UNIVERSITÀ DI BOLOGNA

School of Engineering

Master Degree in Automation Engineering

Industrial Robotics

Laboratory Report

Professors: **Claudio Melchiorri**
Gianluca Palli

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Chapter 1

Arnold

Introduction

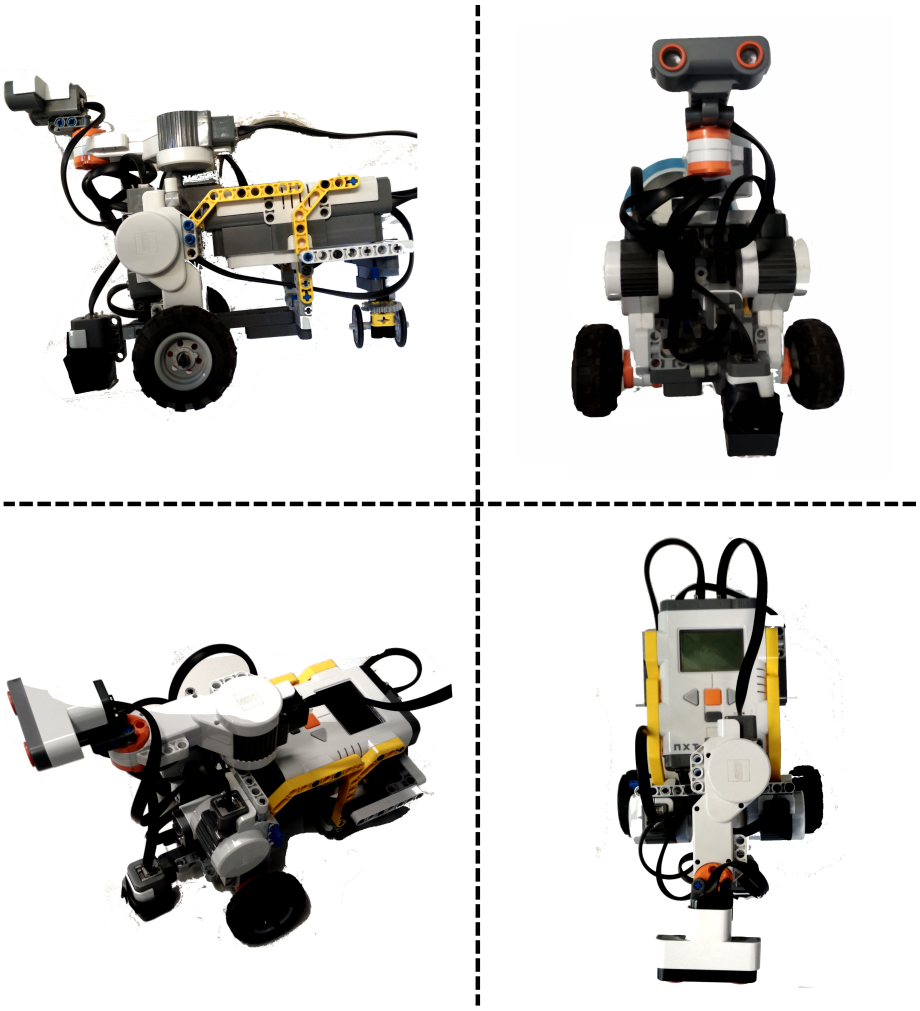
Arnold is the mobile robot that we have designed and build to perform the Industrial Robotics Laboratory Race. The mechanical structure is based on LEGO parts and uses electric motors and some sensors to move and receive informations whitin the environment. The control is performed by a NXT board. The race basically consists in two parts:

- ***Line Following:*** *the goal is to follow a path starting from a square box*;
- ***Obstacle Avoidance:*** *the goal is to move toward an arena containg obstacles*;

1.1 Structure and Hardware

1.1.1 Mechanical assembling

The mechanical assmebling of the various parts and components of Arnold is the one that we show in the next figure containing different views:



This structure has been chosen because it guarantees mechanical stability, symmetricity and allows to properly locate all the sensors and the other components. Furthermore this structure provides a discrete mechanical balance.

1.1.2 Sensors

Arnold uses the following sensors:

- ***Gyroscope:****measures the angular velocity wrt its axis so properly positionating it can be used to determine the robot orientation*;
- ***Light Sensor:*** *measures the light intensity*;
- ***Sonar:****determines the distance of eventual obstacles wrt the sensor*

sending ultrasonic signals and measuring the time in which they come back;

1.2 Algorithms

1.2.1 Threads

We have used a multi-thread structure.

1.2.2 Line Following

The Line Following part is basically performed by using a PID control. This part requires a preliminar calibration part in which we basically define an high light value and a low light value reading them on two chosen surface that we want to associate to these values.

1.2.3 Obstacle Avoidance

The basic idea of the obstacle avoidance algorithm that we have implemented is the potential gradient method in which we define an attractive potential realated to the robot orientation and a repulsive potential related to the obstacles distances. The robot orientation

$$\Theta$$

is measured by using the gyroscope, instead the obastacles distances are measured by using the ultrasonic sensor. Basically we define an angular range in front of our robot and we divide it in 4 sectors. For each sector we apply a repulsive action inversely proportional to the obstacles distance measured in that sector, while the attractive funtion tries to mantain the robot along the direction that is parallel to the walls namely 90 degrees. Negletting all the distances greater than a certain threshold choosen by us we have that along relatively free space traits the robot should proceed along a straightline.

$$u_{left} = minPower + \nabla U$$

$$u_{right} = minPower + \nabla U$$

with:

$$U = U_{att} + U_{rep}$$

1.3 Performances

Chapter 2

Matlab Simulations

2.1 Section title

2.1.1 Subsection title

Bibliography