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ARM MANIPULATOR REMOTE REPLICATOR HAZARDOUS ACTIVITIES

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Abstract. *A handler replicator was prepared using DC motors controlled by the movements of the operator's arm using the command of exoskeleton, demonstrating the new techniques developed. In the exoskeleton, the sensors send information about the position of the operator's arm; the manipulator assumes the same position, being used to prevent harmful contacts with people in specialized high-risk activities, that could be dangerous to their health In order to develop a system that meets the needs of the market, it was designed and built a handler with special features that improve performance in relation to cost and ease of operation. Using an intuitive control system comprising a central station and programmable command compatible with the majority of technical manipulation handlers, such as DC motors, AC motors, hydraulics, etc., as well as the accuracy of the engines. The advantage is that the acquisition of special motors is not required, needing only, to adapt to the existing drive mechanisms. This feature shows the advantages of the cost as it is a cheaper product than conventional precision control systems and has broader compatibility.*

Keywords: *Robotics, Automation, Arm Manipulator, Exoskeleton*

1. INTRODUCTION

To improve and expand the use of manipulator arms, a survey on the shortcomings of existing systems was iniciated. Yet are common activities that expose workers to hazardous situations, and of course, it is thought the use of advances in robotics and automation to remedy the problem. But to use these advances, it is necessary in this time, select areas that have high financial returns due to the high cost of equipment.

For the use of equipment in any activity, it is thought the financial nature of the issue, even at the expense of ethical issues surrounding the safety and welfare of workers.

In order to attend the needs of protection and of cost / benefit, it is necessary to produce a versatile system, compatible with current technologies, with attractive cost and agility similar to man, replacing their presence where there is a risk.

2. CONVENTIONAL SYSTEMS

2.1 Direct Operation Handlers

Most equipments uses direct command of the operator to operate, using hydraulic power. In the example of the great cranes operating levers for moving heavy loads and running large assemblies, some are powered with electricity in laboratory and medical activities.

2.2 Automatic Handlers

They are used mainly in the manufacturing industry in series to perform repetitive tasks, replacing human labor quickly and efficiently, and do not require rest.

Recent Studies (Rosario, 2009) show that, the automation can be defined more broadly as the integration of observation and knowledge that replaces human effort and the decision by devices and software.

The major disadvantage of automatic handlers is the need for specific programming for each use, because they do not adapt to unexpected situations and have high costs.

2. 3 Robotic Handlers

These systems, known as robots, are increasingly developed, and its application is enlarged, with sophisticated designs that mimic human gestures almost perfectly. They also explore planets and distant stars and can respond to external stimuli and adapt to preprogrammed situations.

These devices are mainly characterized by having a positronic brain, which is a system capable to process information brought by sensors, causing it to make decisions, acting through their means of interaction with the environment.

Its main limitations are the cost and the immature development, falling short, especially when compared with the human capacity for decision and agility.

3. PARTS OF AUTOMATED AND ROBOTIC MANIPULATORS

Robotic and automated equipment have similar components, with differences mainly in data processing, and the robotic one being possessed of greater autonomy.

A robotic arm can be divided into two primary parts: software (the program, which has no physical existence) and hardware (physical machine parts, motors, clutches, arms, sensors, etc.).

3.1 Software

The software is a set of preprogrammed routines that define how it should behave when there drive sensors or switches, defining your drive. It is normally inserted into a computer which can be a PLC (Programmable Logic Controller). It operates in the control and interpretation of equipment commands.

3.2 Hardware

3.2.1 Processing

It is the piece of equipment that connects the software, drive mechanisms and sensors of the machine, routinely using the PLC, but there are digital electronic circuits that can do these functions, or even you can use a computer, and with the Programming form the structure of positronic brain.

3.2.2 Sensors

Are devices that capture the information necessary for software power, can be the key contact types, magnetic switches, potentiometers, optical sensors or even in passive, monitoring of a motor operating current.

These devices is increasingly being developed, giving more precision to automated and perception of the environment to robots.

