MIRO TRAINING

ROBOTICS ENGINEERING MASTER DEGREE

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Abstract

MiRo is a social animal-like robot developed as a prototype companion. The aim of the project is to develop a software architecture in order to interact with MiRo through vocal and gestural stimuli. The idea is to replicate a basic dog-like behaviour, in which the actions are predictable. The evaluation of the human-robot interaction will be the starting point for a possible future development, in which more complex and inter-dependable, command-based, robot's actions will be exploited. In the following work the software architecture and the implementation obtained will be discussed.

Introduction

This Project has been developed for the Social Robotics course of the master degree program in Robotics Engineering at University of Genoa. It is a ROS based project and it uses as platform the MiRo robot.
We developed a software architecture in order to interact with the robot through vocal and gestural stimuli. The user has to give commands to the robot, which will react with some fixed actions. The main goal of the project is to create an entertaining human-robot interaction. All the behaviours that the robot executes in response to the commands are predictable. We want to evaluate how the human reacts to the single action of MiRo, which remains unchanged throughout the experiment. This could be the starting point for a future development in which the robot behaviour is not predictable anymore but is influenced by previous user's commands.

MiRo Companion Robot

MiRo is an animal-like robot developed as a prototype companion. It was designed with a bio-inspired architecture based on the neuroscience knowledge of the mammalian brain, and it exposes its interface as a ROS node.

The devices

The users interact with the robot using an external microphone. In order to guide MiRo through gestures the user must wear a smartwatch. For this project a LG G WATCH R with a 9-axis IMU sensor has been used.

1 The Software Architecture

The software architecture (Figure 1) developed for this project is based on a bio-inspired approach. The problem has been addressed by using a behaviour-based design pattern. We managed the vocal stimuli in input to generate a corresponding behaviour of the robot, trying to replicate a dog-like behaviour.
The robot attention is obtained through the vocal activation command "Miro". Only after this activation command the robot is able to execute the following further instructions:

- **"Good"**: The robot expresses a cheerful behaviour, recalling the user's attention by raising his head and beginning to wag his tail. At this point the user has to pet MiRo on the head or on the body, both equipped with sensors. The tail stops and two different behaviour are generated for the respective position of the touch. By touching the head sensors MiRo lowers the head, squints the eyes and the leds light up in pink. By touching the body MiRo raises up and inclines the head, turns the ears and the leds light up in orange.
- **"Bad"**: The robot expresses a sad and offended behaviour for having been scolded. MiRo lowers and inclines the head, turns the ears and starts to turn left showing the back to the user. At the end of the action the leds change from blue to red, expressing its upset state.
- **"Let's go out"**: The robot leaves the charge to the user that, in this way, can control its movements through gestures, with the use of a smartwatch. The gestural commands to use are summarized here.
- **"Play"**: The user shows MiRo a red ball and the robot turns in order to see the object in both the cameras. When this condition is obtained, it starts moving towards the red ball and stops once reached.
- **"Kill"**: The robot expresses anger. It lowers the head, squints the eyes, wigs the tail, makes a pirate sound and the leds light uo in red.
- **"Sleep"**: The robot enters a rest mode. MiRo lowers and inclines the head and tail, closes the eyes and the leds light up in aquamarine. "Sleep" disables the other instructions. Hence, in order to make MiRo again reactive to the

