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FPGA Controlled Rover through Android Smartphone

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Abstract:

Roboticapplicationsaremuchmoreneeded and almostmandatoryrequirementin today'sfastmoving industrialeconomy.Inthesecircumstancesthedevelopment ofRoboticsisalsotakingup thespeed withthehelp ofvarious technologies directlyor indirectlysuitablefor robotic applications.FPGA takes advantage overmicrocontroller due to itshardware based parallelarchitecture.Motorsareoneof the corepartofthe Robots andcontrollingthemwithFPGA is littletricky.FPGAbased wirelessinterfaceisused toremotely control roboticapplications. For thatFPGAbased signalgenerationmethod isused.Codecan bemadein such a mannersothatmultipleparts (motors)can be controlled ata time. Theportsavailabilityalso providesflexibilityto extend the supportfor thenumber ofmotors or anyDataacquisition mechanism.Auserfriendly wirelessinterfaceisdeveloped to controlrobotremotely.

I. INTRODUCTION:

Field Programmable Gate Arrays (FPGAs) have become popular in digital systems in present years. These FPGA's provide high parallelism in computation of different advanced architecture. This increase the feature of FPGA's that find suitable in much application like embedded systems, robotics ,digital signal processing, hardware accelerators, cryptography and many more. By looking the FPGA's internal structure it consists Configurable logic blocks (CLB's), CLB's framed by several look up tables (LUT's) and these are connected through the inter-connect modules. By specified circuits utilized in CLB's that makes the narrow difference between ASIC and FPGA's.Human cannot enter into ever situation such as varied conditions in industries during fire attacks, short circuits and even entering into strange places. For making aware of this kind of environment, robots are Used instead of man. While traversing in vast environments one needs some help like taking photographs and collecting samples to analyze the conditions etc. For all such kind of things this remote Accessing of FPGA robot via mobile is useful. Initially, a robot is proposed to be designed. This robot has to work in all environments around the world without the actual involvement of mankind. For this purpose the robot is designed in such a way that it can be controlled through Bluetooth [1]. One can easily control the robot by knowing its unique username and password. This paper gives the detail description of literature survey, problems with previous models, methodology andExperimental results.This paper organizes as follows. Session II that deals with objective, Session III deals with system architecture of the design . IV deals with Results and analysis of the proposed system with the proposed technique And Section VI concludes the paper.

II. OBJECTIVE:

The main objective of the paper is to control the robot from whole over the world. One of the sources which are available whole over the world is internet. Controlling the robot includes moving in any direction, things like collecting photographs .By this one can use this robot as a servant by sending where ever he wants and can communicate with the people there easily.In recent days existence of electronics with all the features of internet controlled along with video streaming has increased for collection of samples and which can talk with people in front of it. There are application specific robots which just streams video or which sends only speech from one place to another. In Bluetooth controlled robot Bluetooth module is used to receive the commands [2, 3]. To make the robot talk again one has to interface a voice module at the receiver side. This method needs a complex circuitry and huge lines of code. Through Bluetooth module only limited number of tasks is implemented.

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The main aim of this project is to control the robot direction through blue tooth module which is connected to the UART port of FPGA. These Bluetooth modules are more reliable, secure and low power modules and these modules do not require line of sight Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centered from 2402 to 2480 MHz) in the range 2,400–2,483.5 MHz (allowing for guard bands). This range is in the globally unlicensed Industrial, Scientific and Medical (ISM) 2.4 GHz short-range radio frequency band. It usually performs 800 hops per second, with Adaptive Frequency-Hopping (AFH) enabled.

Table1:comparison of various wireless technologies

Parameter	Different technologies			
	RF	*DTMF*	*GPRS module*	*Android mobile*
Area	Less	Less	More	Less
Power	Low	Low	High	Low
Speed	High	Moderate	Moderate	High
Video	Yes	No	Yes, moderate	Yes, High speed
Range	Less	High	High	High
Flexibility	No	No	No	Yes
Portability	No	Yes	No	Yes

This project describes a new economical solution of robot control systems. The presented robot control system can be used for different sophisticated robot applications. The system can be viewed as two different modules- transmitter and receiver sections. The transmitter module consists of mobile phone. The direction of the robot will be controlled by selecting the respective option from the mobile phone, and a character will be will be transferred to receiver through bluetooth module.On the other hand, the receiver module receives the transmitted data and passes the data to the FPGA. Thus, the control unit changes the direction of the robot according to the specified command. Since the controller cannot drive the motors (used for robot) directly, L293D is used as a driver to provide the sufficient current required for the motors.

III. SYSTEM ARCHITECTURE

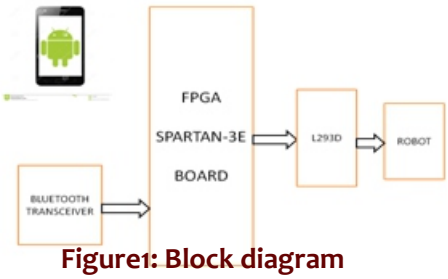

Figure1: Block diagram

In the implementation, FPGA Board will be placed on the robot and used as a controller for navigating the robot in all possible ways. When FPGA is powered on, the UART port will be activated automatically as it is written as a top module. At the UART port, Bluetooth transceiver is connected in order to communicate with the Android Smartphone. Robot is interfaced to the FPGA board via L293D, a motor driver.

