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An FPGA based snake robot

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ABSTRACT

Snake robots are designed to safely perform the tasks that aren't easily done by Humans. There are many applications of Snake robots like Laser cutting from performing surgery to inspection. And also in rescue operations. During the last decade to now, the published literature of Snake robots has been increased vastly. However, no review has done on the locomotion of a Snake Robot using FPGA. The purpose of this paper is to give such review has been widely studied in the past several decades by lots of researchers. In this paper, we survey and discuss the state of the art, challenges, and possibilities of perception-driven obstacle-aided locomotion for snake robots. According to that obstacle, the action is taken on that obstacle by snake robot and how it destroys it. The project is developed by choosing software which we have chosen is Xilinx ISE10.4 environment using verilog and synthesized on FPGA part Spartan3AN board. Xilinx is a powerful software tool that is used to design, synthesize, simulate, test and verify digital circuit designs.

Keywords: *Snake robot, Obstacle avoidance, destroy, Spartan 3AN Stick Board, Sensor, Motor.*

1. INTRODUCTION

A snake robot is slender, flexible robot which is divided into modules. Each and each can be independently controlled. And which controls its position biomorphic hyper-redundant robot that resembles a biological snake.Though, having a powerful control framework to command Snake Robot motions, to close the loop using this framework has proved to be difficult. To generate motions, the desired angles for each module are determined from the specific gait parameters at each step. Each module has a controller which drives its joint angle to the commanded angle, and feedback is provided on the module's actual joint angle and all these are done or achieved via remote control. In previous experiment, accelerometers and gyros were used to fuse the distributed sensors and achieve the robot's pose. But, it is not up to the marking terms of its robustness in practical field use. There were frequent communication dropouts or corrupted data from the modules. Here, they were used all the sensors and accelerometers which are helpful in forming the shape of a snake. It is possible to design and parameterize a shape-controlled motion to provide the locomotion to the simple environments like Grounds, channels. But it falls short of the ability of this Robots to move through the unstructured terrains. In this paper, we are proposing the idea of obstacle avoidance. Whenever robot gets an obstacle in its way, motor which is linked to the snake robots destroys the obstacle.

2. PRE-LITERATURE

The motivation for development of snake robots that exploit obstacles for locomotion is done because of the relaxation of the ground sources dependency by mimicking biological snakes and by using the external objects for forward movement [4]. The result for the research on snake robots for several decades has come with multiple outputs. The world's first snake robot was developed by Professor Shiseo Hirose. The idea of snake robot manipulator done with one end fixed to a base, which can reach the difficult or Hard-to-get-to places. The sealing is done for exterior part of the robot for protection [1]. The movement of the snake robot mainly depends on the movements of the motors used and the controlling is done with motor driving IC. The usage of sensors is also main task of ***locomotion*** of the robot body to make it work in a desired way [7]. As per the new experimental technologies, servo motors are chosen for their angle of rotation which is high than the other motors. This can be contrasted with novel activation technologies *[*9]. The requirement of robots in this advanced world is high and there is a vast application for implementing the automation and robots are used practically in almost every field like medical, construction, from production to entertainment, in defense and from domestic help to advance research. And specialized robots are being developed for every field and we have witnessed the successful use of robots in many domains [10].

3. PROPOSED SYSTEM

Snake Robots, name which sounds different and the purpose of these Robots is to attain the search, rescue and inspection, which is difficult for humans. The main advantage of the Snake Robot is its high degrees of freedom, which gives them the potential to adapt to complex terrain in order to locomotion and manipulate in confined spaces. But at the same time, it is very difficult to use in practice. Here, we have designed a snake Robot to move in a pipeline structures. We have used FPGA for the very first time ever and used Verilog for coding purpose.

For the hardware implementation, taking into the consideration of performance and all the requirements and in order to execute the task perfectly we considered the following Hardware components which have its own significance.

- Spartan 3AN Stick Board
- Servo motors
- DC Motor
- Ultrasonic Sensor

We have designed a snake robot with two segments and we have used one ultrasonic sensor and four servo Motors and two DC motors. The mechanism of these are explained below.

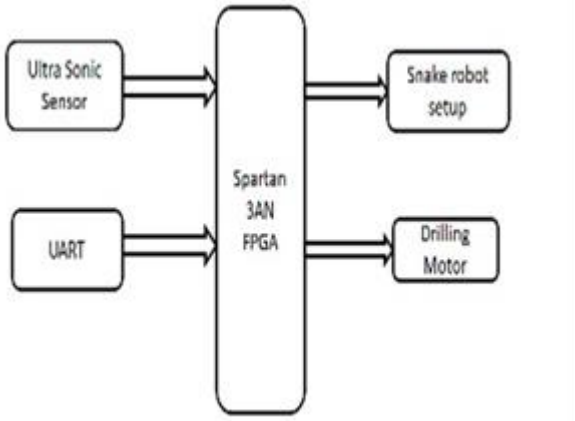


Fig. 1: Block Diagram

The signals from the UART and the ultrasonic sensors are the inputs. The code will be dumped on the FPGA using FPGA Programmer. The movement of the robot and the activation of the Drilling motor when there is a disturbance in its way are the outputs. Operating principle of the robot is that the robot is send into the entrance of level drain pipes from the mouth of the horizontal inspection well by the lifting set and then enters the pipelines to do work. In order to detect obstacles, Ultrasonic sensors are used. A waterproof drilling DC motor is used to destroy the obstacles that come in its way. Pulse Width Modulation is used to get pulses with some required time period.

