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FPGA Based Robot Movement and Direction Controlling System

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Abstract: ***Robot reduces human resources from performing risky tasks. They can work in dangerous circumstance, that human just can't do. The essential design gives autonomy to the robot i.e. avoiding the collision with objects and generates possible moving path. The FPGA (Field Programmable Gate Array) was used in the fundamental construction of robot moment and direction controlling system. We can control the robot moment, rotation using wheel-move mode and leg-move mode.***

Keywords: Verilog, FPGA, CPG, Robot, Moment

I. INTRODUCTION

A robot is a machine proposed to perform at least one mechanism consequently with speed and exactness. Robots are generally undoubted mechanical machines modified to perform explicit continual operations. They are utilized routinely to complete numerous works that individuals would prefer not to do in light of the fact that such occupations are exhausting, messy or perilous[1]. Robots can likewise be customized to do a few assignments that are unreasonably mind boggling for people. Robots most clearly impact regular daily existence while maintaining standards of quality and performance.

Japan drives the world in robot innovation by utilizing robots in cafe kitchens to make sushi and mince vegetables. They are likewise significant prior in food production, planting rice and tending developing yields. Additionally, robots perform different works like serving drinks, cleaning stuff and now and then play out the activity of receptionists [2].

Older individuals living in convalescent homes or nursing homes can likewise profit by robots. A Korean robot which is having similar architecture as a chair can bear people weighing as much as 220 pounds and is controlled with a basic joystick [3]. Robots can cooperate the old to get up and can even give a feeling of friendship to the individuals who are desolate. In case of a prisoner circumstance where police can't get excessively close, they can send in a robot to gather sound and visual information that will assist them with evaluating the circumstance better.

Robots in medication carry out complex medical surgeries. Despite the fact that a specialist sits at the controls and watches everything through a camera, a mechanical arm leads the real medical surgery, which amplifies exactness in fragile medical surgeries [4]. A robot, called Spykee, is Wi-Fi friendly. Controlled through the Internet, it tends to be made to watch, hear, screen and talk on request. It takes pictures, records recordings, makes telephone calls and ensures safety to the family home through video observation [5].

Fig.1 shows the two working models of robot system wheel mode and leg mode. In this we are proposing these two mode operation controlling by using FPGA circuits.

(a) Wheel-move Mode **(b) Leg-move Mode**

Fig. 1 working model of robot system

II. SYSTEM BLOCK DIAGRAM AND OPERATION

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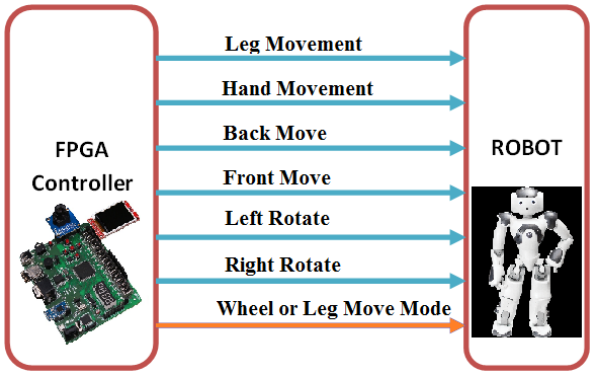

Fig. 2 FPGA Based Robot Controller

Fig.2 shows the block diagram of FPGA Based Robot Controller. This FPGA system can operrated in two modes wheel-move mode or leg-move mode [6]. Under these two mode six controlloing movemets are shown in block diagram. These different robot operations are shown in Table 1. Depending on intput conditions rotate nd movements operations will performed by the robot. Fig. 3 is showing the robot wheel movements and directions.

