FPGA Based Smart Home Automation Device Controller

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Abstract

Due to technology advancements, everything is becoming smarter today. Home automation is one of these most intelligent things. Network-enabled digital technology has been rapidly incorporated into home automation in recent years. With the use of these technologies, it is now possible to automate the home by increasing the connectivity to many appliances. Wise control of electrical and electronic gear in a house or business is known as home automation. The primary concerns of home automation are safety, security, and comfort. This paper proposes a smart home automation controller that interfaces gadgets and sensors to a field programmable gate array (FPGA) to control security and comfort. Home automation controller design carry out tasks including water level indication, door lock security, light on or off depending on door open/close, alerting of windows, and managing of electronic appliances. Xilinx ISE and Verilog HDL were used to implement the suggested design on the FPGA.

Keywords—Alarms, FPGA controller, Sensors, Smart Home, Verilog HDL.

1. INTRODUCTION

Security is a significant part of any business, it is exceptionally useful for humankind to foster a framework that will forestall any break-ins to the home. There are numerous things in an individual's home that are valuable and important, and home automation systems can help secure them. With just one click, you can control the doors, windows, fire alarm, and temperature, ensuring that they are all secure. To control these devices from one place without having to get to the specific location for each action, whether the occupants are home, out, or just sitting in one place[1]. In a certain order, the controller checks each of the devices periodically . A controller or any gadget associated with all other gadgets that should be secured and control the framework. All devices communicate through sensors attached to them. A home automation system can fulfil such needs by providing a secure and comfortable living environment.

This undertaking is to plan a regulator, which gives a robotized home security framework at a reasonable cost [2]. The boundary sensors associated with the regulator will give the expected signs that will actuate regulator to process and make the predetermined move. A framework is intended to control well-being, solace and savvy water tank sign, alarm, charging caution water alert charging alert, windows caution and solace applications are likewise evolved in this undertaking. This undertaking can be stretched out later to control more gadgets or cycles and besides can be web empowered.

2. LITERATURE SURVEY

Ravi Payal, et al [3] security framework recognizes the fire and gate crashers through the entryway, window and carport. Advanced frameworks configuration is the underpinning of savvy home task. Solace and reliability of a house are directed by using this undertaking. Shrewd home robotization is carried out with a savvy Verilog code in this paper. Security, safety and solace are constrained by interacting gadgets and sensors to handle programmable entryway exhibit contracted as FPGA. The code has been incorporated on Xilinx tool. FSM ideas are utilized. Re-enacted waveforms a reacquired and confirmed

Carl J. Debono et al [4] "Implementation of a Home Automation System through a Central FPGA Controller" Innovation headway's have made conceivable the execution of inserted frameworks inside home machines. This has included new capacities and components, in any case, as a general rule, the implementations are elite, and frameworks organization is ludicrous constantly. Notwithstanding, there is a rising interest for splendid homes, where machines answer subsequently to varying regular terms and can be conveniently supervised with one ordinary contraption. This paper presents a likely game plan by which the client controls contraptions by using a central FPGA controller to which the devices and sensors are communicated. Command is passed to the FPGA from a mobile by interfacing it with Bluetooth. The results are basic, practical and it is a versatile system, turning it into a decent possibility for future keen home arrangements

Prasanna S. Bhoite, et al [5],"Wireless Signal Transmission utilizing an Android Portable and FPGA", Today's organizing innovation utilizes remote frameworks generally for the Web of Things (IOT). Trade of control orders and information between gadgets should be possible utilizing remote innovation in spite of the fact that they were at first intended for voice correspondence frameworks. The equipment utilized for the venture incorporate a Bluetooth module communicated with FPGA board, an Android portable with blue term application introduced on it and a Drove light associated with the FPGA board to show the effective transmission. The remote innovation is the most encouraging and famous innovation to control gadgets remotely subsequently the work in this paper, with some change and improvement, can be utilized to fabricate the proficient remote-controlled applications.

IOT utilizes Wi-Fi to trade information remote for huge distances utilizing Web. IOT module (ESP8266) is utilized to control the home modern machines in far off regions anyplace on the planet. Sequential Correspondence trades the information among FPGA and IOT module.

3. HOME AUTOMATION

The great target of this proposed framework is to give the framework for minimal price and simple to use alongside that has high reliability and well-being. This framework is utilized to beat the downsides. The idea of this framework is to supervise the gadgets inside the house. The home automation block diagram is shown in fig.1.

