IMPLEMENTATION OF MOBILE ROBOTIC ARM

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ABSTRACT

The project involves the construction of a mechanical arm which will be operated by a stepper motor. The force exerted by the hand on the object can be measured by a force sensor which will be attached to the end of an end effecter of the arm. This force sensor will provide the necessary feedback to the controller which will adjust the stepper motor to reduce or increase the gripping force exerted.

The controller will be a micro-controller which will control the stepper motor and collect data from the force sensor.

The requirement was to create a mechanical arm which can safely lift a landmine if necessary. The landmine has to be lifted in such a way that there's no risk of it exploding. Therefore the force sensor will make sure that the force exerted is not too much.

The project essentially consists of three main parts, the mechanical construction of the arm, and the construction of the drive circuit for the stepper motor and the obtaining of force profiles for the force sensor.

1.0 INTRODUCTION

It is very important for the current peace process that those who've been driven from their homes can quickly resume their normal life in their homes. One of the obstacles to this is the multitude of landmines buried in the ground. Removal of these landmines has to done as quickly as possible.

Currently there're many groups both locally and internationally that are involved in the removal process. Landmine removal is very expensive since it is a very dangerous operation. It is also very slow because it is done by human beings.

The idea was to automate the landmine removal process by the use of a robot. This project is a part of this bigger project and will be involved in the construction of the arm which will be used by the robot.

The scope of the project was to design the mechanical structure and functions of the arm, construct it and use it to lift an object. The hope was to create the arm in such a way that in can safely lift an egg without breaking.

2.0 LITERATURE REVIEW

2.1 The Mechanical Arm

2.1.1 Material Used

Wood, Steel, Flexible wires, Iron

2.1.2 Components

Springs, Bearing and Shaft, Wooden Fingers, Wooden Body, Wooden Base

2.1.3 Design

The fingers will be moved by the pulling in of wires which will attach to a central shaft. The shaft will be rotated by the stepper motor. The up and down movement will be achieved by having threads in the shaft. A movable component(nut) will be on the shaft and when the shaft rotates the movable component will move up and down, consequently the movement of fingers can be controlled since fingers and nut have been connected by wires.

Furthermore springs have been connected to the outside of the fingers which will be responsible for pulling back the fingers.

The structure was made using the machinery and tools in mechanical workshops.

Shaft and nut with screws were made using the lathe and drilling machines in the lathe machine shop.

Other wooden structures were made using Hacksaw ,handsaw and grinding machines.

Finally finished structure was painted by gold color to gain an attractable appearance.

2.2 The Force Sensor

Excitation schematic

Excitation(vdc) 5typ.,12max

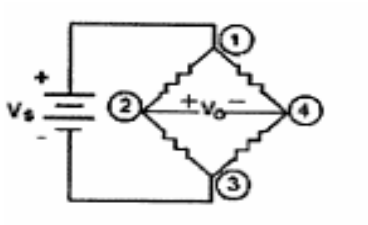

Fig 1: Force Sensor(FS) series circuit

Circled numbers refer to sensor terminals (pins)

Pin 1 = supply Vs(+)

Pin 2 = output (+)

Pin 3 = ground (-)

Pin 4 = output (-)

The force sensor may be powered by voltage or current .Maximum supply voltage is not to exceed 12volts.Maximum supply current is not to exceed 1.6 mA. Power is applied across pin1 and pin 3 .

The sensor output should be measured as a differential voltage across pin 2 and pin 4 (V-out=V2-V4). The output is radiometric to the supply voltage.

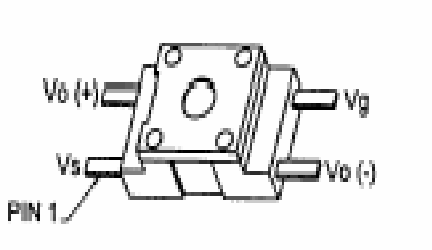

Fig 2: Sensor Pinout

This will be responsible for the force feedback. The sensor will be attached to one finger and when the force reaches a preset value the stepper motor will cease tightening the fingers. If the force becomes too small the stepper motor will proceed to tighten the fingers. This will be a closed control loop which will operate to keep the object securely in the grip of the robotic arm.

The sensor will be tested by attaching it to the fingers of various volunteers and the force profile will be obtained by using a data acquisition card. This will give a good indication of the force profile of the robotic arm when it is lifting an object.. The force profile which was obtained using the data acquisition card (DAQ) and MATLAB, regarding the data acquisition for the force sensor is as follows.

dat = 1.4908,1.9890, 1.4640, 2.3724,2.1062,
1.9963,2.2381,2.3455,1.3516,2.0281,1.7033,
2.3309,1.9939,2.2503,2.1355, 2.0940,1.9817,
2.3236,2.2821,2.2015,2.4969, 2.1551,2.2698,
1.7937,1.6349,2.2601,1.9792,2.2063,2.0476,
1.7228,1.9646,2.0281,1.9548,1.2686,2.1111,
2.1038,1.2589,2.3162,2.1722,1.2735,2.4261,
1.7424,2.3114,2.4188…..etc.

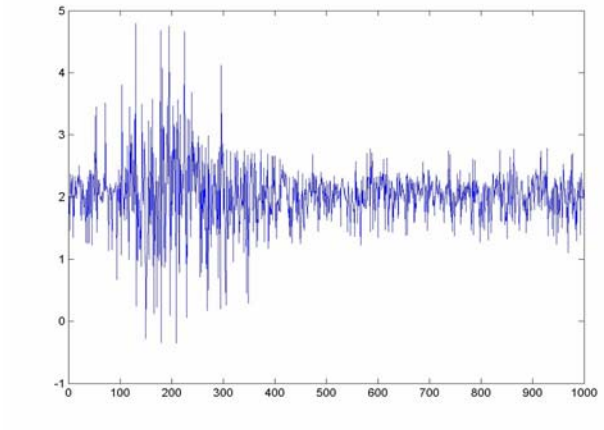

Fig 3: Voltage vs Time

2.3 Drive Circuit

The drive circuit will be responsible for the controlling of the stepper motor. It will take the signals from the microcontroller or the computer via a parallel port and will give the appropriate signals to the stepper motor.

The circuit consists of four units which give an output of 0V or 5V which will be connected to the four ends of the stepper motor. The motor will be operated in a bipolar mode.

The speed of the motor and the positioning can all be controlled by the drive circuit.

3.0 CONCLUSION

The final objective of the project is to develop a robotic arm which will be able to lift a sensitive object safely. The arm will employ a closed loop control system using the force sensor as the input sensor and the computer or microcontroller as the controller and the controller will control the stepper motor.

We used C to write the program which will control the drive circuit. The data acquisition for the force sensor was done by a data acquisition card (DAQ). The force profile was obtained using MATLAB.

The design of the arm was done by PROENGINEERING and the construction of the arm was done in the university workshop.

The arm once completed will greatly assist in the automation of the land mine clearing process. Hopefully this will result in improving the speed with which displaced people can be relocated.

4.0 ACKNOWLEDGEMENT

The knowledge and experience that we gathered from this project was a great encouragement to us in building our self confidence in the Engineering profession.

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We wish to thank Professor J.R.Lucus for his assistance and advice when obtaining the force sensor.

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5.0 REFERENCES

Mobile Robots inspiration to implementation.

(Joseph L. Jones)

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