Implementation of Gesture Recognition System for Home Automation using FPGA and ARM Controller

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Abstract: New natural methods of control are needed due to the increase in the number of industrial and home appliances that must be controlled. In this paper presents releasable fpga based hand gesture recognition system is proposed by using a method called artificial neural network is used this method mainly used to add learning capabilities of gesture recognition system that can be used for impaired people. The sensor based gestures control system is composed by two subsystems that communicated via radio waves. The first subsystem is a transmitter that has an accelerometer which reads predefined gesture values. The second subsystem is the receiver on which the data processing takes place. Field Programmable Gate Array (FPGA) implementation is an easy an attractive way for hardware implementation. The desired network is modeled, trained and simulated by using Xilinx. Network architecture trained with different methods could be simulated and the network that is best performing for given application is chosen for hardware implementation using vhdl language developed by Xilinx Inc. This HDL design can then be synthesized for implementation in the Xilinx family of FPGA devices.

Keywords: Accelerometer, gesture recognition system, zigbees, artificial neural network, Field programmable gate arrays.

1. Introduction

Due to the rapid increase of number of industrial or domestic systems that must be controlled it is clear that new methods of control are needed. Gesture recognition is important for developing alternative human-computer interaction modalities that enables humans to interface with machine in a more natural way. are many types of gesture researches like body gesture, finger point movement, etc

Existing System

Previously we have used the mat lab Simulink environment for designing the system, where only software simulation was used but in the proposed system we are going to use the Xilinx system generator and implement it on FPGA

2. Proposed Systems

This paper presents an Accelerometer interface based on hand’s gesture recognition. The gestures based control system is composed by two subsystems that communicated via radio waves. The first subsystem is a transmitter that captures the movement of the hand using accelerometers. The second subsystem is the receiver on which the data processing takes place. Artificial Neural Networks (ANN) are used to decide the operation. Field Programmable Gate Array (FPGA) implementation is an easy an attractive way for hardware implementation. Accelerometer consists of x y z if move accelerometer x y z co-ordinates are varying that values are send to the LPC-2148 and that will be transmitted to the zigbee .zigbee also transmitted to the receiver side wirelessly. The receiver will received the data ever send transmitter that

2.1 Block diagram

This intelligent Human-Machine interface presented in this paper is composed by two main subsystems.
1) Transmitter.
2) Receiver.

A. Accelerometers

Accelerometers are acceleration sensors. An inertial mass suspended by springs is acted upon by acceleration forces that cause the mass to be deflected from its initial position. This deflection is converted an electrical signal, which appears at the sensor output. Accelerometer x,y,z co-ordinates; those co-ordinates values are transmitted to the LPC-2148.

B. LPC2148

LPC stands for least pin count and these contain in built Arm-7Processor is there. ARM stands for Advanced RISC Machines. It is a 32 bit processor core, used for high end
application. It is widely used in Advanced Robotic Applications.

History and Development
ARM was developed at Acron Computers ltd of Cambridge, England between 1983 and 1985. RISC concept was introduced in 1980 at Stanford and Berkley. ARM ltd was found in 1990. ARM cores are licensed to partners so as to develop and fabricate new microcontrollers around same processor cores.

3. Architecture

![LPC-2148 Architecture](image-url)

**Figure 2: LPC-2148 Architecture**
C. Zigbee:

Zigbee is a transceiver module which provides easy to use RF communication at 2.4 GHz. It can be used to transmit and receive data at 9600 baud rates from any standard CMOS/TTL source. This module is a direct line in replacement for your serial communication it requires no extra hardware and no extra coding to it works in Half Duplex mode i.e. it provides communication in both directions, but only one direction at same time.

One of the intended applications of ZigBee is in-home patient monitoring. Patient’s vital body parameters, for example blood pressure and heart rate can be measured by wearable devices. The patient wears a ZigBee device that interfaces with a sensor that gathers health related information such as blood pressure on a periodic basis. Then the data is wirelessly transmitted to a local server, such as a personal computer inside the patient’s home, where initial analysis is performed. Finally the vital information is sent to the patient’s nurse or physician via the internet for further analysis.

4. Receiver

**Neural network**

Here Kohonen's neural networks are used. Kohonen's networks are one of basic types of self-organizing neural networks. The ability to self-organize provides new possibilities - adaptation to formerly unknown input data. It seems to be the most natural way of learning, which is used in our brains, where no patterns are defined. Those patterns take shape during the learning process, which is combined with normal work. Kohonen's networks are a synonym of whole group of nets which make use of self-organizing, competitive type learning method. We set up signals on net's inputs and then choose winning neuron, the one which corresponds with input vector in the best way. Precise scheme of rivalry and later modifications of synaptic wages may have various forms. There are many sub-types based on rivalry, which differ themselves by precise self-organizing algorithm.

**Architecture of self-organizing maps**

Structure of neural network is a very crucial matter. Single neuron is a simple mechanism and it's not able to do much by itself. Only a compound of neurons makes complicated operations possible. Because of our little knowledge about actual rules of human's brain functioning many different architectures were created, which try to imitate the structure and behavior of human's nervous system. Most often one-way, one-layer type of network architecture is used. It is determined by the fact that all neurons must participate in the rivalry with the same rights. Because of that each of them must have as many inputs as the whole system.
Algorithm of Learning
The name of the whole class of networks came from the designation of algorithm called self-organizing Kohonen's maps. They had been described in the publication "Self Organizing Map". Kohonen proposed two kinds of proximity: rectangular and gauss. The first is: and the second lambda" is the radius of proximity, it decreases in time.

\[ G(i, x) = \begin{cases} 1 & d(i, w) \leq \lambda \\ \frac{1}{1 + \frac{d^2(i, w)}{\lambda^2}} & d(i, w) > \lambda \end{cases} \]

Use of Kohonen’s method gives us better results than "Winner Takes All" method. Organization of the net is better (neurons organization represents the distribution of input data in a better way) and the convergence of the algorithm is higher. Because of that the time of single iteration is a few times longer - wages of many neurons, not only winners', have to be modified.

Here the kohonens neural network code written in VHDL and trend the neural network and that will be born to the Spartan-3E board.

Accelerometer consists of x y z if move accelerometer x y z co-ordinates are varying that values are send to the LPC2148 and that will be transmitted to the zigbee .zigbee also transmitted to the receiver side wirelessly. The receiver will received the data ever send transmitter that signals are send to the sparton board that will be decide the operation that means weather fan or bulb on.

5. Transmitter Flow Chart

6. Receiver Flow Chart

7. Simulation and Synthesis Results

The hardware based implementation of carried out on single Spartan-3E family of fpga. The software development tool used for developing and verifying the design is the Xilinx ISE 10.1 version. Figure-11 to Figure-13 shows MODELSIM simulation results for light and fan ON and OFF.

Paper ID: SUB15476
 RTL Schematics

The Net List is RTL level of the Gesture recognition system, which is synthesizable and can be extracted on the Xilinx tool. By which we can get prefence look of the system and a transition from the frontend of the VLSI designing to backend of the VLSI designing. Which means the same can run on FPGA kit and test its robustness and errors of the system can be debugged before it is taken to SOC Level and to Fab-Labs.
8. Conclusions

We developed a new FPGA implementation of gesture recognition system in xilinx10.1If the system is more complex system we can also include number of of gestures. that means we can interface number of devices .here we can only interfacing light and fan here the system implemented by a five basic gestures used . Left, right, front, back and idle.if you want more gestures the system will received more signals and also controlled by a more output devices.

References


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