FPGA Implementation of Gesture based Home Automation

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Abstract — Due to the rapid increase of a various industrial and home appliances that are to be controlled, we require some new natural methods of automation. This paper presentsan FPGA based hand gesture recognition system which is proposed by using a method called artificial neural network.This method is mainly used to add learning capabilities of gesture recognition system that can be used for impaired people.

I. INTRODUCTION

Home automation mainly concentrates on the issue of controlling home appliances remotely whenever a person isn't available near the switch which turns on/off the appliances. A better home automation system is required for the betterment of the current problematic situation which reports the increase of power wastage, year by year.In order to realize the functionality of home automation systems, there's a need in the deployment of sensors which are capable of collecting various real time information such as motion, light, temperature, humidity etc. These sensors are useful to acknowledge the users about the active status of their home appliances so that they can take necessary actions to control the unnecessary power wastage.[1]

The main aim of the gesture recognition system is to develop a substitute system which support human computer interaction modules that enable the human to interact with a machine in more natural and inherit ways such as body gestures, finger point movement etc.

In this paper we would like to present a Gesture based Home Automation system using advanced method of controlling the appliances through a Gesture recognition kit and a Spartan6 FPGA kit.[2] This system gives feedback to the user regarding the ON/OFF status of the connected appliances according to the user's requirements and needs.

II. SYSTEM OVERVIEW

The Spartan FPGA kit acts as a controller/processor and commands the devices that are tethered to it. The home appliances could be controlled using the deployed sensors. FPGA is given preference when compared with the other micro controllers due to the reason that FPGA can be connected to many devices and also it could be used either as a processor or a controller.[3]

Microchip's MGSC3130 3D Gesture recognition controller deployed in the Gesture board brings out new approach to design instinctive user interfaces. It appears to be a touch pad having an input area extending 10cm upwards towards the space. This board comes with an IDC connecter cable and humans can command a PC or an MCU by gesturing with fingers/hands above the board and also by touching/tapping its surface.[4]

The working prototype of this FPGA implementation of gesture-based home automation comprises of two subsystems. The transmitter which occupies the first subsystem consists of a gesture board with a gesture recognition controller which has capability to read the pre-defined gesture values.

The receiver part comprised in the second subsystem helps to process the input data. Hardware implementation can be easily achieved by the installation of FPGA (Field Programmable Gate Array). Xilinx stimulates and runs the desired network. The network architecture that is trained with various methods could be simulated and also the best performing network is selected for the purpose of hardware implementation using the VHDL language developed by the Xilinx Inc. This HDL design is then processed for the purpose of implementation of the FPGA devices of the Xilinx family.[5]

Fig.1 Working prototype

III. COMPONENTS AND WORKING

Gesture recognition kit detects hand gesture from user and process the data using PIC microcontroller**.** The board comes with an IDC connecter cable. The silkscreen present behind the board depicts various supported gestures (flicking, drawing circles, air wheels, taps and double taps and so on).[6]

Microcontroller present on the gesture produces the output gesture data at digital output in the digital I/O header of the FPGA board.

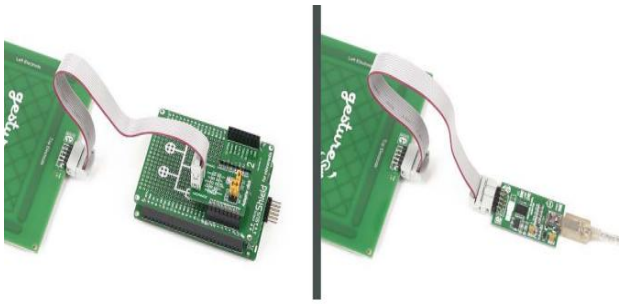

Fig.1 Gesture Board

Spartan6 FPGA project kit directly receives gesture data through I/O pin and perform control statements.[7]The SPI programming files use the .mcs/.bin/.bit file types, FPGA configured files are transferred through the JTAG tag which use the svf/.bin types of files and the USB stick uses the .bit type of file to transfer its files. The above-mentioned file types are created by the ISE web pack of Xilinx and a software named EDK from Verilog, VHDL or schematic-based source files [8] (Micro Blaze embedded processor-based designs use the EDK software).

