EUROBOT 2007

TEAM: ACKROBOT-Team

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I. GENERAL DESCRIPTION

The robot in overall:

The robot is capable to recollect all types of waste. It disposes of two systems for catch the items: a robotic arm for the cans and bottles and a special servo-design with a magnet for the batteries. The maxim capacity for store waste is design for a two bottles or four cans on a supports inside the robot, plus a bottle or can carried with the robotic arm. It's probably known that for Spain round only be able to carry one item placed on robotic arm. Will be four batteries independent servo-systems available that provides four batteries carry places. The intention of the four battery systems is to cover all wide of the robot (6cm wide of each servo-system per 4 systems = 24cm inside robot wide).

The detection of waste is made inside the robot chassis using a CMUcamII, here the need of using potent white led focus. The detection of the rival robot is made by positioning system and using infrared proximity sensor as security.

The way to carry out the objective of the game is catching and depositing the bottles and cans directly with the robot arm. So we have to stay on the waste to catch them, and we have to stay next to the bins to depose the waste inside with the robotic arm. For the batteries, also we have to situate on the each battery, catch it, keep them on the robot servo-system, and deposing all them at once to the battery bin, situating the robot on the battery bin, and actuating the servo-systems mechanisms.

Simple outline of the robot:

The design of the robot is essentially thought for not to trip over the waste. In this way, the inside is 24cm wide (sufficient to pass a bottle in all possible directions) and the exterior wall supports for the wheels are the thinnest as possible (32mm). To solve the worst case that is found waste between the front of robot and the walls, we have disposed two rotational cylinders covered with rubber to move the waste away, to a lateral. So we push the waste the minim as possible. The intention is to travel over them and catch only the ones interest us.

The length of the robot is the sufficient to store a bottle inside plus the servo based system for the batteries, which are stored out of the robot perimeter. We only can detect the batteries inside our robot, so when we detect a battery, we activate the servo-system to catch it. But if there are two batteries together and one belongs to the opponent we can't assure we do not catch it. If we catch an opponent battery, when we realized of that we leave it.

Two diagonal shapes at bottom of the laterals are intended to reduce the total robot perimeter, allowing some error construction measures. The height also is 33,5 cm above the floor, allowing also some error.

Possible strategies:

The strategies used for the game is the last we have planned to define, however some directions we have been thought about.

The principal objective of the robot is to recollect batteries because cans and bottles are more difficult to carry, and one battery scores like 3 cans/bottles. So the most probably at start of the match the robot will go directly to the triangle that have our batteries, passing over the opposite waste triangle to expand the waste a little bit. The batteries servo-system will be pulled down with the intention to move the opponent waste triangle, because it can't pass under the servo-system. We hope not to catch any opponent battery because it doesn't interest us at all.

After start strategy the robot has to ride along the entire surface in S ways to try to recollect the four own batteries. Then, we will travel to battery bin to place batteries inside. Once some batteries will be in the correspondent bin, the robot will situate near to bottles/cans bin and with the robotic arm recollect in the correct bin bottles and cans nearest them. In the case to find a new battery the priority is go to put it to the battery ring. The robot will do this procedure since the 90 seconds end.

II. TECHNICAL DESCRIPTION

Robot moving:

The motors used to move the robot along the gamming zone, are two MAXON A-MAX motor. They are rated 6W to 24V, but we supply them about 22V. The maxim speed rated is 660rpm, but to 22V it will be around the 600rpm. With a pulley relation of 26:28 and a wheels of 48mm in diameter the maximum speed reachable is about 1500mm/s (not intended to arrive at max. speed).

Motors are provided with an optical encoder, 100 pulses per motor revolution. So motion control is based by a PID position control based system. For that reason we expect exact turns to situate the robot in the correct direction and place. A limiting factor is the good traction of the wheels. It is essentially the wheels don't drift.

Power supply:

Batteries used are Li-Po type. There will be six cells of 3.7V each, obtaining a total voltage about the 22V. We are thinking about 3000mAh of battery capacity. It will allow autonomy near to 2 hours, and a total recharging time about an hour with 1C of recharge current.

Cans, Bottles and Batteries management:

As we have explained at general description, the robot has two recollect waste systems: a robotic arm to catch cans and bottles, and a servo based system with a magnet to catch batteries. All actuators used are servos and motors.

The robotic arm is made with 5 servos and a gearmotor with encoder for the lateral movement. So, the arm has 4 axles of freedom, plus a special “hand” designed to catch cans and bottles practically in all possible orientations. It is situated at 27,5cm from the floor and 10cm from the front of the robot. It does the robot capable to put the robotic arm out of the robot near 12cm to put the waste in the bins.

The main captor used by the robot is a CMUcamII, which detects all type of waste inside the robot perimeter and where they are. Other sensors used are infrared distance sensors like Sharp GP2D12 to detect the opponent robot and avoid it. In addiction, we have the position system in the field that uses beacons and encoders in the motion motors.

