Design of an Autonomous Classifier Robot
9th Latin American Robotics Competition. IEEE Open Category

Contreras B. Mario A, Delgado P. José, Ordenes S. Jerick E, Rivero G. Luís E.

***Abstract*— Currently automatization in industries has covered a lot of ground in a very effective manner, this is why advances in this field are very relevant, problems like classification and storage in an industrial warehouse are very common, so the search for new alternatives becomes ever so important. This paper presents the development of the PERSEO robot, which shall participate in the Open category of the IX Latin-American Robotics Competition. Its' task consists of transporting solid products, stored in groups, from the manufacturing area to the selling area, where the products shall be organized in packets according to distribution. Successfully accomplishing this task has its difficulties such as recognizing products according to color, organization, la amount of products to be transported, all of which must be done in short amount of time. Here we shall present how to accomplish this.**

I. Introduction

The world we live in has evolved considerably to this day, part of which thanks to technology. Looking back on history we see that early in the XVIII century, Jacques de Vaucanson created an android that played the flute, as also a mechanical duck that continuously ate and defecated. Towards 1942 Isaac Asimov introduces the word "robotics" and suggests that all robots be governed by a series of moral rules called The Three Laws of Robotics. With the advent of the industrial Revolution, technology becomes widespread as does the attempt to automatize each and every chore.

In time robots nowadays are used to carry out dangerous, repetitive or difficult tasks for. Thus due to its uses, manufacturing and production lines are the main markets for robotic use where robotic arms similar to a human's are the most common.

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Contreras Baruh Mario Alejandro, student at the School of Systems Engineering, Faculty of Engineering, Universidad de los Andes, Merida, Venezuela (e-mail: mariocontreras@ula.ve).

Delgado Pérez José, student at the School of Systems Engineering, Faculty of Engineering, Universidad de los Andes, Merida, Venezuela (e-mail: josedelgado@ula.ve).

Ordenes Sepúlveda Jerick Emilio, student at the School of Electrical Engineering, Faculty of Engineering, Universidad de los Andes, Merida, Venezuela (e-mail: jerick@ula.ve).

Rivero Garcías Luis Enrique, student at the School of Systems Engineering, Faculty of Engineering, Universidad de los Andes, Merida, Venezuela (e-mail: luisrivero@ula.ve).

Tasks such as soldering, painting, machine lifting and product handling have become a constant which is why our study focuses on the development of a prototype capable of classifying an array of products for sale. This autonomous robot is capable of transporting, organizing and classifying the packages incoming from the factory to be shipped to the vendors' zone in the least amount of time possible.

The idea of a mobile robot carries with it a set of clearly defined behaviors: the capacity to move, to collect information from its surroundings, to reason and establish its own pattern of behavior. This article shows a proposition made by the LaSDAI Team, which seeks to explain what systems allow collecting information and with this in account to reason and complete the assigned task.

II. Task Description

In Figure 1, a diagram of the competence field is shown. The environment consists of the Producers' zone and the Vendors' zone.

--The Producers' zone is divided into 5 sectors, in each of these sectors there are 12 units of a product stacked by color and are organized in rows of 4 with 3 levels.

--The Vendors' zone is divided into 12 sectors that are initially empty. In each sub-division a unit must be organized to contain a package of the existing product brought over from the Producers' zone. (Each unit is made up of 5 packages)

The products in each package must be organized in a specific order and be arranged in a row inside the sub-division with no separation between products. The robot must leave from one of the four crosses located in the center of the setting. The robots' position and the arrangement of the packages should be no obstacle for the robot to complete its' task.

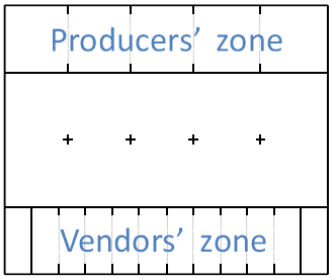

Figure 1: Definition of zones. Taken [1]

III. PROPOSED SOLUTION

To successfully accomplish the task the robot must be capable of overcoming the following:

--Determine the location of The Producers' zone and The Vendors' zone.

--Determine the position each product has in the Producers' zone.

--Moving the products from the Producers' zone to the Vendors' zone without dropping any products along the way to avoid penalties.

--Organizing the products in the Vendors' zone.

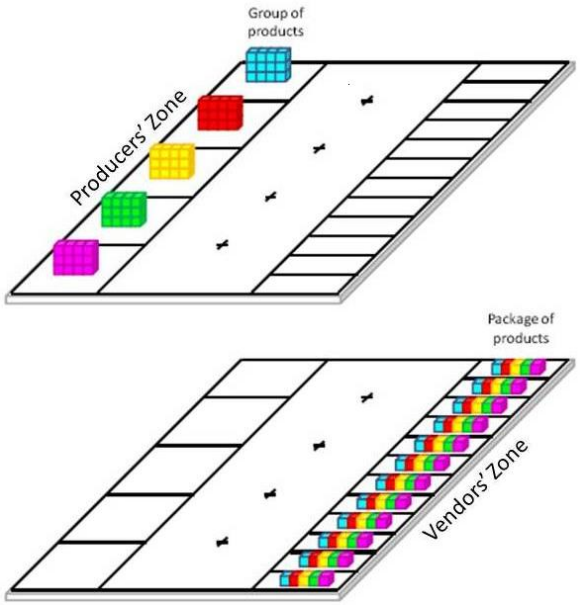

Figure 2: Stage of competition. Taken [1]

After analyzing the restrictions of the problem, it was agreed to build a robot that has 2 storage deposits, one loading tower, color identification system, a proximity warning alarm and an array of sensors located in strategic points that allows for previous detection of anomalies in the scenario. At first a visual recon system was to be included but after acquiring the color ID system this was deemed surplus to the requirements.

