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IoT based home automation using FPGA

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Abstract— Comfortable lifestyle is improving with the advance in technology day by day. Internet helps us provide any required information which any individual wants. IoT abbreviation for Internet of things helps us not only to get a comfortable lifestyle but also helps us to establish smooth and errorless transfer in communication. In Home automation any appliance can be connected through IoT and can be used by our smart phones through application. Home automation is the future to smart homes. Wireless Communication using Wi-Fi is always placed into consideration compared to wired communication, as it is not only reliable but also easy to use. Wireless Communication like Bluetooth, Zigbee have a very short range. IoT uses WiFi to transfer data and it also helps to transfer data over a long-range using Static IP address and Internet. FPGA helps to establish smooth connection between FPGA and home appliance. FPGA board provides high security and flexibility to the circuit. Home appliances are controlled using FPGA board and it receives commands in serial communication from IOT Module through the application in the smart phone. It can also give us alerts through our application and also through the web IP address which can be protected by password. It can also help us in long distance communication with the home appliances. There many more advantages which can help us lead the comfortable lifestyle with IoT and FPGA board.

Keywords— IoT (Internet of Things), FPGA, VHDL, Hardware Description Language, Android Application

1. INTRODUCTION

Technology helps us connect worldwide where information can be transferred within seconds. Wireless communication is preferred over wired communication, as it is fast and also easy to access with the developing technology. Technology also helps us getting comfortable and having an approach to our daily work in an easiest way possible. IoT technology is the most efficient and easiest way of communication. IoT can be accessed through IP address and can be accessed through web.

Compared to Bluetooth Modules IoT Modules are cheaper and can give required output with minimum errors. Home Automation is the process where you can access your household equipment's through your smartphone or through web. The IoT module used in this project is ESP 8266 (NodeMCU). IoT when used with FPGA Board gives not only an easy and flexible communication but also increases the security of the communication transferred. The FPGA board used here is Spartan 6 Starter Kit. FPGA also provides high output where many applications can be implemented which can help us convert our home into smart home. Also, long distance communication can be established between the user and the home appliance.

2. PROBLEM STATEMENT

While people are pursuing ever growing high quality of their lives today, also considering pandemic issues, social distance and personal hygiene is important. Usually, conventional wall switches are located in different corners of the house and thus necessitate the need of manual operations like pressing to turn the loads on or off. It becomes difficult for an elderly or physically handicapped people to operate them. This leads to more facilities and home appliances included at their places where the control is handy and easy to use. High security and error less appliances are also a high quality of their lives today. In this work an attempt is made to control various electronic devices by an android application.

3. IMPLEMENTATION The basic flow of the circuit connection goes as per the block diagram. Here we begin with a Mobile phone where basically an android application is developed using MIT app inventor to control the home appliances. The application is developed using MIT App inventor which is an online open-source platform. The next is the IOT Module that is ESP 8266 (NodeMCU) it is a Universal Asynchronous Receiver/ Transmitter to Wi-Fi module. This module is easy to use and can be easily connected to any FPGA

wirelessly to the internet. By simply connecting FPGA to the IOT Module serial communication can be done using the Internet. The next connected is the FPGA Board where we design hardware by coding for this project, we have used VHDL language which is a hardware description language. FPGA board controls the home appliances through relays. FPGA provides flexibility and security. It basically comprises of all the instructions that are utilized to control the home appliances.

