임베디드 M2M 원격제어 시스템을 위한 FPGA 보드 구현연구

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FPGA Board Implementation for an Embedded Machine-to-Machine Remote Control System

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Abstract

This project presents a concept of mobile robots using prototypes, computing proposal oriented to embedded systems implementation. We implement our system using GPS module, Ultrasonic sensor(range sensors), H-bridge dual stepper control, DTMF(Dual-tone Multi-Frequency) and LCD module. In this paper we construct a mechanical simple mobile robot model, which can measure the distance from obstacle with the aid of sensor and should able to control the speed of motor accordingly. Modules were interfaced with FPGA(Field Programmable Gate Array) controller for hardware implementation.

1. Introduction

The goal of the present project is to develop a general purpose framework, which provides facilities for attaching and fitting different kinds of sensors and actuators. This general purpose framework provides an easy way to turn a general purpose robot into a special function one.

2. System Overview

1) Sytem structure

The attached sensors collect information from the surrounding world and send it to an FPGA board. The FPGA board will control the sensors and processes the measured values. Using the measured data the FPGA board can control the robot's movement. The implementation platform chosen is
Nexys 2 board(XC3S500E FPGA microcontroller). The sensors are attached to the board and are displayed on seven segment. Finally, the robots can communicate to each other with the DTMF decoder . Fig 2.1 shows the system architecture. The other mobile phone is connected to the Spartan board to achieve communication between the robot and the mobile phone. The software implementation was done using VHDL language program.

Figure 2.1 system architecture

2) DTMF module

The robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed, a tone corresponding to the button press is heard at the other end of the call. The robot receives this DTMF tone with the communication. The received tone is processed by the Nexys 2 board with the help of DTMF decoder MT8870DE. The mobile that makes a call to the mobile phone connected board DTMF module. The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is sent

to the Nexys 2 boards. Nexys 2 board is preprogrammed to take a decision for any given inputs ,its gives decision to motor drivers in order to drive the motors for forward (press button 2) , backward (press button 8), turn left (press button 4), turn right(press button 6) and stop (press button 5). Fig.2.2 shown the Table I.

		High Group Frequencies Nominal Frequency in Hz			
		1209	1336	1477	1633
Low Group Frequencies Nominal Frequency in Hz	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

Figure 2.2 The tones and assignments in a DTMF system are shown in Table I.

3. Hardware design

The important components of this rover is DTMF decoder, XC3S500E processor and motor driver. All types of the MT8870DE series use digital counting techniques to detect and decode all the DTMF tone pairs into a 4-bit code output. When the input signal is given in a single-ended input configuration, it is recognized to be effective, the correct 4-bit decoded signal of the DTMF tone is transferred using output pins of the DTMF board to input pins JA0 through JA3 of Nexys 2 board. The decoded signal is inverted between transmission using an inverter . Fig 3.1 shows the Table II (DTMF data output of MT8870DE.)

Digit	TOE	INH	ESt	Q_4	Q_3	Q_2	Q_1
ANY	L	X	H	Z	Z	Z	Z
1	H	X	H	0	0	0	1
2	H	X	H	0	0	1	0
3	H	X	H	0	0	1	1
4	H	X	H	0	1	0	0
5	H	X	H	0	1	0	1
6	H	X	H	0	1	1	0
7	H	X	H	0	1	1	1
8	H	X	H	1	0	0	0
9	H	X	H	1	0	0	1
0	H	X	H	1	0	1	0

Figure 3.1 Table II

Outputs from port pins JD0 through JD3 of the nexys2 board are fed to the inputs IN1 through IN4 of motor driver L298N module respectively to drive two geared DC motors. The nexys 2 output is not sufficient to drive the DC motors, therefore voltage drivers are required for motor rotation. Two enable inputs are provided to enable or disable the device independently from the input signals. An additional supply input is provided so that the logic works at a lower voltage.
For ultrasonic range sensors, it triggers from the nearest object in its vision. when the echo pin will go TTL high for a period proportional to the length between the DYP-ME007 and the nearest object. The ultrasonic sensor echo and trig pins are attached to pins JB0 through JB1 of the Nexys 2 board. Fig 3.2 Shows the FPGA control board structure

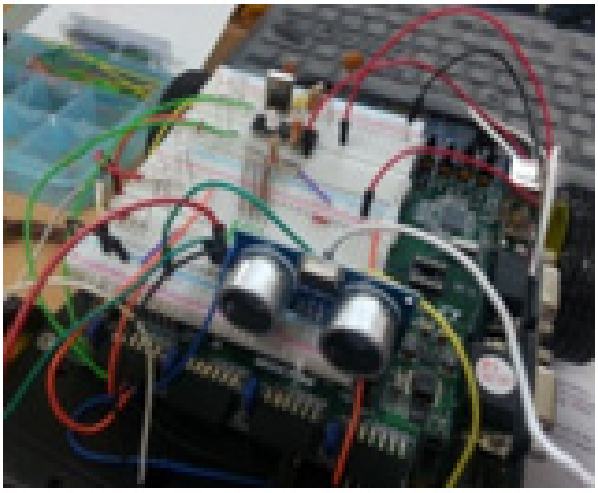

Figure 3.2 Shows the robot design

4. Conclusion

Autonomous mobile robots can be used to deliver parts in factories, being complementary platforms in a security system, human face recognition spy robot and they also can be used in hazardous areas where humans can not stay. This approach can be extended to more demanding applications by adding Face detection camera and RGB camera using other modules, or other peripheral interfaces.

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