CACIC Documentation

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CHAPTER 1

Who am I?

CACIC is a Pioneer 3-AT, four wheeled robot built by Omron Adept MobileRobots, owned by Computer Science Department at University of Brasilia, BR.

The main documentation is organized into a couple sections:

- *Hardware*
- *Software*

1.1 Camera

Cacic has a PTZ Camera, Canon VC C50i

1.1.1 Camera Specs

- Resolution: 640x480
- Zoom: up to 26x optical
- Pan/Tilt range: 200-degree pan range, 120-degree tilt range
- Pan/Tilt speed: up to 90-degrees Pan and 70-degrees Tilt per second
- Format: NTSC
- Power Supply: 13 VDC
- Stream Interface: RCA-BNC Cable
- Control Interface: Custom multiconnector with terminals S-VIDEO OUT, RS232 OUT and RS232 IN
- Framegrabber: Sensoray 311

Note: There is wireless controller that came with camera, it work but is not used.

1.1.2 Linux Drivers

For the Camera

The cameras's stream can be retrived with OpenCV using Video4Linux. Checkout this code.

For the Pan-Tilt-Zoom

Camera's PTZ can be controlled with P2OS package in ROS

1.1.3 Framegrabber

Sensoray 311 with interface PC104+, manufactured by Sensoray

Linux 2.4.x Driver Use built in 'bttv' module with parameter: card=73

Linux 2.6.x Driver Use v4l with parameter: card=73

1.1.4 Troublehooting

Blue or black screen when retriving frame using OpenCV

1. **Check the camera's LED** The camera is switched off, start P2OS to switch the camera on.
2. **Check the power** If the LED is off, maybe the power to the camera is switched off. Press the AUX 1 and AUX 2 buttons on the robot's panel.

Blue or black screen when retriving frame using another software

Same for OpenCV, check the section above.

Scramble image

1. **Switch v4l to retrieve the input with NTSC format** Open the terminal and try

```
$ v4l2-ctl -s ntsc
```

2. **Using gscam and ROS?** Set enviroment variable GSCAM_CONFIG

```
$ GSCAM_CONFIG="v4l2src ! video/x-raw-yuv, width=320, height=240 !␣
↪ffmpegcolorspace"
```

More trouble?

Check here.

1.1.5 IF YOU ARE TR00 FUCKING HARD

Maybe you want to use it.

1.2 Laser

Cacic has Scanning Laser Range Finder, Hokuyo UTM-30LX

Image credit: RobotShop

1.2.1 Laser Specs

- Supply Voltage: 12VDC +- 10%

- Supply Current: 1.0 MAX, 0.7 NORMAL
- Detection Range: 0.1 ~ 30 m
- Measurement Resolution: 0.1~10 m: $\sigma < 10$ mm, 10~30: $\sigma < 30$ mm
- Scan Angle: 270°
- Angular resolution: 0.25° (360°/1440)
- Scan Speed: 25 ms
- Interface: USB 2.0

1.2.2 Driver

The communication with the device is provided by a ROS node, go to How to use the laser for more details.

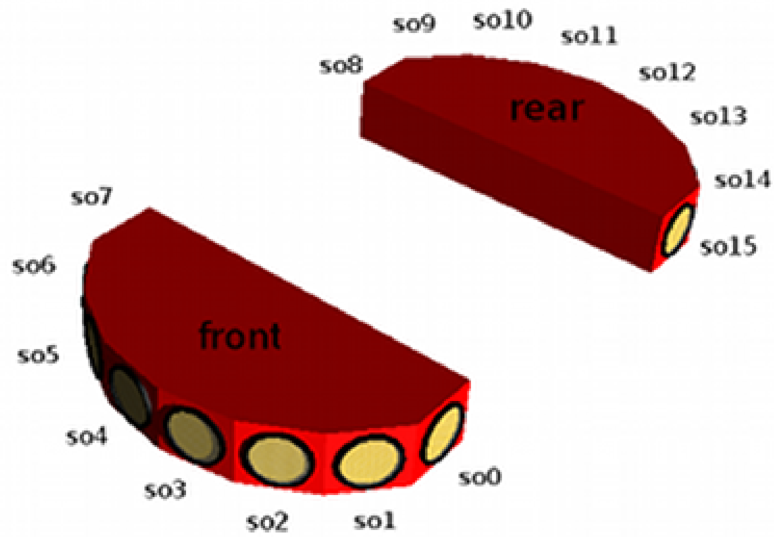
Note: The urg_node is the only driver for Hokuyo Laser since ROS Kinetic and fully REP 138 compliant, maybe in the future we will use it.