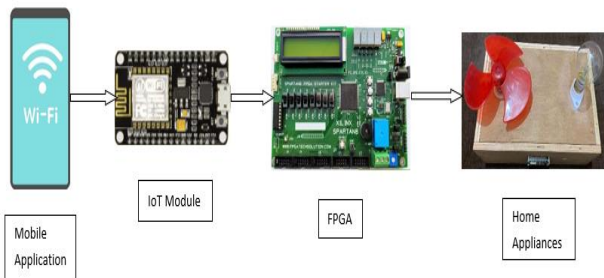


Fig. 3.1. Block Diagram

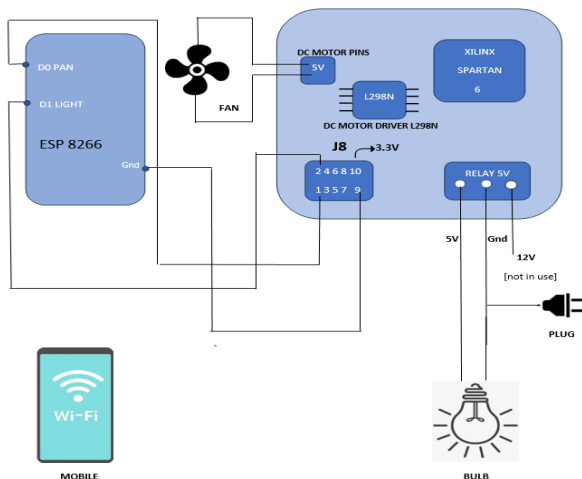


Fig. 3.2. Interfacing of circuit

Turn ON the Wi-Fi in our mobile phone and ensure that the Wi-Fi is in ON condition. Once the Wi-Fi is turned ON it gives control supply to the ESP8266 IOT module and pairs it with the android mobile by means of Wi-Fi. Once the pairing is finished, it is secured by Static IP and port number given by the Arduino IDE. Ensure that the IoT module is connected with the power supply. Then interface the FPGA and the ESP8266 module. This exchanges the data in serial way. Presently, design application bit file in target FPGA and afterward give the guideline. This direction given to control the appliances that are to be controlled. Once, if a guideline is given in the application, FPGA gets the direction by means of serial port and after that it checks whether the given guideline has valid address or not. If the direction is valid then the appliances works and on the off chance that it is not valid, the system will repeat the procedure until a valid guideline is given to the FPGA. At the end are the Home appliances where we are using a Bulb and Fan. Fan (1000 RPM Motor) is connected to the DC motor driver and the Bulb is connected to the 5v Relay present on the FPGA Board.

4. VHDL CODE

```

• FPGA Code (configuration of Target Devices):
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
entity FINALHM is
    port (LIGHT_IN, FAN_IN: in std_logic;
    LIGHT_OUT, DC_M1, DC_M2, RELAY: out std_logic);
end FINALHM;
architecture Behavioral of FINALHM is

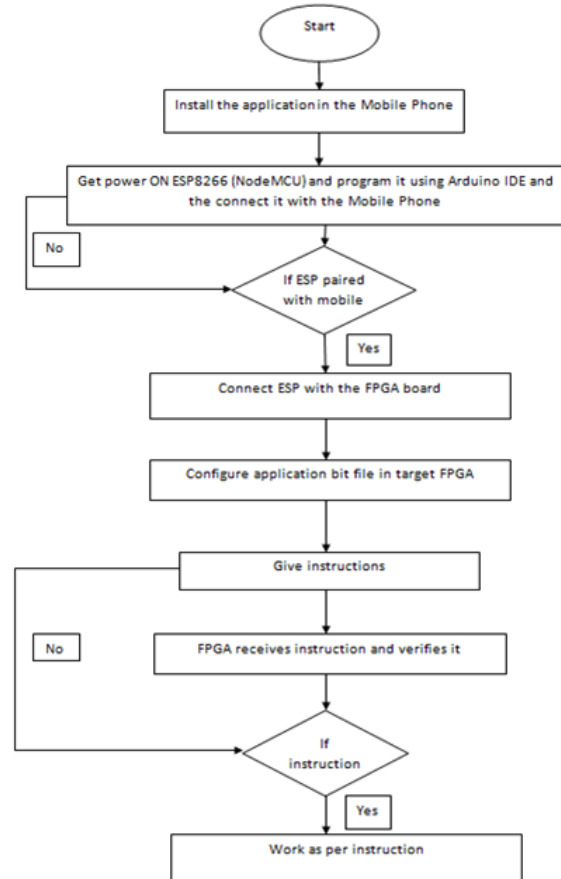
```

```

begin
    LIGHT_OUT <= LIGHT_IN;
    RELAY <= LIGHT_IN;
    DC_M1 <= FAN_IN;
    DC_M2 <= '0';
end Behavioral
• FPGA Code for Port assignment:
NET FAN_IN LOC = P29;
NET LIGHT_IN LOC = P27;
NET DC_M1 LOC = P143;
NET DC_M2 LOC = P144;
NET LIGHT_OUT LOC = P12;
NET RELAY LOC = P97;