3.2.3 Motors and Actuators

They are responsible for the movements of the equipment may be motors, solenoids, valves, pistons, among others. They are the driving force of the equipment or the tool used.

The motors commonly used are the stepper ones, being seldom used the ones with continuous or toggled current, because they have no positioning control system, mostly.

3.2.5 Structure

May vary according to the application arm, being dimensioned according to need charge and effort required, or to adapt to specific working conditions which need a special shape.

This part corresponds to the whole passive part of the device, similar to the skeleton in the body and may be, stems, arms, grippers pedestals, bases, among others.

4. DEVELOPMENT

4.1 Intuitive Control Concept

The main feature that differentiates the configuration of this equipment from the others is the use of the concept of intuitive operation, where the operator would not need extensive training to operate the mechanism, because only with the movement of exoskeleton attached to your arm, you could run movements complex which would be imitated by the handler, with great difficulty using conventional control mechanisms.

So the operator uses his manual skills to perform complex tasks and delicate distance avoiding the risk of contact with environments, dangerous substances and equipment.

4.2 Development Criteria

In developing some criteria were adopted to serve as guideline for its preparation:

- The handler should have similarity with the anatomy of a human arm for the operator to identify with the system's mobility, operating it intuitively.
- To facilitate development of the prototype the handler will have 3 degrees of mobility.
- The handler operation use system that transforms the movement of the operator's arm into commands that can be interpreted and transformed into moving the equipment.
- The handler movement will not be performed by stepper motors reducing costs.
- The operator must stay away from the handler, away from risks.

4.3 Mobility

Three movements of the human arm were selected that would reach better equipment, to explain the concept of handler.

Circumduction movement is described by the formation of a cone based on one of the vertices in the joint of the arm, turning it round. This movement is limited to 180 °:

Figure 1 - Circumduction Movement

The movement of adduction and abduction movement is characterized by the body's clearance in the abduction and their approach in the adduction. This movement is limited to an angle of 90 °:

Figura 2: Movimento de Abdução e adução.

The movement of flexion and extension is characterized by folding and extension member. This move will be limited to 135 °:

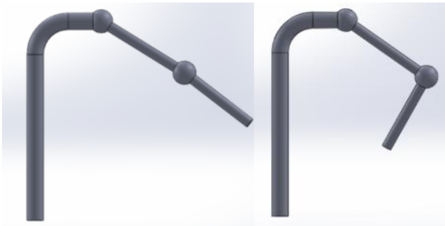

Figure 3: Bending movement.

4.4 Commands

For perform the replication the gestures, we need a way to capture the movements of the operator's arm. So it created a structure in which the sensors needed to capture the information have been installed.

The structure was designed so that the operator hold one lever and moving his arm, the mechanism assume a similar position.

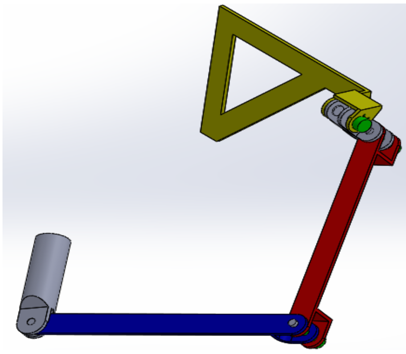

Figure 4: Control of Exoskeleton.

4.5 Sensors

After a survey of existing sensors, which proved more feasible was the pot, an electronic component where it turns a shaft, which changes the resistivity between its terminals.

Figure 5: Potentiometer

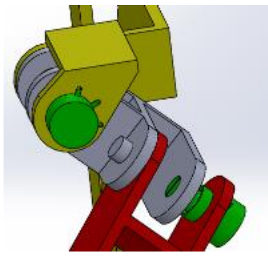

Figure 6: Installation in the joint

This component can be used to transform the angle of its axis in a specific voltage and reference of command and handler position. It must be installed in the joint system according to Fig. 06, to perform the drive shaft when the angle thereof is changed.

Thus, the only link between the operator and handler would be some low voltage wires, which would walk the signals responsible for the command handler, and the operator to be several meters away from the machine, removing physical, radiological, chemical, biological between others.