1.2.3 DC-DC Power Supply

The Laser has a custom circuit board to supply voltage and current with high precision. The project was made in Frienting? by a Nordic gnome, you can view and modify the project in whatever.

1.3 Sonar

Cacic has two sonar arrays (front and rear), sonar or ultrasoud is a sensor that uses sound wave for detect obstacles and range information for collision avoidance.



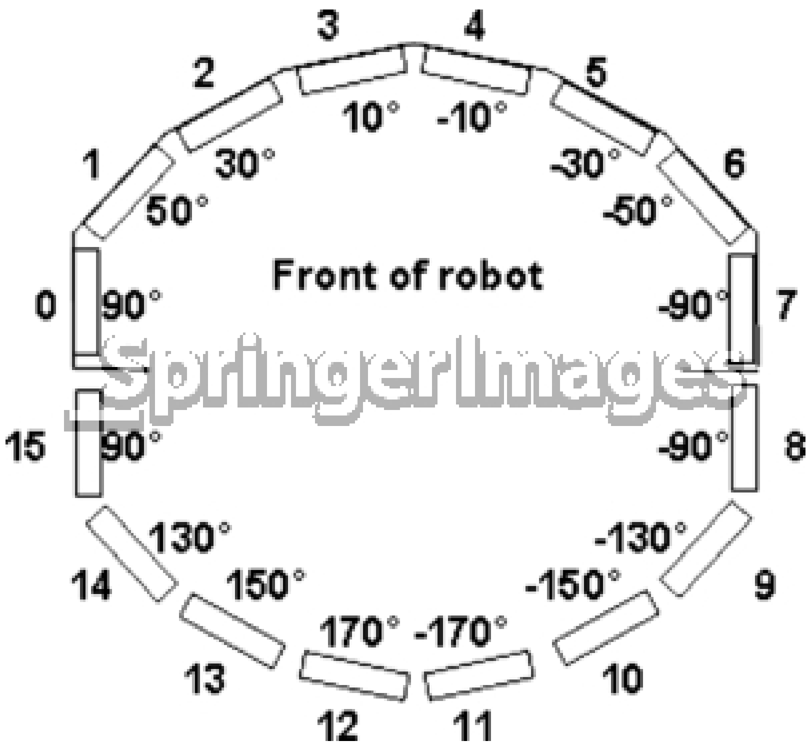
1.3.1 Sonar Specs

- Range of view: 0.1 m ~ 5 m
- Aquisition rate: 25 Hz

Warning: If the sonar doesn't view anything in its cone of view, it will send to the software the max range.

1.3.2 Geometry

The position of each sonar is showed in the image below.



Important:

- All these locations are fixed in the robot.
- There're a URDF file, describing these locations to ROS. Please see the section description of the robot.

1.3.3 Sensitivity Adjustment

The driver electronics for each array is calibrated at the factory. However, you may adjust the array's sensitivity and range to accommodate differing operating environments. The sonar gain control is on the underside of the sonar driver board, which is attached to the floor of each sonar module.

Sonar sensitivity adjustment controls are accessible directly, although you may need to remove the Gripperto access the front sonar, if you have that accessory attached. For the front sonar, for instance, locate ahole near the front underside of the array through which you can see the cap of the sonar-gain adjustment potentiometer. Using a small flat-blade screwdriver, turn the gain control counterclockwise to make the sonar less sensitive to external noise and false echoes.

Low sonar-gain settings reduce the robot's ability to see small objects. Under some circumstances, that is desirable. For instance, attenuate the sonar if you are operating in a noisy environment or on uneven or highly reflective floor, a heavy shag carpet, for example. If the sonar are too sensitive, they will "see" the carpet immediately ahead of the robot as an obstacle.

Increase the sensitivity of the sonar by turning the gain-adjustment screw clockwise, making them more likely to see small objects or objects at a greater distance. For instance, increase the gain if youare operating in a relatively quiet and open environment with a smooth floor surface.

