Team CROFI-UNAM

Team Description for IEE Open Category- Beach Cleaner Robot of LARC 2013

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***Abstract*—This document describes in a general way the operation of the beach cleaner robot, designed and built in CROFI, detailing every subsystems that compose the mechanical,electronic and software's system. With the goal of giving more tan the contest demands and increase the developement of this category.**

Keywords—Beach Cleaner, FitPC2i, OpenCV

I. Introduction

Our beach's cleaner robot, named CHAMAL KIIN, that means green caterpillar in Maya, because at the beginning of the built of this robot, it counts with caterpillars like a crane that helps to increase the traction in all surfaces, and green because the entire robot's cover was in this color. The robot belongs to CROFI,where in a parallel way we design other robots for several contest . In this category we have participated as national competitors in three times, being in the last, where we won the chance to represent Mexico in the Latin-American Championship.

The mechanic design process of the CHAMAL KIIN prototype arises from the needing for the robot to travel in all kind of surfaces and conditions, for example, in dry or wet terrains, such as construction sand or ,for example, wet grass whit stones nearby, and surfaces with mud too.

II. HARDWARE

The CHAMAL'S Platform counts with a chassis built with Steel, manufactured with hollow steel rectangular pieces with .5 inches width and 1 inch high , and joined with electric welding, all realized by the CROFI team members.

A. Movement and displacement.

To achieve a displacement, the platform counts with 4 wheels of 100mm of diameter and 76 mm of width, with different heights in the Surface of the tire, which allows a better traction in the field. This wheels are attached to the chassis by four hexagonal axes with 9mm of thickness, which are coupled to steel gears that provide torque to the front and rear wheels with a transmission chain.

The traction system is composed using two motors that provides two different ways of movement, Left Traction (LT), and Right Traction (RT).

The system that couples the motor axis to the traction chain for the front and rear wheels is a gear system that guide the chain all around the main gear (the one that comes directly from the motor axis), to increase the torque and secure the permanent contact between the chain and the main gear. The entire system was designed and made by members of CROFI to secure a good and stable torque to increase the efficiency of the motors and generally the powertrain.

To achieve the robot's orientation and turn, we power on the motors in opposite ways, for example, if we want that the robot turn right, we power on a positive voltage on RT and turn off LT and if we want to turn left ,we power on a positive voltage on LT and turn off RT,and if we want reverse, we have to power on both motors with a negative voltage, and the turn them just a little, in order to re-orientate it and evade the obstacle, or to avoid the water of the sea's simulation.

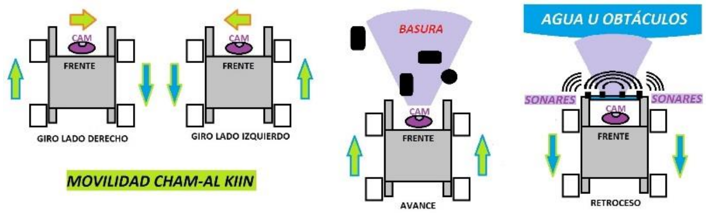

Illustration 1-Graphic Description of the robot's displacement: Right Turn, Left Turn, Fordward and Reverse.

The motors implemented to provide mobility to wheels are cyclic motoreductors @24v and 500mA/60RPM with 15 kg/cm and 550gr each one.

To provide electrical power to the Robot, we implement two batteries Ballistic, which are mounted in both sides of the chassis, between the front and rear wheels, and with this configuration we can take advantage of the empty spaces that are disposed .The battery cases are also from steel and they cover almost completely the battery, with the objective to ensure the battery in al moment to its original position.

One of the primary goals of this design was to integrate all the mechanical components of mobility, processing (mini-computer), control electronic and batteries in the smallest possible space, with this in mind, we can set free important space required to deposit more cans in a row.

B. Recolection

To solve the necessity to pick up the cans from the sand, we implemented a system based in the mechanic of an elevating arm which stay retracted to the garbage deposit.

This system is composed from two motoreductors from plastic ASMO, with 8kg/cm and 350gr each one.

The activation of this mechanism is attached to the detection from the vision, the picking up arm remain attached to the deposit during the searching of garbage, all the mechanisms are disposed in the way that they didn't hinder the other mechanisms tasks, and it doesn't hinder the pull down of the garbage in any moment.

The arm is attached to the deposit's base structure, which simplifies the clearing out of the garbage with the elevation of the two systems at the same time.