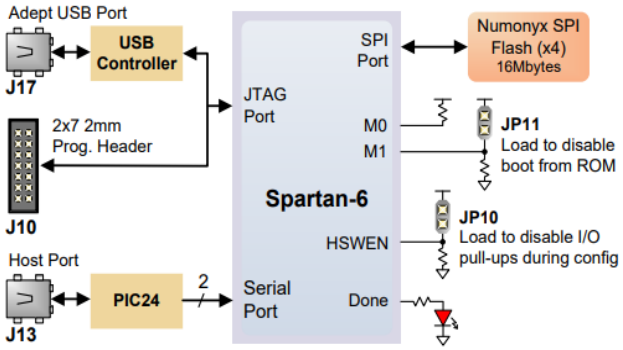

Fig.2 FPGA Board

The control statement includes door open/close control using stepper motor with ULN2003 diver circuit which refers to the relay circuit.

S.No	CONTROL VALUE	CONTROL OUTPUT
1.	00	Relay OFF – Light OFF
2.	01	Relay ON – Light ON
3.	10	Stepper motor clockwise-Door closed
4.	11	Stepper motor anticlockwise-Door open

Fig. 3 CONTROL statements of an FPGA

An electromechanical switch which provides segregation between the low and high voltage circuits is called a 'Relay'. These circuits possess different voltage rates. One might be a high voltage side where as the other one being a low voltage side. Relay switches between 5V circuits and 220/120 V AC circuits.

Also lights ON/OFF control using Relay interface with CFL Bulb.All the control operation gets displayed in 2x16 LCD interface

IV. HARDWARE DESCRIPTION LANGUAGE

Logic simulation has become a vital role in design process since the designs got complex and larger. For a long time, the computer programs that were sequential in nature were described by the programming languages such as Pascal, Fortran & C. [9] Similarly, in the field of digital design the need of a standard language to describe the digital circuits has evolved HDL (Hardware Description Language).

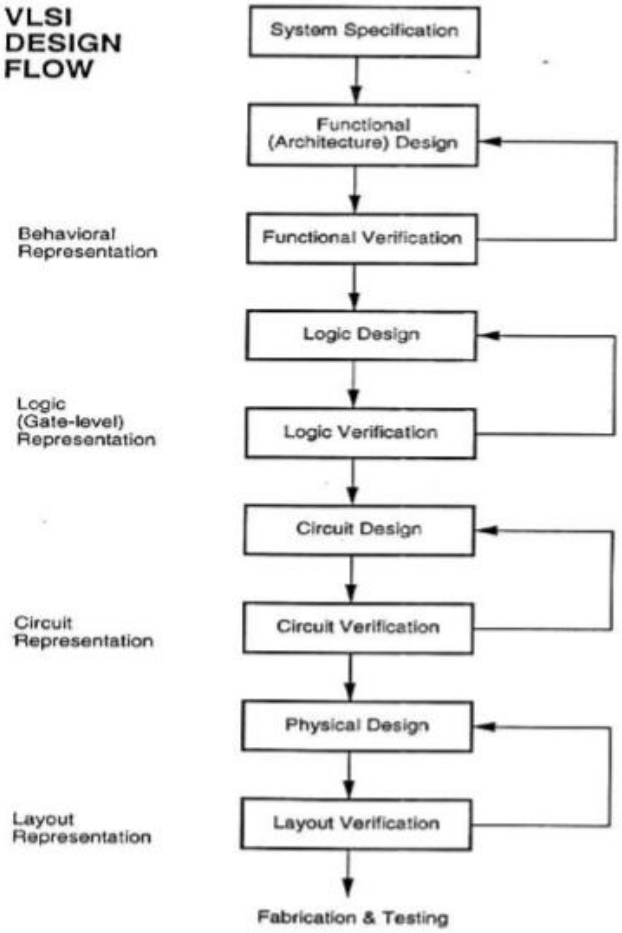

Fig.4 VLSI Design flow

This language allowed the designers to design the coevality of the processes deployed in the hardware elements. Variants of a Hardware Description Language (HDL) are as follows:

1. Verilog HDL
2. Very High speed integrated ckt HDL

Features of Verilog

• Extensibility: It extends Verilog capabilities by allowing Verilog PLI.