As Home Computerization is an association of hardware, correspondence, and electronic marks of connection that work to organize customary contraptions with one another through the Web. Every contraption has sensors and is related through Wi-Fi, so we can manage them from PDA or tablet whether we are at home, or a long ways off[6]. This enables us to switch on the lights, cease the front doorway, or even switch 0ff the power..
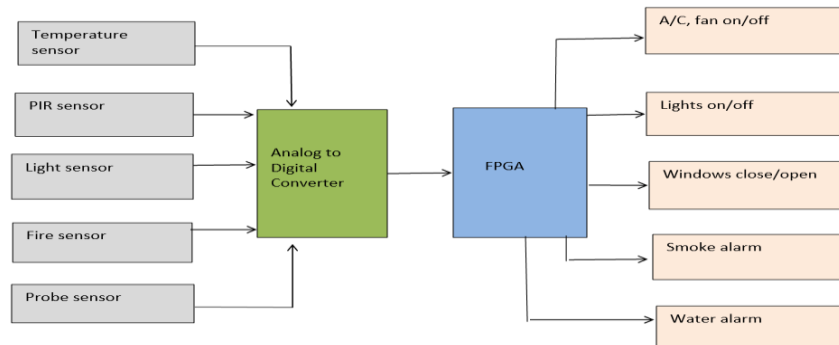

Fig 1: Home Automation Block Diagram

There are three principal components of a home Automation framework:

Sensors can screen changes in sunlight, temperature, or movement identification. Home Automation frameworks can then change those settings (and that's just the beginning) to the inclinations.

Regulators allude to the gadgets like PCs, tablets or cell phones used to send and get messages about the situation with robotized highlights in home.

Actuators might be light switches, engines, or mechanized valves that control the genuine instrument, or capability, of a home mechanization framework. They are customized to be initiated by a remote order from a regulator.

3.1 Sensor Module

1) Temperature Sensor:
Here we are involving LM35 as temperature sensor. For this situation we will get the result which is relative to the temperature, the worth will be in degree Celsius. LM35 is more precise than ordinary thermistor. There won't be event of oxidation due to the use of fixing over the hardware. On contrasting and thermocouple LM35 produces higher result voltages. Since it is delivering higher result voltage, there is no need of independent intensification. Through involving this addition as well as decrement in the temperature can comprehend. It is having most extreme stockpile voltage of 35v and greatest result voltage of 6v.[7]

2) PIR Sensor:
A PIR motion sensor recognizes the movement of things.This sensor is widely utilized with an ultimate objective of wellbeing alerts. It recognizes the movement of any article in its surroundings. This sensor includes pyroelectric sensor, which can recognize the infrared radiation at various stages. It doesn't emanate the genuine energy anyway gets the energy inertly. It perceives the radiation from the surroundings. With temperature the presence of human or an article can be recognized. The PIR sensor doesn't discharge and convey the energy. The

Pyro sensor sees the advancement of an article variations in temperature. The perceived radiation changes over into electrical sign. Then, this sign boats off the outcome that is the caution. Alert indicates that a person has gone inside.

3) Light Sensor:

Here, the radiance sensor is using LDR. This LDR involves photoresistor which is includes silicon material. This sensor responds as soon as it recognizes the light. When the light beams fall on it, then, at that point, quickly the resistor likewise changes. At the point when the light level expands the opposition esteem additionally increments. At the point when the light level declines the opposition esteem likewise diminishes. The LDR will perceive the light through that resistor it responds to it and it will ship off framework according to it. With the goal that consequently the capabilities will work. The resistor diminishes in the brilliant and expansion in dim. In this lengthy frequency resistors are utilized. The light sensors is available in various models, sizes and shapes.

4) Fire/Smoke Sensor:

The smoke sensor senses the fire/smoke in our surroundings. Smoke sensor is a functioning assurance to individuals which cautions individuals with the alert. Whenever there is an existence of fire/smoke these sensors will turn on. The smoke sensor sees the infrared fire streak technique which permits recognizing the fire and intensity. It will answers effectively at specific reach .When the sensor distinguishes the smoke, it will convey a message to the caution framework to actuate , then the caution gives alert with the sound. Utilizing this sensor, the harm of the frameworks is limited.