Input Bits	Right Rotate	Left Rotate	Foront Move	Back Move	Wheel Movement	Leg Movement	Hand Movement
0000	0	0	0	0	0	0	0
0001	1	0	0	0	1	0	0
0010	0	1	0	0	1	0	0
0011	0	0	1	0	1	0	0
0100	0	0	0	1	1	0	0
0101	1	0	0	0	0	1	0
0110	0	1	0	0	0	1	0
0111	0	0	1	0	0	1	0
1000	0	0	0	1	0	1	0
1001	1	0	0	0	0	1	1
1010	0	1	0	0	0	1	1
1011	0	0	1	0	0	1	1
1100	0	0	0	1	0	1	1
1101	0	0	0	0	0	1	0
1110	0	0	0	0	0	0	1
1111	0	0	0	0	0	1	1

Table 1 Robot Operations

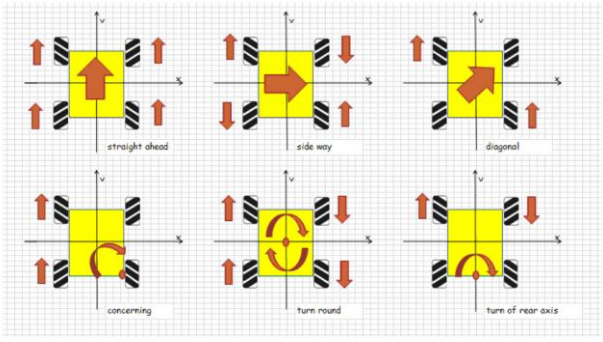

Fig. 3 Robot wheel movements

Depending on the given input bit, output is driven. If input bit is given as binary value of 4'b0000, then the robot will be in stable position. If input bit is given as binary value of 4'b0001, then the robot will rotate right and when the input bits are binary values of 4'b0010, 4'b0011, 4'b0100 then robot will rotate left, move front, move back respectively, but there will be no leg/hand movement [7].

And for the next four operations i.e., where input bits are binary values of 4'b0101, 4'b0110, 4'b0111, 4'b1000 robot will rotate right, rotate left, move front, move back respectively along with leg movement. When the input bits are given as binary values of 4'b1001, 4'b1010, 4'b1011, 4'b1100 robot will rotate right, rotate left, moves front, moves back respectively along with both leg and hand movements.

Next three input bits are given as binary values of 4'b1101, 4'b1110, 4'b1111 for which leg movement, hand movement and for the last condition both leg and hand movements will be there, apart from these all the remaining operations will be in stable condition [8].

III. IMPLEMENTATION

We have used FPGA technology along with Verilog HDL coding. The Spartan 6 FPGA used to generate control signals for robot movement and direction. This system consists of a reconfigurable FPGA-based architecture acts as a central pattern generator (CPG). FPGA is an integrated circuit (IC) that can be customized in the field after assembling i.e., reprogrammable. FPGAs are relative on a primary level to, however have boundlessly more extensive potential application than, programmable read-only memory chips [9]. Fig. 4 shows the FPGA schematic in view of system. Where two-dimensional configurable logic blocks (CLBs) are prearranged and are connected by programmable routing resources. I / O blocks are positioned at the grid's edge and are also connected to the interconnected programmable routing.

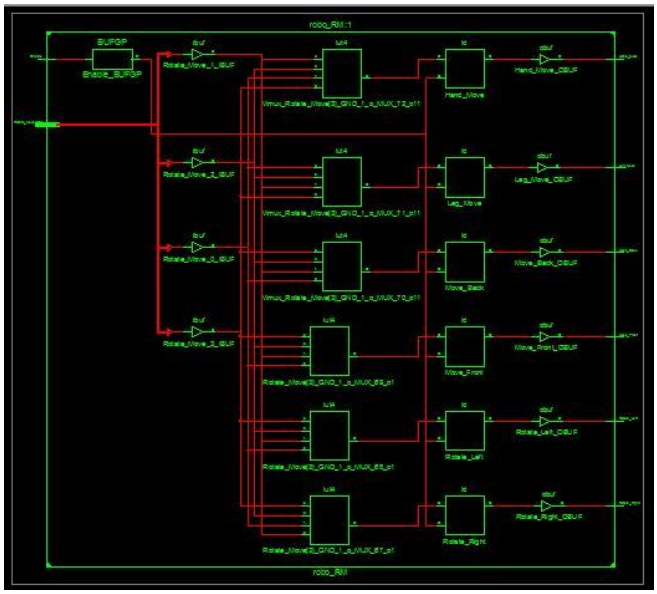

Fig. 4 FPGA schematic view of system

This optimized FPGA Design Summary is, 4LUT are 6, Flip flops 6, IO buffers 10, clock 1, Minimum input arrival time before clock: 0.625ns, Maximum output required time after clock: 0.694ns.