• Industrial support: Synthesis is very efficient and simulation is very fast.[11]

• Strong Background: Supported by Institute of Electrical and Electronics Engineering standardized and open Verilog international.

• Universal: The entire process can be represented in one design environment.[12]

V. COMPARISION WITH THE EXISTING METHODS

EXISTING METHOD

Previously we have used the mat lab Simulink environment for designing the system, where only software simulation was used.

MATLAB R2009a is being used in this system which is both hardware and software implemented. It is comprised of three main processes in which voice training, recognition of voice and integrating the hardware part with the MATLAB is done. It was dependent on speaker.[13] It is operated on the basis of control of loads by recognizing speech through MATLAB and thus turn OFF/ON through the parallel ports connected to a computer

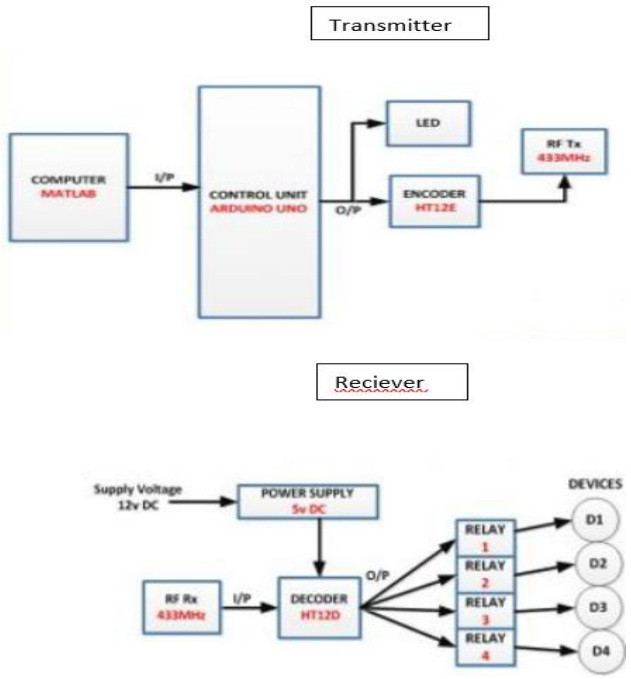

Fig.5 Hand gesture system using MATLAB

VI. PROPOSED METHOD

This paper presents a gesture-based home automation system which is accelerometer interfaced. The control system is composed by 2 sub-systems which communicate with each other through radio waves.[14] The 1st sub-system comprises of a transmitter that uses gesture board to capture the movement of hand where as the second one is the receiver which processes the data. The operations which are to be carried out are decided by Artificial Neural Networks (ANN) and hardware implementation is easily acquired by implementing FPGA (Field Programmable Gate Array).

