FALCONBOTS TEAM DESCRIPTION PAPER ROBOCUP 2018 MONTREAL, CANADA

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abstract. This article describes the functioning of the FALCONBOT system by briefly detailing the scientific aspects developed in the robotics and mechanics laboratory ITSSMT for participation in RoboCup held in Montreal, Canada. In addition to describing in chronological order the passage of FALCONBOTS by RoboCup.

INTRODUCTION AND COMPLETE PARTICIPATION

The technological institute of San Martin Texmelucan, concerned about the development of its students, decided to promote the application of the specialized studies taught in that institution by creating the Robotics and Mechanics Program of the ITSSMT (PROMETEC) to be able to promote projects oriented to robotics that will promote human resources avant-garde of high quality.

Under the premise of competing year after year and better results obtained in Robocup the research team of FALCONBOTS will work, having the first participation in 2011 held in Turkey and participating consecutively in Mexico, the Netherlands, Brazil, China, Germany and Japan, the FALCONBOTS team has a great experience with its FALCONBOT platform.

Commitment

The FALCONBOTS team is committed to participate at the RoboCup 2018 in Montreal, Canada and provide a referee knowledgeable about the rules of the humanoid league RoboCup.

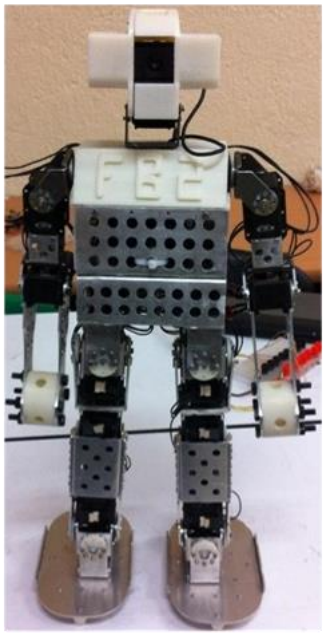
Mechanical structure

The last versions of FALCONBOTS in its construction has been made with aluminum 5052 H32, once with a thickness of 2.32 mm, the material is chemically treated in order to make the sea stronger. Currently we use CNC and 3D technology to comply with the machining of each of its components, allowing robots to be built by ourselves. With the help of the PROMETEC ITSSMT research laboratory, robotic prototypes are under construction with specific activities promoting the research developed in the research laboratory.
The mechanical structure of the FALCONBOTS robot versions is based on the frame of 20 degrees of freedom, placing two in the part of the head, three in the arm and five that make up each leg. In each version the torque in the motors is improved and restoring the dynamic and kinematic calculations, this has caused an increase in the size of the robot.

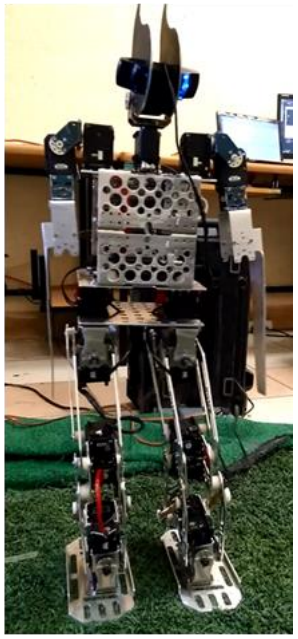
The first version of FALCONBOT maintains a height of 54 cm, the next version has a minimum height of 60 cm,

the third version of FALCONBOT has a remarkable remarkable enough, has a minimum height of 80 CM.
In the following image shows, the three versions of FALCONBOT, where you can see its main characteristics that make changes and have had a part of its mechanical structure.

1. FALCONBOT ONE



2. FALCONBOT TWO



3. FALCONBOT THREE

Sensor and actuator

The robots of FALCONBOTS, has as a method of driving the joints, high torque motors brand Dynamixel, of different series, we use the series MX28, MX64 and MX106, which are implemented according to the nature of the joint. The actuators are placed in strategic positions according to the kinematic configurations to fully exploit the capabilities of the actuator. Constant feedback is obtained to optimize engine performance, setting a look-up table for optimal performance of each actuator. In addition, HALF DUPLEX communication is used in four open channels to control

the actuatorsbilaterally, this leads to better use and more feedback cycles for optimization.

Our robots use the readings of a 9DOF IMU to know the physical state of the system in space in very short periods of time. A predictive autobalance algorithm uses these readings to optimize and improve the position and stabilization of the robot. The sensors in conjunction with the system use the inertial movement of the body to generate an improvement in the position of the body when the robot is parked or when the robot is dynamically walking.