4.6 Motorization

The motorization must have sufficient torque and speed to perform the movements quickly and accurately, and lower cost than stepper motors. The dc motors, fulfill the basic criteria, but would still be a problem for precision control functions, therefore mostly, have not been designed for this function.

Was selected windshield wiper motor, because it has 12V working voltage, maximum speed of 100 rpm, maximum torque of 38 Nm, coupled gearbox, continuous work regime and high robustness.

4.5 Control with PWM

The use of a PWM (Pulse-Width Modulation), allows to control the speed of DC motor to maintain constant torque, providing accurate movement is required will control the speed of the motor gradually enabling appropriate decelerations and accelerations, with minimal losses of torque.

4.6 Command system

To interpret the data provided by the sensors, it is necessary to use programmable platform able to interpret analog data, and also to control outputs using PWM controls.

The platform chosen was the ARDUINO UNO as it is a programmable system versatility, meeting all the design parameters, based on the ATmega chip, able to write and execute a program written in C ++.

This platform has moderate priced, with the following characteristics:

- Programming in C ++;
- PWM control outputs, ready and easy to use;
- Analog inputs with built-digital converter;
- Speed compatible response;

4.7 Use of H-bridge transistors with FET

To amplify the low power signal provided by ARDUINO, it is necessary to use H-bridge, endowed with the type FET (Field Effect Transistor) transistors.

The transistors of the FET, work through the effect of an electric field at the junction, with it the main feature low input impedance, providing a consumption very low gate of excitement, and much lower than the voltage. Malvino (2008).

It uses the FET due to low drive voltage with a set of digital controls for convenient interface with the Arduino.

Studies (MARSTON, 2000) show that FET transistors are unipolar devices that have two major advantages over bipolar transistors: Being almost infinite input resistivity, thereby bringing gain amperage and power also almost infinite and your commute is not affected by cargo storage problems, overcoming most of bipolar in digital switching speed.

The use of photo-couplers connected to the FET gate it provides insulation of control circuits and and switching, protecting the ARDUINO.

4.8 Programming

The programming operates using information from the sensors to determine the amplitude, speed and direction of movement.

When the command is in a similar position to the handler, it becomes static, but if we cause a drive in the command, the sensors send the new positioning information to the center, which defines how the handler should move to equalize its position with the command, and commands the motors to move a timely manner. The sensors of the handler, in turn, check the position and send to the center, which stops the movement when the balance with the command sensors occurs.

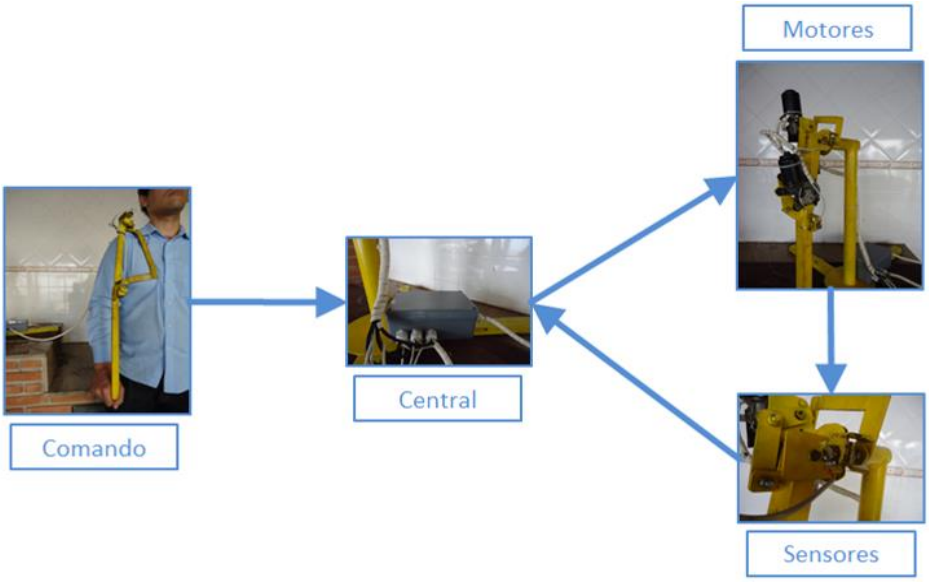

Figure 7: System operating flowchart.