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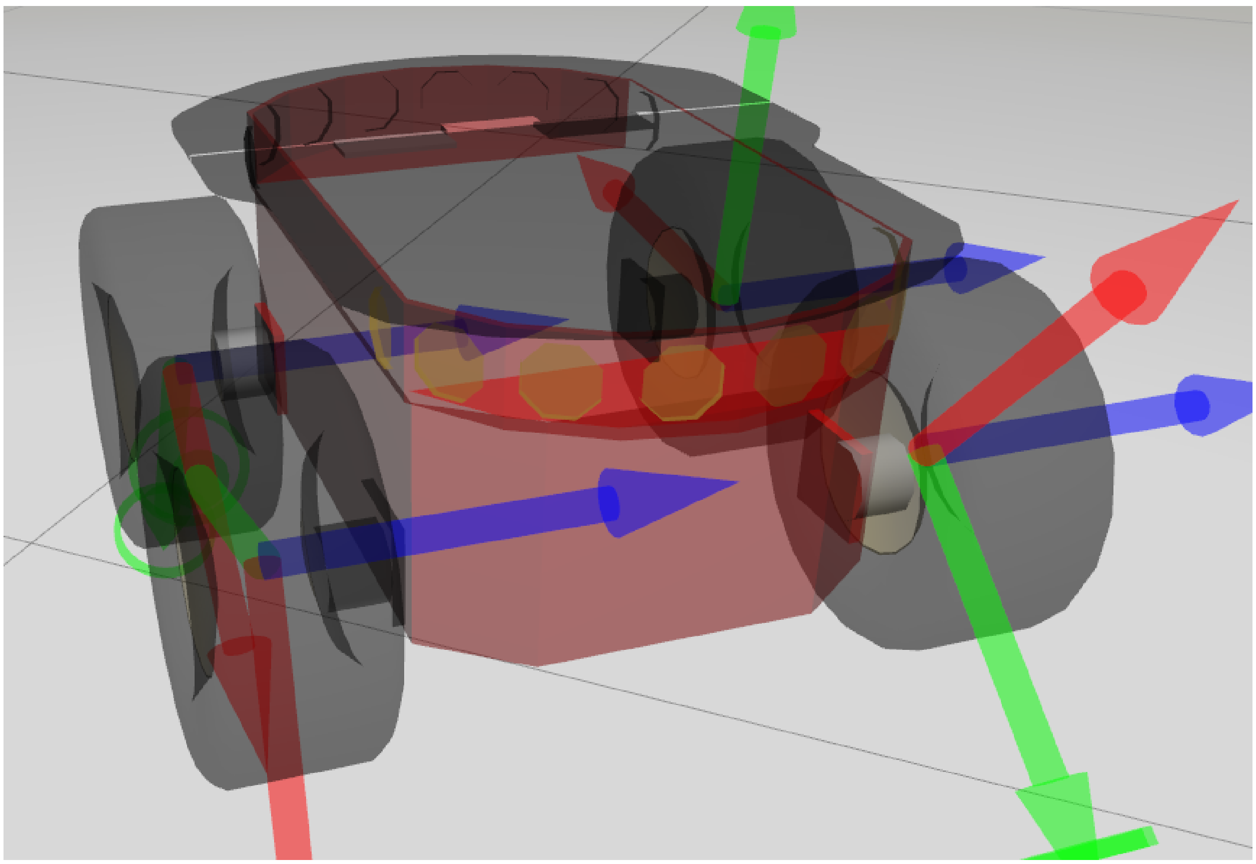
Hint: See more in the manual.

1.3.4 Software

We use the p2os to read the sonars readings and the sonar_viz to transform the readings in standart data to better maniplation.

