his mail and also automate the sprinklers to only activate when the water content in the soil is low. RFID technology can also be implemented to the alarm system so that the house can automatically unlock whenever the owner approaches the house. This will help in situations where it is not convenient for the owner to pull out his phone to manually unlock the doors. RFID can also be used to automate unlocking room doors based on each user's specific RFID tag in their devices. All the electrical appliances can be Wi-Fi-enabled to reduce the wiring cost and cost of implementing enterprise grade networking equipment. With Wi-Fi, the appliances can be easily connected to the network without the need of tedious cable work. With integration with Internet-Of-Things, the smart home system can be set-up to be more user-centric and change controls based on Wi-Fi-enabled wearables such as heart rate sensor and blood pressure sensors. Smart homes can manipulate the variables of the home environment to best suit the users' mood and condition.

VI. CONCLUSION

In the grand scheme of things, this Smart Home Control System is successfully developed and is definitely useful in making it convenient for the home owners to monitor and control functions in their house and provide energy savings in the long run. The ability to control all the major functions in the home such as lights, climate control, alarms, curtains are all embedded in this system that is completed in mere months. The intuitive user interface that resembles classic controls will help new users especially the elderly as it is familiar to traditional switches used. In the near future, Smart Homes will be a thing of norm in our society. For now, the only obstacle preventing smart home industry from bursting into fame is the lack of applications that provide the ease of use and seamless transition from a physical toggle to a touch screen control. (Tso, 2014) With LabVIEW, it is possible to create a smart home system that is easy to use and with an easy learning curve. By automating many of the functions in the home, it is possible to increase the efficiency of electric and water use, but at the same time provide the same level or better living experience in the homes. With home automation, users have more time to ponder upon more critical issues than wasting time figuring out whether if the front door is locked. Last but not least, a lot of continuous research is still required to expand smart homes and integrate Internet-of-Things into smart homes. A cry for an open standard protocol for all appliances to inter-connect is present in the world where brands try to monopolize the market with proprietary software and APIs. With the establishment of a public open source standard and a platform for users to create their own interfaces, the adoption of smart homes are sure to skyrocket in the future.

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