```

5. FLOWCHART



6. RESULTS

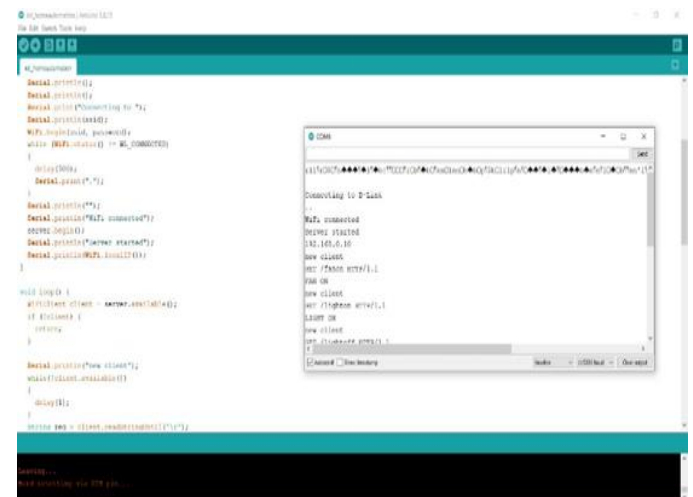


Fig 6.1 Arduino IDE execution

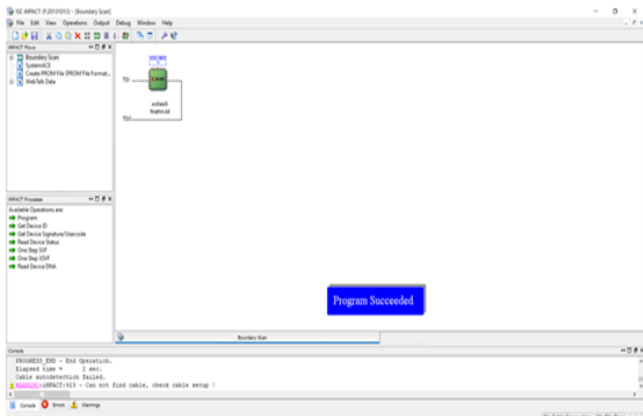


Fig 6.2 Xilinx ISE execution

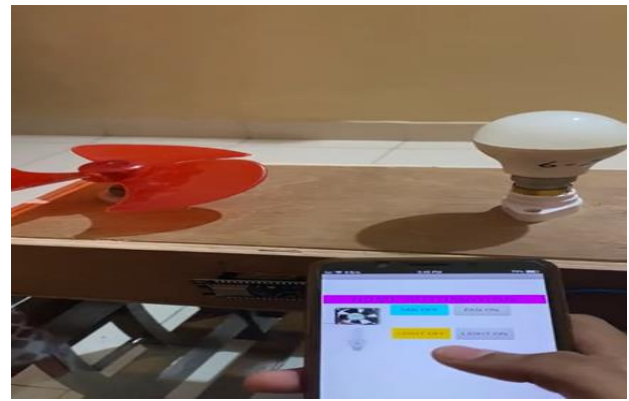


Fig 6.6 Working with application



Fig 6.3 MIT App Inventor



Fig 6.4 Mounted FPGA Board

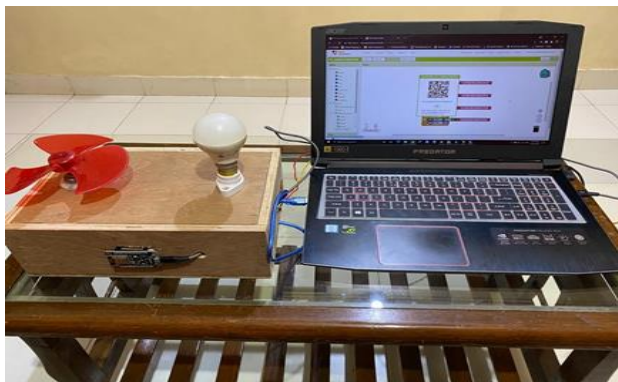


Fig 6.5 Overall circuit setup

7. RESULT AND INTERFACING VIDEO

<https://drive.google.com/file/d/1kSkUa5YmIzfMTuhzD7LnkWab9GMwmdp6/view?usp=sharing>

8. CONCLUSION

This project IoT Based Home Automation using FPGA Board helps us control all the home appliances by just the use of our phone through the android application. Everything right at the tip of our fingers and is an easy way to develop a smart home. Future is about the Internet and how well it can be used and how applications can be created with this. Home automation is the perfect example of how appliance is connected with the internet and is available to the user in form of simple input through their smart phones.

This also helped us study FPGA Board, IoT Module where further FPGA board can be used to implement many applications in future. Considering the Pandemic and hygiene of every individual access of the required appliance can be within the individual and can be modified according to his/her needs, which also makes sure that social distance and hygiene is maintained which can help prevent diseases caused due to interaction. It is also handy where it can be made and interfaced very easily through internet at a very low cost and is also reliable for a long time.

9. REFERENCES

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