The storage deposits are of great importance as they allow the organization and mobilization of 2 packets simultaneously (10 products) and allow them to be unloaded in the Vendors' zone perfectly organized thus saving time and associated expenditure.

The loading tower is crucial to the design because each product is taken from the Producers' zone to the Vendors' zone through this tower and is stored in the deposits.

The color ID system serve to determine the location of each product en the producers' zone through previous recon of the area and later, allows the identification of the product as the robot takes position in the sub-division to seize the product.

The proximity warning system helps in locating the Producers' zone through the detection of products stored in this area. This system also allows for correct placement of the robot as it takes the packets from the producers' zone.

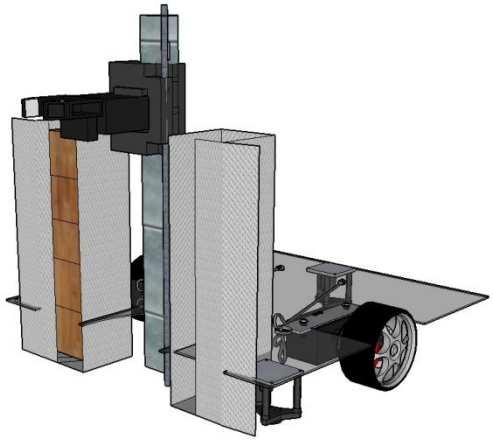

Figure 3: PERSEO. Side view.

IV. MAIN CHARACTERISTICS OF PERSEO

Here are the most important modules parts of the robot PERSEO: Storage Tanks, Loading Tower and Color Determination System.

A. Storage Tanks.

The design of these deposits came through the need to place the packets with surgical precision and to diminish moving time. These are two boxes, manually built out of galvanized metal 1mm thick, 260 mm high and 54mm x 54 mm wide thus allowing the storage of up to 5 products in each deposit. The Storage Deposits are located vertically at the fore of the robot and are only 3mm off the ground. They are uncovered to allow the loading tower to place the products inside.

The deposits are fixed to a hinge that allows them to be laid simultaneously through the action of a motor to rest in its original position after being unloaded. To accomplish this, the front part of each box has a hatch door that shall open (through the use of a servomotor) once the box in laid down, letting the products fall neatly into place.

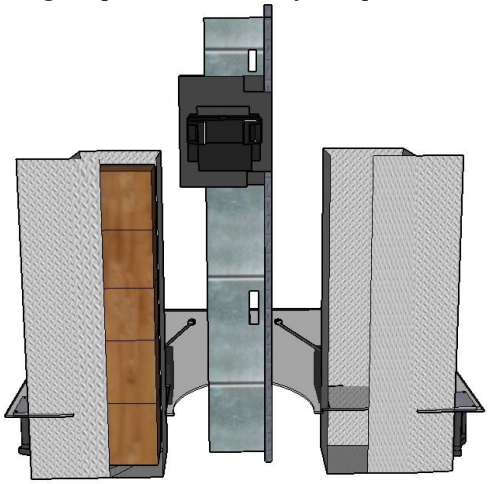

Figure 4: PERSEO. Front view.

B. *Loading Tower*

The design was inspired by the loading tower of a simple freight lifter, adapted to the needs of filling 2 storage deposits. It is 290 mm high and, as the storage deposits, is located 3mm off the ground. It is located in the forward part of the robot *between* the two storage deposits. It has a base that can either ascend or descend to allow for easier placement of the product and later be able to reach the superior part of the storage box and place the product inside. This tower is mobilized through the use of a servomotor adapted to a pulley. Also included is a pincer in the form of a scissor, constructed manually and actuated through the use of a servomotor. It has the capability to turn precisely on its own axis to place the product in the tower located beside it. This was accomplished with the adaptation of a rotating axle fixed on top of a gear clutch system which allows for precise control through the use of a motor.

C. *Color Identification System*

The color ID system was designed through the use of two ColorPAL 28380 sensors and a PIC16F877A microcontroller unit. One sensor is located to the right lateral zone of the robot and is used for recognizing the producers' zone while the second sensor in located in the loading tower pincer and allows for color verification when the robot is in loading position.

Figure 5: ColorPAL 28380 Sensor. Taken [2]

V. CONCLUSIONS AND FUTURE WORK.

The achievement of this job leaves great results, primarily the knowledge and experiences of each team member. A robot capable of realizing the proposed task was designed. The success of our job is in the modular development, the mechanical design and each of the strategies used to accomplish our objectives.

As a future objective, the installation of a sighting module that allows for increasing and improving the behavior of the PERSEO robot shall be proposed.

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