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ROBOTIC ARM DESIGNED FOR ACTIVITIES IN HAZARDOUS ENVIRONMENTS

ȘTEF Darius Augustin[1], BUCUR Gabriela[1]

[1] Petroleum Gas of Ploiesti, 39 Bucharest Bd. , ZC 100680,Ploieşti, PO BOX 52 Romania,
e-mail address: dariusstef2001@gmail.com

Abstract : The purpose of the project that is presented in this document is to present the idea of a robotic arm that is capable of operating in environments that present imminent damage to living organisms. Mainly , this robotic arm is designed to be easily built, maintained, operated and the possibility to be replaced partially or totally at a reasonable cost and be a reliable tool.
Key words : Arduino, configuration, environment, hardware, hazard, measurement, microcontroller, robot.

1. INTRODUCTION

Robotic arms, aptly named because they resemble a human arm, are typically mounted to a base. The arm contains multiple joints that act as axes that enable a degree of movement. The higher number of rotary joints a robotic arm features, the more freedom of movement it has.

A robotic hand is a mechanical device designed with multiple degrees of freedom to mimic the physiology of the human hand, enabling it to adapt to various constraints and perform tasks such as apprehension and manipulation in coordination with a robotic arm. [1], [2]

2. METHODS AND RESEARCHES

The robot in separated into 2 main parts: the hand and the main console.

The hand is the execution part of the project . It's purpose is to grab objects, move them around, measure the temperature of the object, calculating the distance to obstacles in proximity and avoid them. In order to operate, an Arduino Uno microcontroller is used, which will be referred from now on as "Arduino-HAND". The hand utilizes in its purpose 5 low weight servomotors operating each finger, and one medium weight servomotor operating the wrist.

On the external part of the hand 2 sensors are placed: one thermic and one for proximity. Each sensor is connected to another Arduino Uno microcontroller which will be referred to from now on as "Arduino-LCD". [3]

These controllers are non-linear control elements, which have a static relay characteristic with hysteresis. [4]

The main console is the "head" of the robot, not just for the purpose of controlling the entire ensemble but because of the real-time feedback features as well. The commanding part of the hand are the 2 Arduino microcontrollers mentioned. The feedback part is represented by the LCD located in the middle of the console as well as the module on the top mentioned later on as the "Timer-Module".

The Timer-Module has 2 main purposes, displaying the exact date and time and to overview the temperature at the level of the console. It is important to mention that the temperature detected at the level of the hand and the temperature of the console are entirely different measuring systems, with different purposes and feedback settings.

As presented in the main configuration, although the system is by all means automatic, and can operate without a person giving it commands, it is highly recommended that the robot should be supervised at least in this stage of development.

The external hand presents an addition to the main hand, a piece of material called "The Shield" which has 2 purposes: facilitates the mounting of the sensors and protects the fingers from damage that can intervene due to improperly handling the arm.

2.1 Hardware configuration :

On the shield are placed as shown in the external hand configuration the sensors as follows: the proximity sensor is situated in the upper middle part, identification area extending from the front of the fingers to the backhand and in the bottom center of the shield the temperature sensor is situated, having the purpose of detecting the value of the temperature of the object in

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hand and to prevent thermal degradation I the internal components.

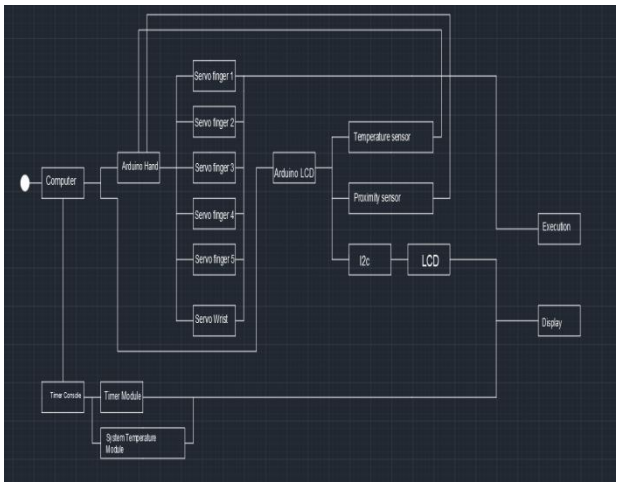

Figure 1 Hardware configuration [5]

Temperature is a physical quantity of great importance for understanding the state of natural and industrial processes. [3]