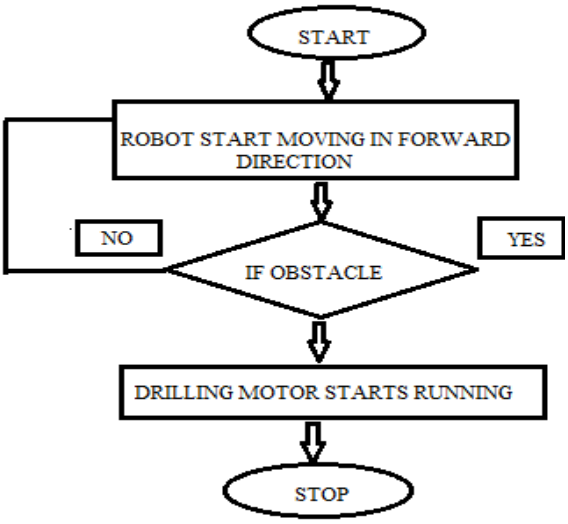
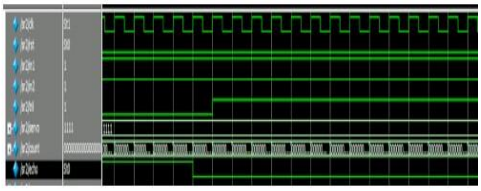


Fig. 2: Flow chart

The basic idea of the project can be referred from the Flowchart. The Robot will start moving with the triggering and the power supply. When the trigger is in ON condition, the echo will be in active state (echo will be initialized) which is reflected back to the ultrasonic sensor. The Robot will move in forward direction or along the path of the pipe. If there is any obstacle detected, then the echo will not be reflected back to the ultrasonic sensor which gives an indication of an obstacle and the drill motor will start and drill the obstacle.

4. RESULTS



Device Utilization Summary (estimated values)			
Logic Utilization	Used	Available	Utilization
Number of Slices	68	704	9%
Number of Slice Flip Flops	58	1408	4%
Number of 4 input LUTs	132	1408	9%
Number of bonded IOBs	8	108	7%
Number of GCLKs	1	24	4%

Fig. 3: Simulation results

Fig. 4: RTL Schematic

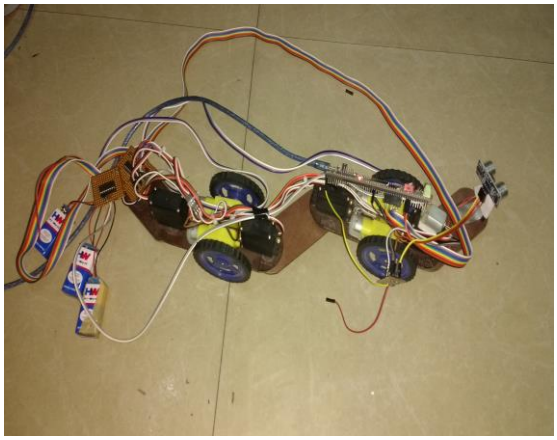


Fig. 5: Hardware results

5. ADVANTAGES AND APPLICATIONS

There are many advantages of these snake robots varying with the applications. This type of automated robot is helpful in such conditions where the man power is not enough to handle the situation for e.g.: To overcome the peril situations like machine failure, man cannot check for the damage in the pipes or machines which happened internally. Considering the fact that this is flexible and the structure is suitable in construction related problems like checking of wiring.

6. CONCLUSION

This project is mainly concerned to detect and to destroy the obstacle in the pipeline. The Robot will move through the pipe and if it detects a paper or a plastic cover, it will tear that paper or cover. And if it detects a stone, it will drill the stone by using a drill motor. And it will clear the path in the pipes. As, there are so many robots available for so many purposes but there is still some scarcity in finding the robots in such (pipeline) environment and not all equipment could go through the pipes. The flexible structure and the zigzag movement of this Snake Robot will be suitable in the best way. The snake robot can be further implemented in so many fields. Here, we didn't use camera. By using camera and other components like Raspberry pi and we could notice the vast change in recent technology, and it would definitely continue with the Snake robot.

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