To the GPIO lines of FPGA Board, L293D is interfaced in order to control the electrical motors of a robot to which FPGA is mounted. The directions of electrical motors are controlled by the user through an application which is installed in the Android Smartphone. Graphical User Interface is designed at Android Smartphone for user-friendly. It will be having five buttons, and to each button a specific character is stored. The Bluetooth of Android Smartphone will be connected with the Bluetooth which is interfaced to FPGA in order to control the robot.As FPGA is powered on, and it receives data at the UART port as Bluetooth Transceiver is connected. Based on the data received by the FPGA, it produces a digital logic at the output pins to where L293D is connected. That digital logic will be amplified by L293D and thereby motors will be rotated. Thus, the robot is navigated in the possible direction given by the user using Android Smartphone application.Whenever anyrobotisto be remotelycontrolledthrough a serial-wirelessmodulethenserialinterfacing isvery important-tocommunicate between them.Inthis experiment, toc ontroltherobotthroughBluetooth,RS232 interfacingis done.Spartan3E FPGAkit hason-board DTEandDCEDB9-portandRS232voltagetranslatorIC in thekit.

IV. RESULTS

The major components in this proposed module are been interfaced to a robotic model which consists of a chassis, constituting of four dc gear motors which operates with a voltage of 12v and a current of 1amp, these motors helps in traversing in four different conditions like front,back,right,left and the default condition is stop where all the motors are in halt mode. The below figure shows us the interfacing of FPGA to the robotic model.The FPGA kit acts as the control unit which takes the commands through the serial port of it interfaced to the Bluetooth module which is placed at the right side of the FPGA board .the blue tooth module here is a serial module which

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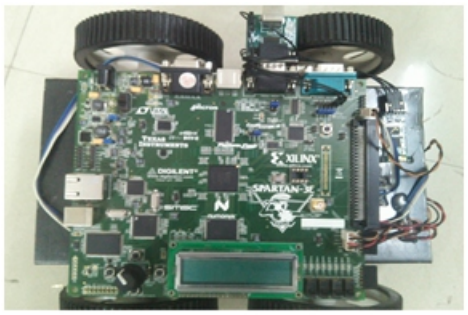

Figure2: Interfacing of FPGA to robot.

transmits the data in a serial fashion to the uart of the FPGA,.here in this system commands in the form of characters is sent to Bluetooth module which acts as a receiver .these commands are transmitted from the mobile phone which has a Bluetooth inbuilt .in order to send these commands to the receiver one should get both the modules paired to each other, the Bluetooth receiver module used here is HC05 which is shown in the figure below. Whenever a the user press a button on the mobile a corresponding character is been transferred to the receiver like F-for front ,B-for back,L- for left,R- for right,S-for stop. Once the FPGA receives the command through the Bluetooth receiver interfaced to the uart the control unit decidesOnce the FPGA receives the command through the Bluetooth receiver interfaced to the uart the control unit decides the operation to be performed by the robot according to the command received. The power source to the system is a 12v 1.3 amp rechargeable battery is given to a voltage regulator and is dropped to 5v and this 5v is given as input to the FPGA board and to the Bluetooth module.

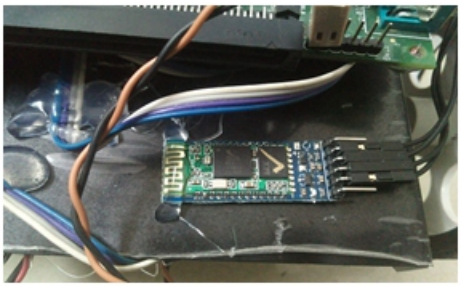

Figure3: interfacing of Bluetooth module HC05.

Since the FPGA GPIO's cannot produce the required voltage or current to run the motors one need to go for a motor driver which acts as a current amplifier ,so an L293D is interfaced to the FPGA,the operation of the robot is decided according to the command received through the uart port and the FPGA will give the respective inputs to the motor driver to drive the motors ,the motor driver here will be having two input power sources, one source is 5v which acts as operating voltage for l293d and other is output power to run the motors with maximum required voltage.

V. CONCLUSION

Inthispaper,FPGA basedrealtimecontrolsystemis developed forwirelesslycontrol roboticapplications. Addressingofcontrolsignalsand sending datatoparticularsignalareimplemented inthis paper.Hardwaremodule isdevelopedtogenerate logic to the driver circuit,which arethebasicbuilding blockstodrive robots.Withtheuseofcommunicationinterfacesprovided, allmodules canbeeasilyaccessible.Bluetooth andFPGA interfacingwasalsosuccessfully developed. Functional verifications aredonebyapplyingthelogicontherobotic applications. Thisworkwastheprototype ofabigsystem. Byappliedlogic,fourmotors canbecontrolled butby takingadvantage ofFPGA,morenumberoflogicscanbe addedintothedevelopedcontrolsystem.

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