5) Probe/Water Level Sensor:

To measure the water quantity and for recording data this sensor will be useful . At a point when the water quantity is peak or less this sensor conveys a message to the board to set off the alert. To deal with the water quantity the test sensor assists with controlling it. On the off chance that the water is unfilled in tank, the test sensor will identify the conductivity of opposition in it then it sends the data through a signal. By utilizing the caution the client receives the data regarding the measure of the tank.

3.2 Security Module

Security module includes door lock and windows alerting.

1. Door Lock:

When an individual at the door step enters the secret key accurately it initiates to the high and unlocks the entryway consequently if not the caution will ring.If the client fails to remember the secret key or mistypes the secret key abruptly, they can attempt the secret key again by tolerating the message which they will get to their account.The initial step is to introduce the counter to nothing.Once the counter is set, four-digit secret phrase is placed. Assuming that the got secret phrase is right, entryway is opened else count is augmented by one. In the event that the count isn't equivalent to three, secret phrase can be returned again else assuming count is equivalent to three, the entryway is locked.[8]

2. Windows Alerting:

The sensor detects the climate, assuming that it is downpour/wind/thunder the windows will close any other way windows will open. Flow chart for door lock is shown in fig.2.
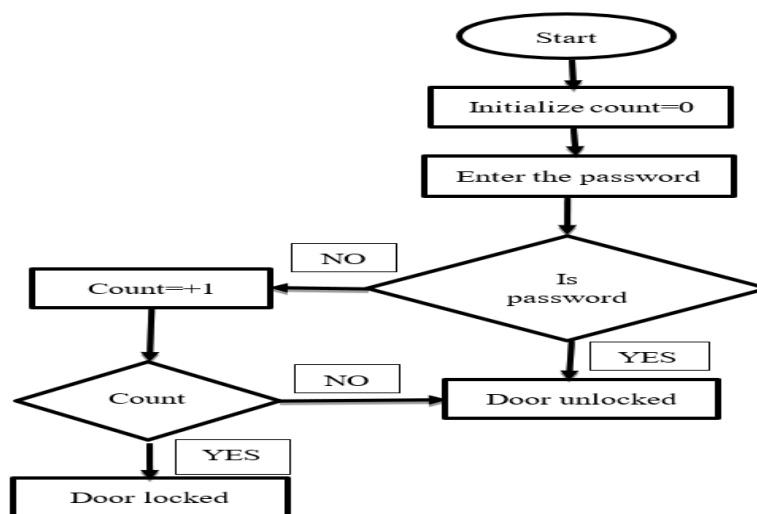

Fig 2: Flow chart for door lock

3.3 Comfort Module

Comfort module includes Lights ON/OFF based on door open/close and water level indicator.

A. Water Level Indicator:

The tank is full or not is demonstrated using a water level pointer with the assistance of a signal.

B. Automatic Lights On/Off Based on Door Open/Close:

After unlocking the door, the PIR sensor senses the event of entering the house. The stream graph for programmed lights on/off in view of entryway open/close is displayed in fig.3. The initial step is to introduce the sensor, here we are utilizing the PIR sensor to detects the article development. Assuming the sensor detects the item development (i.e., entryway open) the lights will be ON any other way lights will OFF.
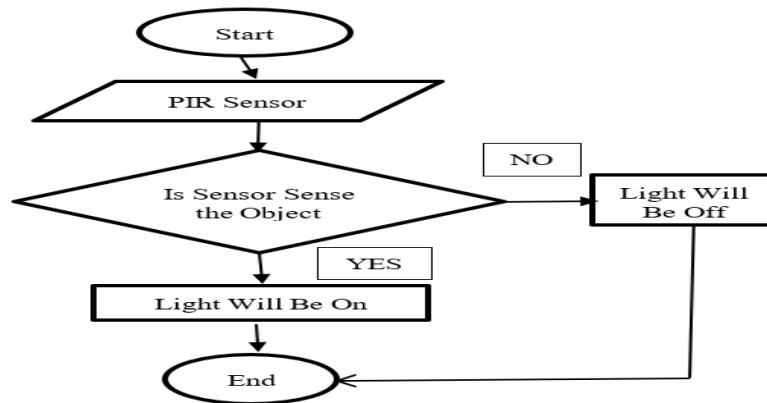

Fig.3: Flow chart for automatic light on/off

3.4 Safety Module

A. Water Alarm:

So these are initially in starting stage, these are position to zero phase just so next activity we resemble assuming condition resembles we on the engine the water level beginnings increment we are given 4 cycle input that mean most elevated esteem is 15 right so level comes till 14 addition is finished yet it not over stream then the condition is in else on the off chance that not increase then, at that point, remain in same condition or, more than likely caution rings .