IV. RESULT AND DISCUSSION

From fig. 5 we can identify a waveform generator for the various robot positions and movements. The FPGA generating signal data is a four bit binary data. With respect to the binary data the predefined or programmed control signal or operation will activate and it will control the robot motion and direction.

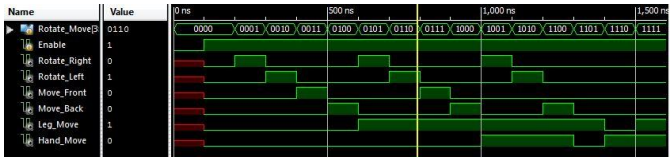

Fig. 5 FPGA control conditions for robot motion

The entire system is designed by using Verilog HDL code and it is compiled with test bench in Xilinx vivado. If the enable signal is logic-0 then this system will be in stable mode. The FPGA will generate different conditions only when the enable signal is logic-1. The conditions are same for wheel-move mode and leg-move mode except only need to select first which mode of robot we are operating.

FPGA Control Bits	Robot Operation
0000	Rest Mode
0001	Right rotation using wheels
0010	Left rotation using wheels
0011	Front move using wheels
0100	Back move using wheels
0101	Right rotation using legs
0110	Left rotation using legs
0111	Front move using legs
1000	Back move using legs
1001	Right rotation using legs and hand movements
1010	Left rotation using legs and hand movements
1011	Front move using legs and hand movements
1100	Back move using legs and hand movements
1101	Only leg movements
1110	Only hand movements
1111	Only leg and hand movements

Table 2 FPGA control signal bits and robot operations

We have got the simulation results as shown in table 2 FPGA control signal bits and robot operations. The control signals are in two modes in wheel movement mode or leg movement mode. If we want fast movement we have to enable wheel movement mode and if we want step movement we have to enable leg movement mode. The sixteen type operations can perform and control by this implemented model.

V. CONCLUSION

In this paper we had designed FPGA based robot movement and direction controlling system using the Verilog HDL. The direction and movement information is automatically sent to the pre-programmed contacts. Based on the details immediate action is takes place from the FPGA conditions. After detecting the signal from FPGA, robot will automatically take steps. The FPGA give the reprogrammable and optimization facilities to the designer.

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Fazal Noorbasha was born on 29th April 1982, Vedullapalli, Bapatla, Guntur, Andhra Pradesh, India. He received his, B.Sc. (Electronics) Degree in Physical Sciences from BCAS College, Bapatla, Affiliated to the Acharya Nagarjuna University, Guntur, Andhra Pradesh, India, in 2003, M.Sc. Degree in Electronics Sciences from the Dr. HariSingh Gour Central University, Sagar, Madhya Pradesh, India, in 2006, M.Tech. Degree in VLSI Technology, from the North Maharashtra University, Jalgaon, Maharashtra, INDIA in 2008, and Ph.D. Degree in VLSI Technology from Department of Physics and Electronics, Dr. HariSingh Gour Central University, Sagar, Madhya Pradesh, India, in 2011. Science 2011 he is working as an Associate Professor, Department of Electronics and Communication Engineering, and Associate Dean-Academics, Koneru Lakshmaiah Education Foundation (K L Deemed to University), Guntur, Andhra Pradesh, India, where he has been engaged in teaching, Administration and research. His interest of research and development is Low-power, High-speed CMOS VLSI SoC, Memory Processors LSI"s, Digital Image Processing, Embedded Systems and cryptography systems.

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