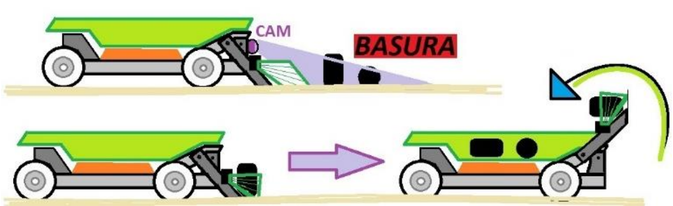

Illustration 2- Description of the objects and garbage recollection system.

C. Deposit

To elevate the deposit in order to pull out the garbage to the biggest deposit, we implemented a Moto-reducer ASMO @12v & 270mA with 1.86 RPM, 20KGforce and 350gr for weight. This component help us to generate an elevation in the deposit, which help us to pull out the garbage in the inorganic can.

Illustration 3 – Garbage Dump System

In the National Robotic Tournament we obtained excellent scores in all the stages, and fortunately we won the championship of this category whit this design.

Ilustración 4 – Displayed Design at TMR (Mexican Robotic Tournament) 2013, in Puebla, México.

III. ELECTRONIC

The CHAMAL KIIN implements a FitPC2i computer with the operating system Ubuntu 12.04, which develops image processing from a picture obtained with a Webcam Logitech c920.
For the calibration of the color filter parameters involved in the image processing in a remote way with a computer via Wireless we decided to use a Wi-Fi Module TPLink with high gain.

The complete base of the robot (like sensors and motorcontrollers in general are controlled by an Arduino Mega 2560 which communicates with the computer to control all the steps involved in the processing and the orders that they send to the power stage, which involves the motors previously mentioned in section number 2 via Mosfets, we like that components because they have demonstrated dependability in management of high currents.

For the control interface we used a general button,(high current switch) that starts or stops the robot in a general way (including the motor and all the steps involving all their parts),also there

is a switch that handle the motor current in case of a control failure of any of the systems of the robot (emergency stop).
We implemented a system with four push buttons for multipurpose and program variations for the CHAMAL, also 4 leds to have a signal of the robot's status and a speaker from a laptop which, via audio, show the robot's status using a voice program named "espeak[1]" previously installed in the FitPCi2 computer.

For the power supply we implemented two batteries from LiFePo with 4 cells @13.6V and 8 Amp. Brand Ballistic, which are mounted in a serial setting to deliver 24 V.
Also we add it a 5V voltage regulator, so at the end, we have as outputs: 5, 13.6 y 27.2 VDC.
We use 4 Ultrasonic sensors model SRF02 for detection and avoiding of obstacles, with also two quadrature encoders with 100ppr for controlling and calculating the advance of the robot, in addition we used four bumpers (switches with mechanical push) that help us to know the actual state of the box and the shovel (Up or Down), also there are two servomotors HiTec HS485 that support the collect arms [2].

IV. SOFTWARE

We used the Arduino and the C++ native platforms to control the robot motors (can recollection & deposit, and traction actuators), also for sensing all the environment and for communicating the status of the robot via screens and speaker, all this in the configuration of a slave that is controlled by USB connection in serial mode read by the main computer.

The computer, running Ubuntu 12.04 OS, use the Python environment to carry out the following tasks.

Vision, Base and platform control, remote control for last calibrations using sockets, and all the other tasks needed in order to clean the beach.

We use the Thread-Programming technic, which allows us to execute all tasks at the same time.

V. VISION

The vision, programmed in OpenCV under Python, is a program for recognition of several characteristics, for example, shape and color, and that's how it works:
First we capture and image with the WebCam in a native RGB Color processing , and then we convert to the HSV space of colors, this to have a better control over the image, the we do several morphologic operations to reach the processing of image, like for example : Blur, Dilate and Erode.
Then we separate the image in well identified color spectrums and then we convert it to a binary image with a specific color, from where we can obtain an area moment, and then a centroid, and with this parameter we obtain the localization of this specific object, which can be water, the inorganic container or a can, and all the previously identified objects have their own parameter configuration (for example can.txt), all this parameter under the HSV color format and the identified dimensions of the object.
We build this parameter calibration at the beginning of the contest, because we have to consider all the changes in the environment, for example illumination, that is made in a graphical way to make the process more interactive. [3]

Illustration 5 – Processed Image Proofs with detection of specific colors: black (can-garbage), blue (box-water) and red (cable-inorganic container).

VI. CONCLUSION

Whit the feedback generated from the two previous versions we are capable to identify the options that can be handled to obtain the greatest version ever made, and with all that information and skills, now we are working in the fourth version, which will be even better.

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