B. Fire Alarm

When fire level beginnings increment, we are given 4-digit input that mean most elevated esteem is 15 right so level comes till 14 augmentation is finished yet it not over stream then the condition is in else on the off chance that does not increase then stay in same condition or, more than likely alert rings.[9]

C. Current Alarm

So current is fundamentally in starting stage these are position to zero phase just so next activity we resemble assuming condition resembles we on the meter it ought to have greatest number of readings just so the perusing level beginnings increment we are given 8 bit input that mean most elevated esteem is 256 watts right so level comes till 250watts augmentation is finished yet it not get more number then the condition is in else on the off chance that not increase then, at that point, remain in same condition or, in all likelihood caution rings.

D. Charging Alarm

Charging are fundamentally in beginning stage these are position of zero phase just so next activity we resemble assuming that condition resembles we on the switch the battery level beginnings increment we are given 4 bit input that mean most elevated esteem is 15 right so level comes till 14 addition is finished however it not over charged then the condition is in else in the event that not increase then, at that point, remain in same condition or probably caution rings.

E. Motor Alarm ON/OFF:

- Water level sensor senses the level of the water in the tank, note down the recordings.
- If the water level is less than the value 3 then alarm is ON and then have to ON the motor, water is pumping
- If the water level reaches to the value 10 or greater than 10 then alarm goes to OFF and then have to OFF the motor.

3.5 Verilog HDL

In the VLSI industry, Verilog is a gear entrancing language utilized to show electronic systems. Verilog HDL is one of the most customarily elaborate language in the arrangement, check, execution of mechanized reasoning chips at the RTL of consultation. This is like manner used in the check of straightforward and going against message circuit. The design in Verilog holds pecking order of elements that are subsequently attached and functions as total framework.[10].

4. RESULTS

A. RTL Schematic

The RTL schematic is truncated as the register transfer level it signifies the blueprint of the architecture and is utilized to check the planned design to the ideal design that we are needing improvement. Fig.4, fig.5 and fig.6 are showing the RTL Schematics of different modules.

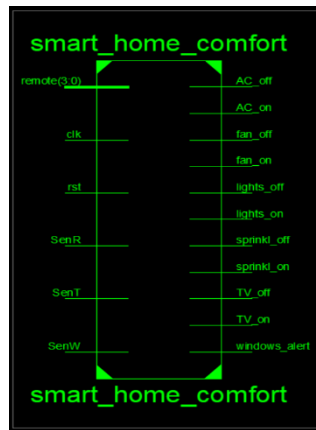Fig.4: RTL Schematic of smart home safety

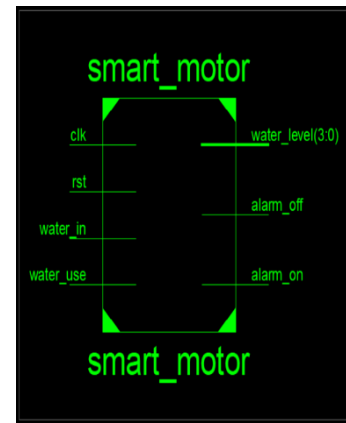Fig.5: RTL Schematic of smart home comforts

Fig.6: RTL Schematic of smart motor

B. Technology Schematic

The innovation schematic makes the portrayal of the architecture in the LUT design ,where the LUT is consider as the boundary of region that is utilized in VLSI to appraise the engineering plan .the LUT is consider as a square unit the memory distribution of the code is addressed in there LUTs in FPGA. The technology schematics and simulation results of smart home modules are shown in fig.7 to fig.12.
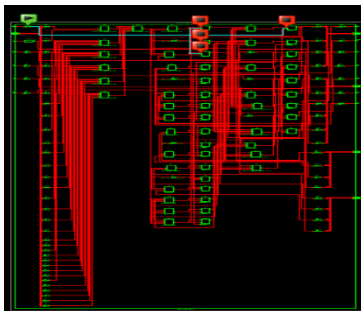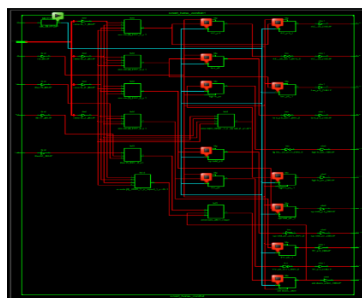