Position of robot on the game area:

The main way to positioning the robot around the game zone is made with the beacons. The encoders of the motion motors normally only are used to turn the robot. But, also is the “emergency” positioning system if the beacons don’t work correctly. The opponent robot is detected by 2 ways. If all work well, we detect the opponent robot also with beacons, but the robot also has infrared distance sensors for emergency situation.

We only use two beacons of the game zone, the 2 ones that are situated nearest to our bins. Also we use the opponent robot beacon support to situate on it another beacon. In this way we always know where the opponent robot is placed on the game area.

The beacon system is designed like “sonar”. It uses ultrasonic transducers to detect the time between each beacon and our robot. The synchronic signal is made using infrared diodes to send an encoded and modulated message and photodiodes to capture it. The last step of the system is send the opponent robot position to us and it is done with an Aurel radiomodem by radiofrequency. The information is Manchester encrypted and there are some acknowledge bits.

A problem we have thought about is the possibility of coincide with the opponent team in the beacon system frequencies. This situation is bad for all in the way that only emergency systems could be use and the game can be bore. So we have ready two different frequencies for the ultrasonic transducers and infrared transmissions and ten different communication channels for the radiofrequency transmissions. Then is easy according with the opponent team the frequencies used by each team and we will avoid problems.

Bins for the cans and bottles are not detected by the robot, so they are in a fixed position on the game zone and only is need to situate the robot to this position. The battery bin is detected by the CMUcamII travelling over it.

Robot intelligence:

The “intelligence” system is based on PIC microcontrollers. There are some different boards to control different parts of the robot communicated with a main board by I2C bus and some IRQ dedicated lines.

The family of microcontrollers used is 18F microchip type, programmed with C18 and hi-tech specific compilers and microchip ICD2 programmer.

The type of structure used is to accelerate development time of the software, so each team member can program different robot parts practically at the same time and independently. Also it is easy to debug the algorithms. Other reasons to use particularly boards are that are easy to design and construct, main CPU is liberated from repetitive and cyclic algorithms, we have more resources to use and it is easy to modify some design errors.

III. ORGANISATION

Member competences:

All members are electronic design components. We all have experience to design and construct our own robot for another category robot games. There aren't mechanics in the team, so we help with each own experience to collaborate in the robot design and construct.

There is a project manager who supervises our tasks. Also we have created a private forum to talk themes by internet, and every week or two week we meet to decide and to talk about work made by each team member.

Mechanics systems have been thought by all members; the mechanic parts also have been found and decided by all. Then a member has designed the assembly of all parts with a 3D program and two members have constructed the robot structure and pieces.

After it, each member is the responsible to design the electronics from a part of the robot. Finally, we all decide the strategy to do during the game and each one will program his part on the robot.

Schedule planned:

September '06:
- 12 Sept: First proposing email
- 26 Sept: First meeting of the members

October and November '06:
- Find sponsors
- Think about possible structures and strategies
- Documenting of systems to control and situate the robot
- Find robot parts to use

December '06:
- Constructs part's prototypes and prove they
- 1 Dec: Principal sponsor find: ACKSTORM SL
- 5 Dec: Team name's got: "ACKROBOT - team"
- 25 Dec: Game zone constructed

January '07:
- Getting some robots elements (captors, actuators,..) and testing they
- 20 Jan: Closing investigations and prototypes
- 24 Jan: Web page finished and uploaded

February '07:
- 20th Feb: Mechanical designs and strategies perfectly defined

March '07:
- Electronics parts and boards designs
- 5th Mar: Robotic arm mechanical finished
- 15th Mar: ACKROBOT team T-shirts gets
- 21rst Mar: Electronic designs finished
- 26th Mar: mechanical robot structure constructed
- 29th Mar: electronic boards constructed and tested

April '07:
- 1st Apr: Robot assembly finished (electronics and mechanicals)
- 2nd Apr: Starts to program all robot parts
- 9th Apr: Start to test programs
- 20th Apr: Robot FINISHED

Available equipment:

We all have all equipment to design, construct and test electronic boards (including oscilloscope). For the mechanics, the only we have is the common machines of a domestic home. The patient and “right hand” is our best tool.

The home of a member there is a local to place the game area constructed and it will be where we can test the robot while we are programming. Periodic meeting of the members have been placed in many sites: a bar, someone’s home, public local borrowed by the town council, ACKSTORM office’s… And the best way to puts all in permanent contact have been a yahoo group webmail.

Partnership:

Our main partner is ACKSTORM SL with 1500€ of money. The others partners are small and have supplied wood to construct a game zone, the design of the web page and aluminium to construct robot chassis.

For the contest we have ordered some T-shirts with our sponsor’s logo for all team members.

The rest is from each one pocket. We are happy doing it.