The camera is the most important sensor of our robots, since we know the state of the system and space to determine the next action. The camera used by our robots is the LOGITEC C920 brand, with a resolution of 640 * 480, and the YUV color space.

Main Controller

To optimize processing and improve system speed, a NUC INTE, with 4GB in RAM, is used in conjunction with the Linux-based operating system. This computer version is used for the resources offered and thus maximize the results of all algorithms.

The interfaces used in the main computer are the ETHERNET port and a USB-SERIAL converter, in order to communicate the robot with the secondary card. This communication makes possible the feedback by some sensors in the robot.

Sub Controller

Development board STM32F4DISCOVERY is used to create a gateway to the main computer in the Falcnbot TWO, In the robot Falcnbot 3, a card developed by the research laboratory PROMETEC is used, which has an IMU sensor of 9DOF for the inertial measurement of the robot. This card offers 4 channels of bilateral open communication with the actuators, to improve the speed of communication with these and thus improve the feedback to make the corresponding improvements.

Software

The control system and decision-making is scheduled MatLab with a main control module and the vision system, and c ++ and assembly for motor control and acquisition of inertial data through the gateway.

The system is divided into 4 modules of interest:

- Artificial vision module
- Locomotion and kinematic control module
- Module filtering and interpretation of inertial data
- Localization Module

Artificial Vision System

In the competition of RoboCup in humanoid league, mostly in the category was established that the ball game, the goals and lines of the court were white, that means that most elements are there in the environment have a Color in common.
This makes difficult the collection of data of particular interest. In order to facilitate recognition of objects of interest within the vicinity of the soccer field, apply techniques to make the

computational cost is cheaper and at the same time facilitate the recognition of patterns.
Image acquisition is done through the C920 camera in his YUV color space, to subsequently apply a Gaussian filter to improve the image basic medium. An algorithm for optimal recognition of light in the environment applies to level the native camera settings and so have the optimal image.

$$f(x) = ae^{-(x-b)^2/c^2}$$

Recognition of the ball and the goals is performed under two conditions, the first is to have only a pattern and unique colors for detection, ie, the minimum detected colors to save computational resource. The Kmeans algorithm is used to cluster with pixels. By applying the Gaussian filter and jointly kmeans algorithm, the result is an image with only 8 detectable and filtered to make a mapping of colors in which the target will be the important colors.

$$\arg\min_{\mathbf{S}} \sum_{i=1}^{k} \sum_{\mathbf{x}_j \in S_i} \|\mathbf{x}_j - \boldsymbol{\mu}_i\|^2$$

Later when the image is already in the core data, two sets of individual data are separated by applying a basic Hough transform algorithm, to detect patterns in a circle and patterns shaped line, and the ball correspondingly goals. All this is done through Octave.

Locomotion and behavior control

The behavior of the robot is based on the classic control system of finite state machines, where viewed from high level, this provides behavior based on the decision making process of the central control system. The main decision is based on what the vision

processing system. A finite state machine high level controls movement of the body in general.
In low-level system of locomotion it is in kinematic analysis. The resolution of inverse kinematics is based on the resolution made by the team Darwin for robot DARwIn OP. Kinematic analysis is solved and through the technique of pendulum balance invested a stable ride is done. 20 DOF robot-like DARwIn OP, make the system locomotion much lighter and stable.
The center of mass of the robot is in the right spot to generate a higher speed in the FALCONBOT TWO, ONE unlike FALCONBOT.

Electronics

The electrical system of the robot Falconbot One is based on the robot DARwIn OP, with an CM730 controller for controlling the motors and sensors. A serial communication interface to a compass through the i2c bus was implemented. The compass sensor is implemented to cast the orientation of the robot on the field.
In the Falconbot two, the control system is based on the discovery SMT32f4 microcontroller, which serves as a gateway between the servomotors and the computer through a direct communication to UART2 serial bus.
In the FalconBot Three robot, the control system is based on a microcontroller PIC 18F2550, with direct communication through its USB interface and using an FTDI logic converter, it is connected through its serial port to the servomotors.

Conclusions

This paper mainly shows the progress of the FALCNBOTS ITSSMT team, facing the next RoboCup 2018 in Montreal, Canada. It shows improvements from the first version of our robots to the latest version that is currently under development, which will feature 24 DOF and high torque motors in most joints.

References

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