Fig.7: Technology Schematic of smart home safety

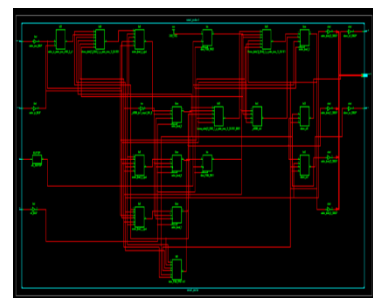
Fig.8: Technology Schematic of smart home comforts

Fig.9: Technology Schematic of smart motor
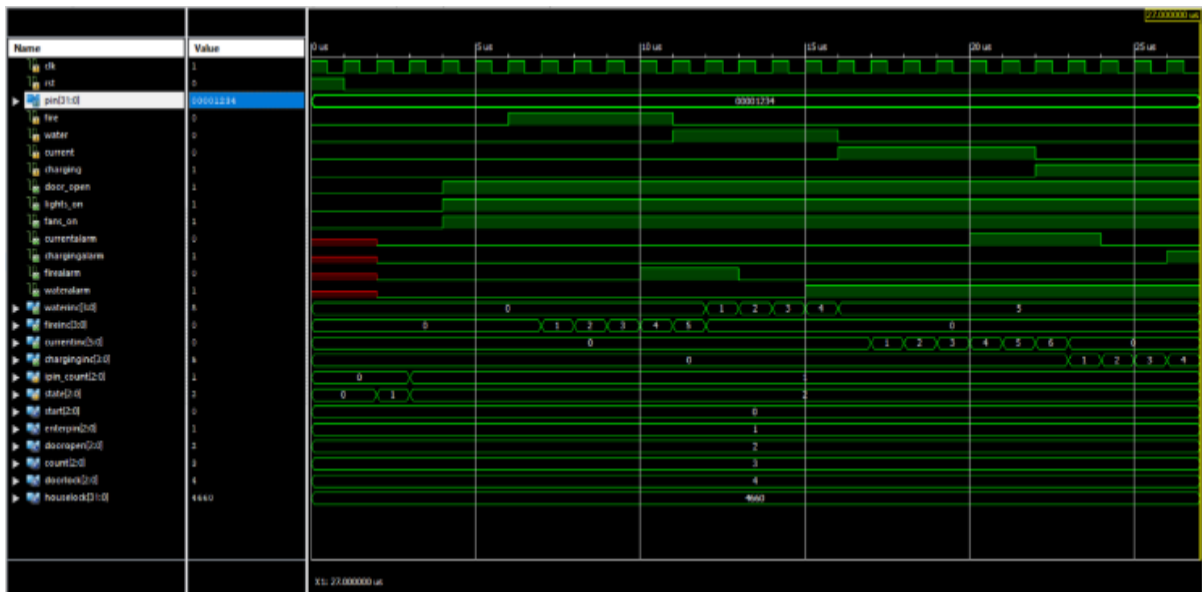
C. Simulation Waveforms

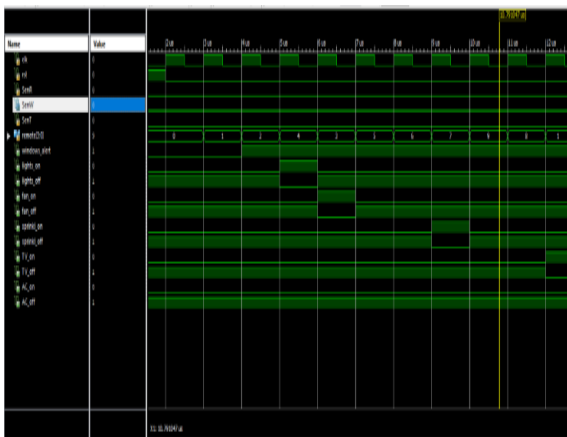Fig.10: Simulated Waveforms of smart home safety

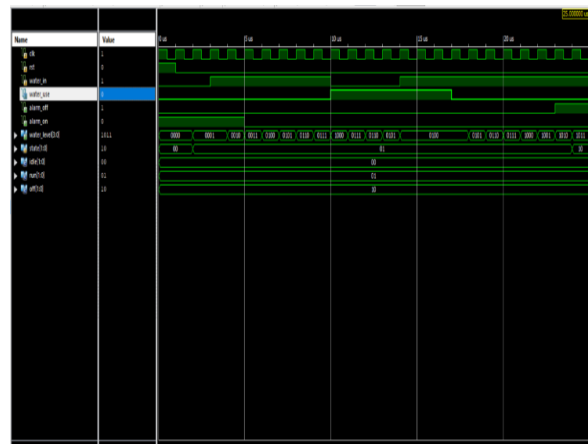
Fig.11: Simulated Waveforms of smart home
comforts