1.4 Motors

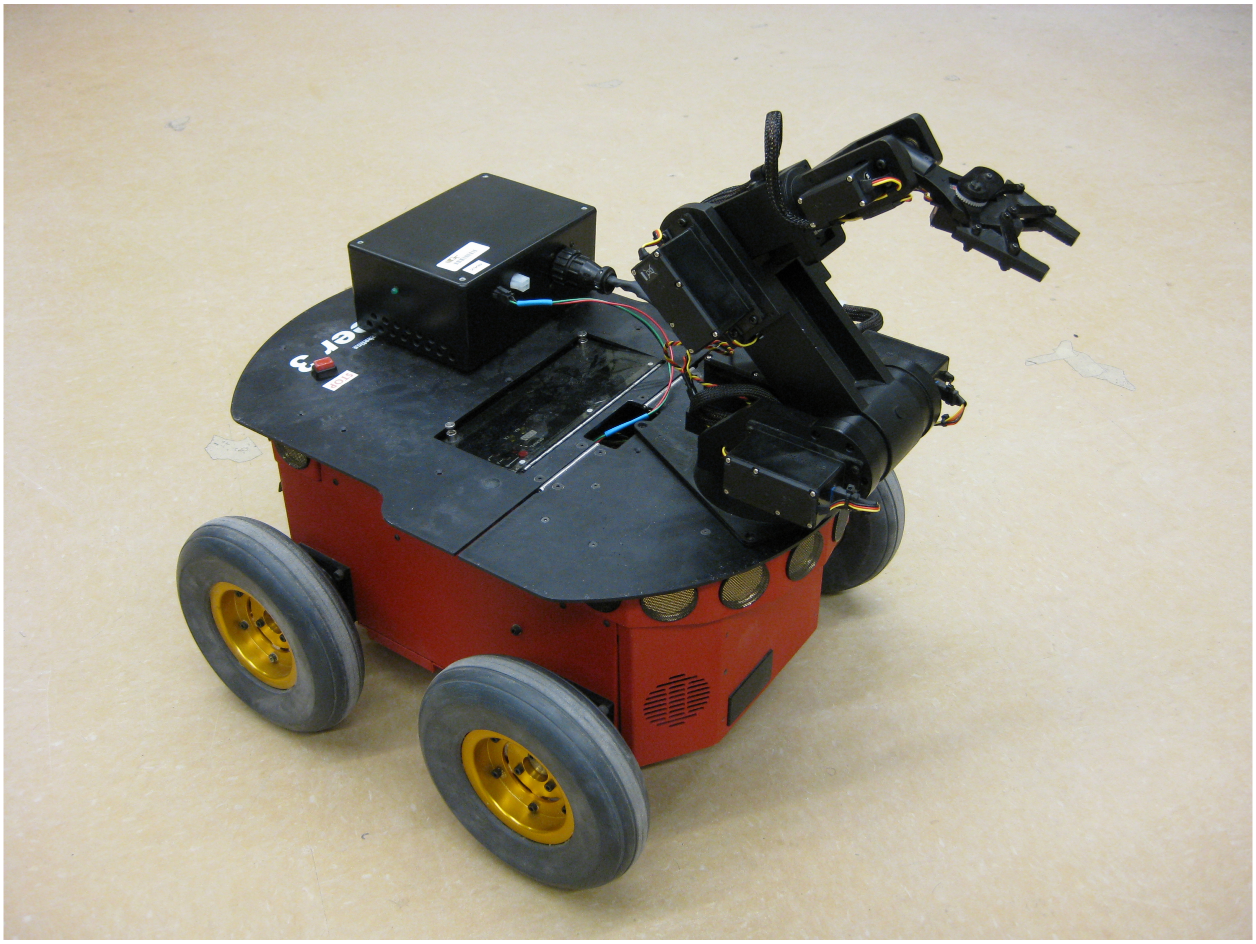
Cacic is a four wheeled robot, but it has only two motors, one for each side. A drive belt transfer the rotation to the wheels.



1.4.1 [Hot] Wheels

Cacic has two types of wheels, off road and indoor. The first one is for outdoor enviroment and rough terrains:

and the second is for flat surfaces/floors:

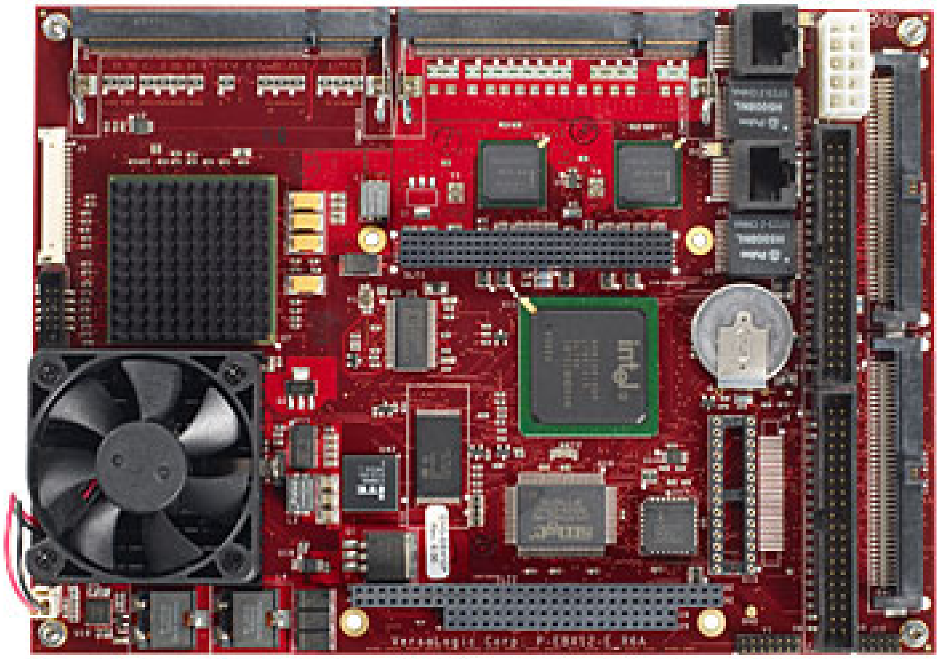


1.4.2 Odometry

Odometry is the use of data from motion sensors to estimate change in position over time. Cacic and others Pioneer-3AT has in its motors sensors (position encoders) that senses the rotation velocity then the microcontroller? or p2os? integrates this data and estimates the robot's pose relative to a starting location.

1.5 Computer

Cacic has onboard computer where the sofware run.



1.5.1 Computer Specs

- Pentium M 745 1.8 GHz
- RAM 1 GB DRR2
- HD 120 GB
- 2 RS232, one for robot's microcontroller
- 2 USB
- Interface PC/104+
- WiFi
- Camera's framegrabber
- VGA out

1.5.2 Connectors

The computer have a USB connector with pinout

Table 1: USB pinout connector

pin number	data	pin number	data
1	USB1 +5V	6	USB2 Shield
2	USB1 Data -	7	USB2 Ground
3	USB1 Data +	8	USB2 Data +
4	USB1 Ground	9	USB2 Data -
5	USB1 Shield	10	USB2 +5V

1.6 Batteries

Cacic contain three sealed lead-acid batteries accessible through a hinged and latched rear door. The batteries charge life typically ranges from two to three hours.

Important: Batteries have a significant impact on the balance and operation of your robot. Under most conditions, we recommend operating with three batteries. Otherwise, a single battery should be mounted in the center, or two batteries inserted on each side of the battery container.

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1.6.1 Batteries Specs

- Lead-acid
- Sealed
- 12 VDC
- 4 Ah
- With 3 batteries, 252 Wh
- Hot-swappable

1.6.2 Battery Indicators and Low Voltage Conditions

The User Control Panel[1] has a bi-color LED labeled BATTERY that visually indicates current battery voltage. From approximately 12.5 volts and above, the LED glows bright green. The LED turns progressively orange and then red as the voltage drops to approximately 11.5 volts.

Arually, the buzzer will sound a repetitive alarm if the battery voltage drops below 11.5 VDC. If the battery voltage drops below 11 VDC the microcontroller automatically shuts down a client connection and notifies the computer to shut down.

Note: The batteries voltage is monitored by a own package, this package if necessary notifies the user and shut down automatically the operating system. See more in robot monitor.

1.6.3 Recharging

Standart Charger

This accessory recharge the batteries in the fast-charge mode (4A maximum current). The fast-charge mode is showed with an orange LED and trickle mode by a green LED, which the batteries are given only enough current to remain at full charge.

Warning: In the fast-charge mode, care must be taken to charge at least two batteries at once. A single battery may overcharge and thereby damage both itself and the robot.

[1] See in the manual.

Power Cube

This accessory allows simultaneous recharge of three batteries outside the robot.

1.7 ROS

The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms. ROS has chosen as CACIC's framework because within it we can develop robotics software together with the community. Below are listed the packages that today are used and tested in the robot. To learn how to use ROS in the robot please click here

1.7.1 Description of the Robot

Custom package that contains the configuration files for CACIC, e.g. CAD, map, hardware configuration, hardware communication and navigation files. View the package in github.

1.7.2 p2os stack

The p2os is a stack, collection of packages that interface robot's microcontroller with the ROS system.

1.7.3 hokuyo_node

hokuyo_node provide data stream from Hokuyo laser range finders.

1.7.4 sonar_viz

With this package is possible to view in rviz the sonar readings.

1.7.5 gscam

1.7.6 vcc50i_opencv

1.7.7 navigation stack

amcl

gmapping

1.8 p2os

1.9 sonar_viz

1.10 OpenCV

1.11 How To

1.11.1 Install ROS

1.11.2 Use PTZ Camera

1.11.3 Teleoperate the robot

1.11.4 Use the Laser

1.11.5 See the Sonars

1.11.6 Move the Base