5. PROTOTYPE CONSTRUCTION

The equipment was developed mainly targeting meet the educational criteria being used to demonstrate the possibility of implementing satisfactorily movements.

Considering that its use occurs mainly in academic environment, it could not give up the security, requiring a careful execution of the stages of the project and its execution, made of SAE A-36 steel.

5.1 Prototype Modeling

SolidWorks modeling was used to evaluate the dimensional characteristics required for adaptation of the motors and also the development and design of each of the mechanisms.

This process was avoided the use of noncommercial profiles to be no difficulties in its construction.

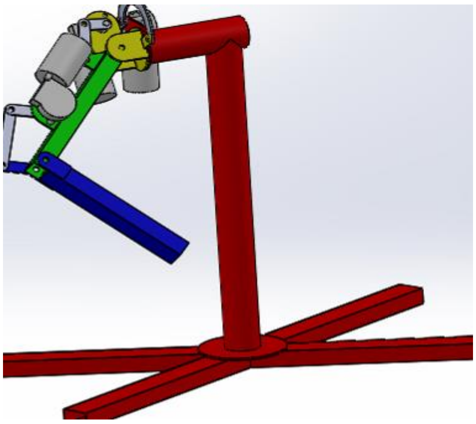

Figure 7: Manipulator Modeling.

For the construction of the manipulator used were three types of profiles.

- Tubular Round 80mm x 2mm
- Rectangular tubular 30mm x 50mm x 1.2mm
- Flat bar ¾ "x 2mm

5.2 Assay finite element

Several tests using a software through finite element you can determine which is the maximum torque provided by the engines for the proposed system.

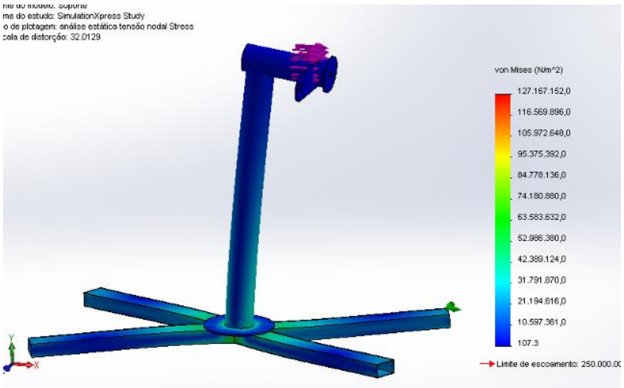

Figure 8: Assay in finite elements.

5.3 Project Execution

All parties were, after proper sizing, made of steel and joined by electric arc welding process using E7018 type electrodes providing the necessary rigidity to the prototype.

Figure 9: Prototype finished.

6. RESULTS

With the construction of the prototype, it was possible to demonstrate the practicality of "intuitive controls" regarding the direct commands of the lever or button type, bringing a new level of interaction between man and machine, improving the safety of market control systems.

It would be perfectly feasible, with further development, the construction of lower cost equipment for carrying out dangerous tasks, thus avoiding physical damage to workers, but also the costs incurred by the severance pay from labor accident occurrences.

7. DISCUSSIONS

It could replace human presence without replacing its labor in hazardous activities, with this or other technologies based on the same concept of intuitive operation of equipment at a distance.

So it should be taken into account the social and ethical nature of the issue, which is the problem of the cost of acquisition of this equipment despite reduced relative to other options, it is still high compared to ease of replacing a human being hurt by other health at work field.

8. FINAL CONSIDERATIONS

The proposed system makes the worker is not exposed to risk situations, seeking to reduce the number of accidents by unhealthy and dangerous conditions.

It is common in our days doing the assertion that if an idea is very simple, surely someone already performed, it is shown increasingly as untrue. After all, they must not forget that there is always one point where they are in a position to contemplate the situation so that the others may not.

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10. RESPONSIBILITY NOTICE

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