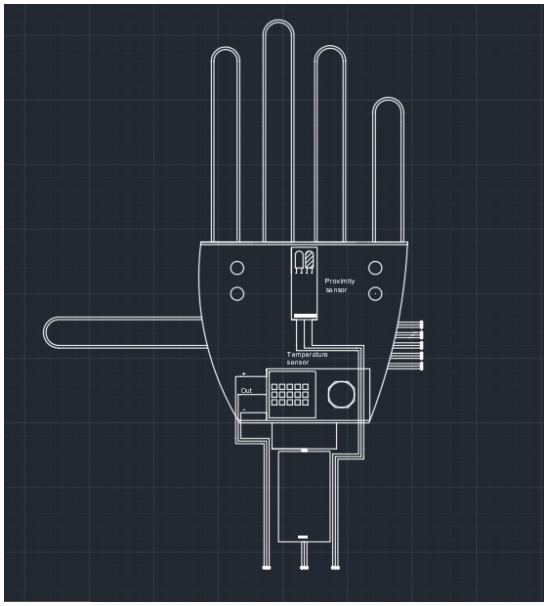

Figure 2 External hand configuration [5]

2.2 The main console of the robot:

The following configuration represents the main console of the robot. This is where the movements are programed, overwritten, the feedback is showns and presents the largest part of the project that can be technologically improved.

The placement of the components is as follows (Figure 3)[5]:

- Top center: Timer Module
- Upper left side : Transformer for Timer-Module
- Center left side : Backup Relays
- Cenrter: LCD
- Upper center: I2C Module
- Center right side: Power supply (reserve)
- Far right side: Timer-Console (small console used to manually program the Timer-Module in case it not displaying the right data)
- Bottom left side: „Arduino_HAND" microcontroller

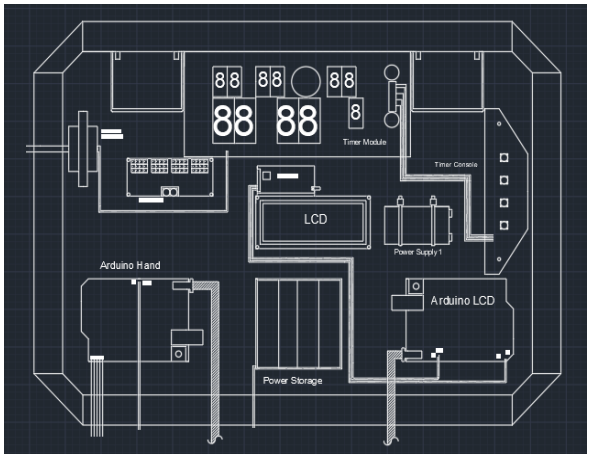

Figure 3 Console configuration

- Bottom side : Power Storage (Inactive at the moment , part of future developmets)
- Bottom right side: „Arduino-LCD" microcontroller.

2.3 The robot's performance:

Control of a multi-fingered robotic hand is usually based on the theoretical analysis of the kinematics and kinetics of the fingers and of the object. However, application of such analyses to a robotic hand is difficult because of modelling errors and uncertainties in the real world. Moreover, the complexity of multi-finger manipulation makes the programming difficult, even for a simple motion.[2]

Paper's:

Speeter [7] described a hardware and software hierarchy to control manipulation with the Utah/MIT dexterous hand, and addressed an abstraction of dexterous manipulation and a control scheme for the Utah/MIT dexterous hand with a set of just over 50 primitives. " A functional approach to the control of manipulation is described and the functional philosophy is embedded within HPL (Hand Programming Language), which provides an abstraction of the process of manipulation through its use of motor primitives".[7]

Michelman [8], [9], [10], [11] showed how the primitive manipulations can be combined into complex tasks.

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Shirai, Kaneko and Tsuji [12] found that the grasp patterns should also be changed according to the surface friction and the geometry of a cross-section of an object in addition to the scale.

Figure 4 Hand representation [5]

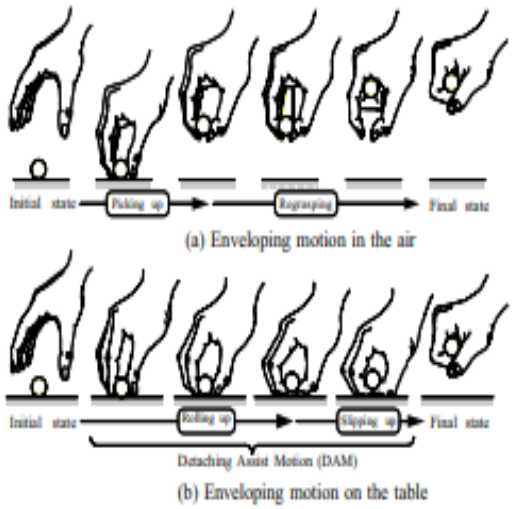

Figure 5 Two Grasp strategies for enveloping an object placed on the table [12]

They verified the grasp strategies by experiments with DAM (Detaching Assist Motion) (Figure 4, Figure 5).[12], [13].

Many other experiments were during the time for robotic arms. [14], [15]

3. CONCLUSIONS

The robotic hand is a tool built with mainly recycled components which is a reliable marker to confirm that it is a cost-friendly pilot project, and it is expected that future development such as adding more types of sensors, adding one more arm or the ability to offer feedback in other ways can only sustain the idea that is presented in this document.

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