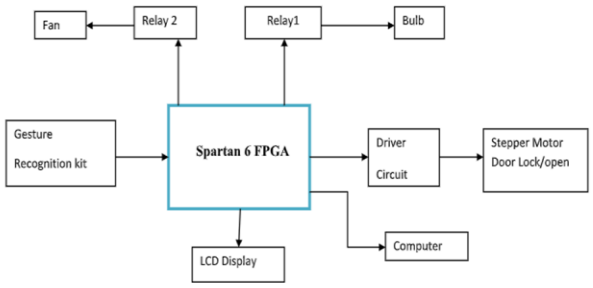

Fig.6 FPGA imp of gesture-based home automation

VII.RESULTS

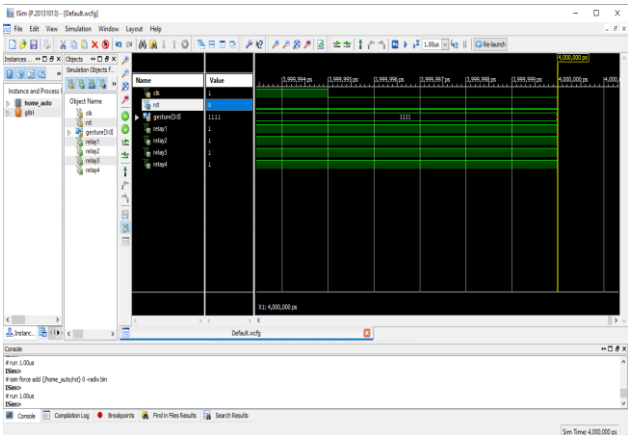

Fig.7 Simulation results

```
Primitive and Black Box Usage:
------------------------------
# BELS                              : 9
#      LUT4                        : 9
# FlipFlops/Latches                 : 4
#      FDR                         : 2
#      FDRE                        : 2
# Clock Buffers                     : 1
#      BUFGP                       : 1
# IO Buffers                        : 9
#      IBUF                        : 5
#      OBUF                        : 4

Device utilization summary:
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Selected Device : 6slx9tqg144-2


Slice Logic Utilization:
 Number of Slice Registers:             2  out of  11440     0%
 Number of Slice LUTs:                  9  out of   5720     0%
    Number used as Logic:               9  out of   5720     0%

Slice Logic Distribution:
 Number of LUT Flip Flop pairs used:    9
   Number with an unused Flip Flop:     7  out of      9    77%
```

Fig.8 Synthesis Report

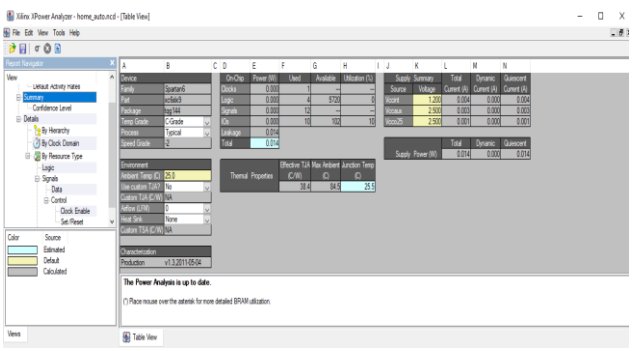

Fig.9 Power results

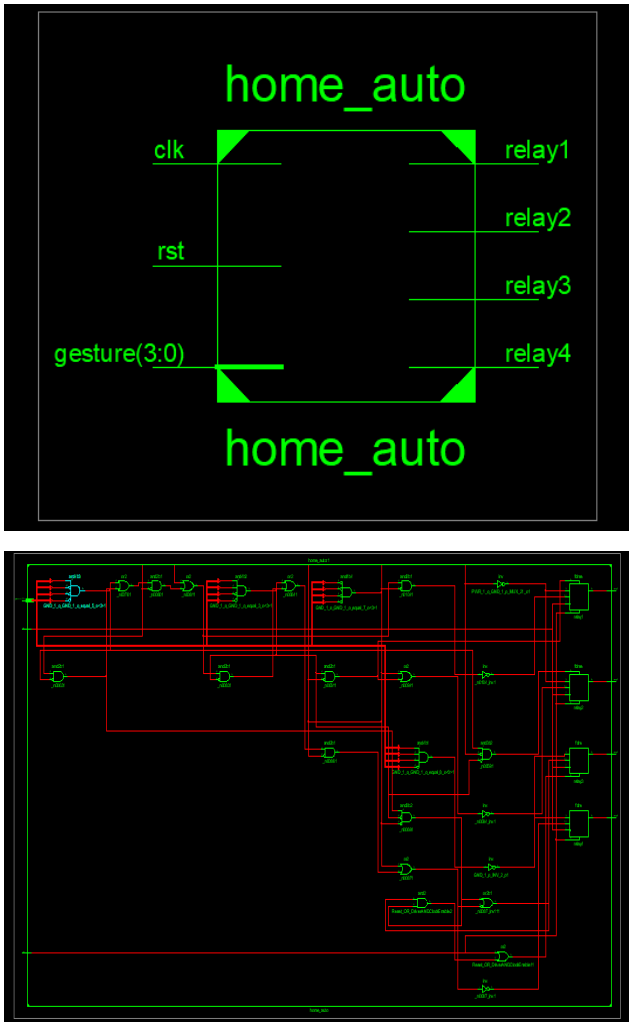

Fig.10 RTL Schematic

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