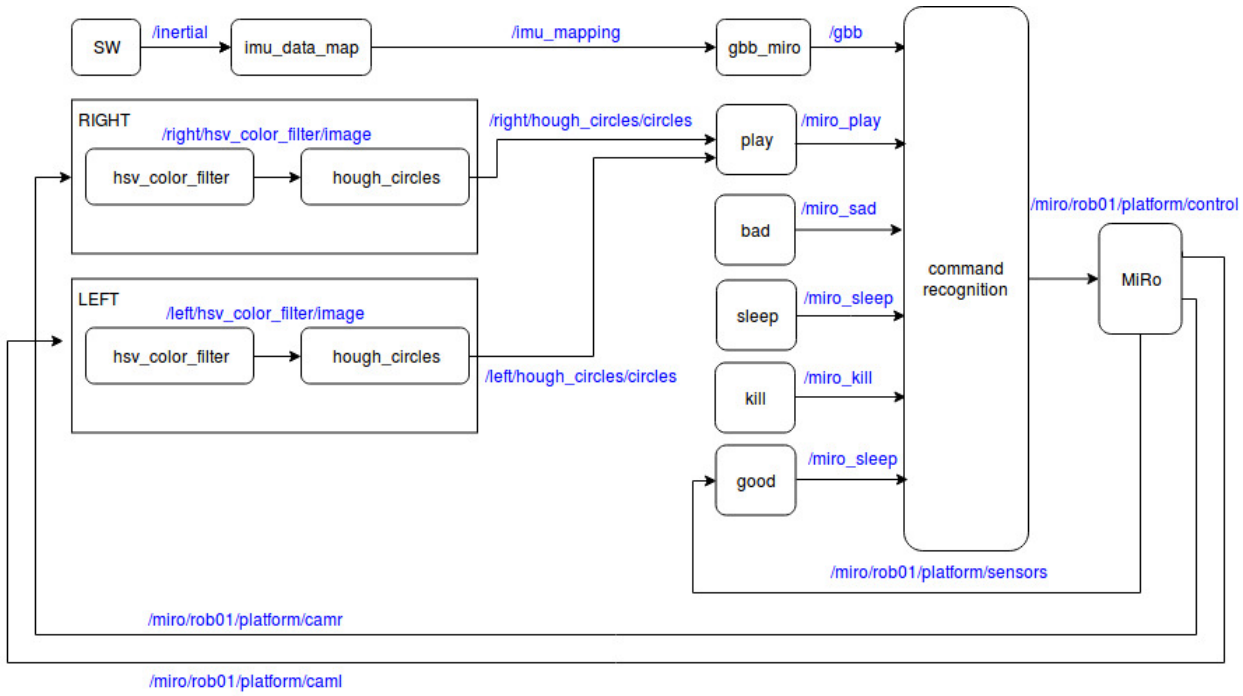

Figure 1: The Software Architecture

action commands, the user has to use the activation command "Miro".

Each module part of the architecture has been implemented as a ROS node. The communication between nodes has been realized through a Publish/Subscribe messaging pattern, in order to exploit the characteristic of modularity and scalability.

1.1 The Speech Recognition

For the realization of the speech recognition the Google API interface has been used in combination with an external microphone. The web page is based on the Google Speech Demo and is implemented as a ROS node through the javascript ROS Bridge. It realizes a speech to text recognition for robotic operating systems. It also implements a text to speech conversion in order to make the robot speak. In this project only the speech to text converter tool has been exploited, by generating a string from each user's verbal command. The written instruction is then read by the **command_recognition** node, that handles the execution of MiRo's behaviours.

1.2 Color-based Object Detection

As previously mentioned MiRo's cameras are used to implement the "Play" behaviour, in which the robot has to follow the red ball shown by the user. In order to achieve this, a two steps process is implemented. First of all a color segmentation of the frames captured by the cameras is performed in order to discriminate the red pixels from the others. After that, a Hough transformation allows to recognize the circular objects. The final result is a segmented image in which the round shape is highlighted by a red circle.

1.3 The Gesture Based Behavior

The Miro's Gesture Based behaviour requires the use of a smartwatch in order to control the robot's action. Basically, the IMU data from the smartwatch's accelerometer are converted into input linear and angular velocities for MiRo platform control. Specific IMU values corresponds to a different movement directions of the robot.

2 Experiments

The experiment has been organized in order to evaluate the human reaction to robot's predictable behaviours. The aspects that we want to study are:

- Human behaviour during the session
- Human subjective evaluation after the experiment

The aim of the experiment is to evaluate if the human robot interaction satisfies the usability dimension criteria. In particular we want to assess if the system is enjoyable for the user (**satisfaction**) and if it is easy to learn how it works (**learnability**). The goal is to conduct an exploratory study on the interaction between the user and the robot with a predictable behaviour.

Human behaviour during the session

By studying this, we want to understand the learnability of our system. In particular we want to evaluate the efficacy of the chosen vocal commands by

analysing how many times the delivered command is wrongly converted to text by the API. Another aspect that we will observe is if the user easily remembers how the command logic works. This is performed by evaluating how many times he tries to interact with MiRo before the activation command, e.g when it is in ”Sleep mode”.

Human subjective evaluation after the experiment

We want to observe if the use of a vocal interaction increases the overall engagement of the user. This is performed through a post experiment survey that queries the human perception about the session. Most of the questionnaire will be organized on the base of a Likert scale. Despite the possibility of bias, this method offers a more granular feedback with respect to dichotomous questions.

2.1 Experimental Setup

The experiment is carried out in a not isolated environment, since the speech recognition tool is pretty robust. The system is meant to be used by people of different ages, but we performed the experiment with 10 subjects in the 20-30 age range. In the experiment the user will have to interact with MiRo by using an external microphone and a smartwatch. Before the session the subjects will be instructed on the available commands and on how the system works. Then the user goes into a 2-3 minutes trial in order to gain confidence with the setup. After that he is left free to interact with the robot with the commands that he prefers.

The metrics used to evaluate the results are:

- post-experiment questionnaire based on Likert scale [Here]
- command error rate. The number of the wrong pronunciation of the command w.r.t the total repetition of the same.
- number of wrong sequences of commands over the total number of instructions.

3 Future Development

After the evaluation of the basic interaction a more complex structure could be implemented. The idea is to allow the user’s command to influence MiRo’s emotion, that will affect the outcome of the following commands. For example if the user wants to ”Play” with MiRo but the command before was a scold (”Bad”), the robot will ignore him. It could be interesting to analyse if this less predictable behaviour is more engaging for the user.