Fig.12: Simulated Waveforms of smart home motor

5. CONCLUSIONS AND FUTURE SCOPES

The goal of this paper is to plan a regulator at a reasonable cost which contains a robotized In-house security framework. This kind of controller is minimal expense and it very well may be upgraded to cutting edge regulator by rolling out couple of improvements. It is extremely simple to utilize and we can coordinate with some other device. The Savvy home works on the way of life of the control of the home gadgets. The essential boundaries are security and solace of a home. Home Computerization includes shrewd monitor and control of gadgets in home. In this undertaking, Savvy home mechanization regulator was proposed in which Security and solace is constrained by connecting gadgets and sensors. Home Computerization regulator configuration performs tasks, for example, water level pointer, entryway lock security, light on or off in view of entryway open/close, windows cautioning, controlling of electronic machines are planned . This proposed plan executed and integrated on Xilinx ISE vertex low power utilizing Verilog HDL.

For future advancements, there are couple of suggestions for making this framework an attractive item. Execute the equipment part by utilizing the sensors and gadgets. Simply fabricating it on a chip makes it a gadget that can be installed to a computer and so on. Improve it as web empowered to remotely control the framework. The proposed plan was entirely adaptable so we can expand similar plan with additional security and solace applications in future.

The dream is a future where data is bestowed among devices and human without relying upon manual commitment of individual bytes. There are a few new advancements which can turn into a piece of home soon:

- Increased efficiency, control, and customization
- Integration of Smart home devices
- Child Monitoring
- Smart spaces outside homes
- Development of smart appliances

REFERENCES

[1] N.Chintaiah, K. Rajasekhar, V. Dhanraj, "Automated Advanced Industrial and Home Security using GSM and FPGA", International Journal of Computer Science and Information Technologies, vol. 2(4), 2011.

[2] Dr. Sanjeev Sharma, "FPGA Based Cost Effective Smart Home Systems", International Conference on Advances in Communication and Computing Technology, Ahmednagar, India. February, 2018.

[3] Ravi Payal, Akanksha Saxena, Beena Chanda, "Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language", IEEE International Conference on Advent Trends in Multidisciplinary Research and Innovation (ICATMRI),Buldhana, India, December 2020, 10.1109/ICATMRI51801.2020. 9398499.

[4] Carl J. Debono; Kurt Abela, "Implementation of a home automation system through a central FPGA controller",16th IEEE Mediterranean Electrotechnical Conference, Yasmine Hammamet, Tunisia,March 2012, DOI:10.1109/MELCON.2012.6196513.

[5] Prasanna S. Bhoite , Madan B. Mali, "Wireless Signal Transmission using an Android Mobile and FPGA", International Journal of Advanced Research in Computer and Communication Engineering, E&TC, Vol. 5, Issue 5, May 2016

[6] P.A Bawiskar and Prof R . K. Agrawal, "FPGA Based Home Security System", International Journal of Innovative Research in science Engineering and Technology, Vol. 4, Issue 12,December 2015, DOI:10.15680/IJIRSET.2015.0412139.

[7] Nikhat Parvin, Pramod Kumar Jain, Devendra Singh Ajnar, "Automated and Secured Smart Home through FPGA Controller", International Journal of Innovative Technology and Exploring Engineering, Volume-8 Issue-11, September, 2019.

[8] Greeshma Arya, "Smart Home Implementation using Verilog Hardware Descriptive Language", International Journal of Engineering Research & Technology (IJERT),Vol. 11 Issue 02, February, 2022.

[9] Kandepi Madhuri B Likhith Sai Bysani Sai Sirisha, "A Home Automation System Design Using Hardware Descriptive Tools", International Journal of Engineering Research & Technology, Vol. 2 Issue 7, July, 2013.

[10] Komol Arafat Gani, Farzana. Yasmin, A B M Najmul. Karim Iqbalur. Rahman, "Home Automation System Design Using Verilog Hardware Descriptive Language", International Conference on Recent Trends in Computer and Information Engineering, December, 2013.