Nego-Bot: A human-robot negotiation system

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Abstract. In this paper we present a platform composed of a low-cost robot and a multi-agent system that uses deep learning algorithms, whose objective is to establish a negotiation process and persuasively sell items, maximising their price, thus gain. To do this, we have focused on developing an interactive process that is able to interact with humans using a camera, microphone and speaker, to establish all negotiation process without physical contact. This is relevant due to the current COVID-19 situation and arisen issues of human contact. Validation processes with university students have revealed high interest and success in products' negotiation.

1 Introduction

In the process of human-machine interaction, there is a feeling of displeasure on the part of the human. This feeling is due, in some cases, to the feeling of wanting to trust the decisions that the machine makes. The discomfort felt is not because they think that the robot can deceive them. It is because they are not sure if the robot has the necessary knowledge to validate the decision [1]. An inherent distrust towards these systems arises, leaving them aside and omitting their recommendations. Studies have shown that providing an embodiment of a person, whether video-based or robot-based, can improve human acceptance values [2].

For this project we have designed and built a low-cost robot expert in trading and sales tasks. The goal is to provide a complete human-like shopping experience by visually identifying the object that the user (in this case acting as a buyer) wants to buy, to interact orally with the user while negotiating the price. To infer the negotiation process we use a multi-agent system that levels current prices, availability and demand and calculates the lowest possible price, the utility function being profit maximisation. Thus, the negotiation follows a

bazaar-like style, where user and robot try to maximise their utility functions in each interaction. While, in the current phase, the visual appearance of the robot is bare, the features are enriched and designed to maintain a fluid conversation without the user having to touch any kind of screen or control to interact with it.

2 Robot Trading Assistant

This section describes the operation of the robot trading assistant, detailing the different software and hardware tools used for the creation of the system. The proposed system is shown in the Figure 1.

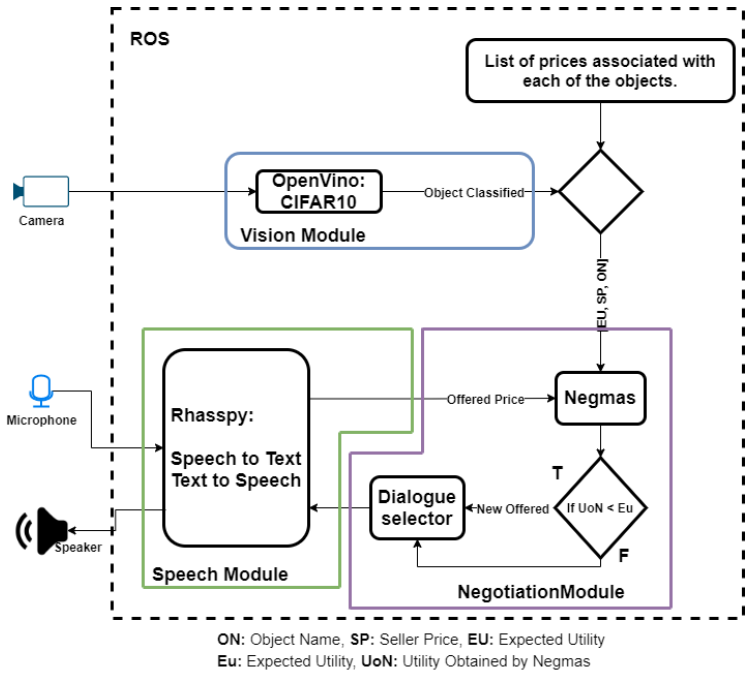


Fig. 1: Proposed system architecture.

The proposed robot (see Figure 2) uses ROS (Robot Operating System) as the control and interaction tool. ROS provides a set of libraries and software tools to help the creation of robotic applications, aiding in the easy integration of motor control systems, AI algorithms, among other tools. ROS was designed to be a loosely coupled system in which a process is called a node and each node must be responsible for a task. In our proposal, each of the modules (speech, vision and negotiation module) runs on independent nodes, and the system makes

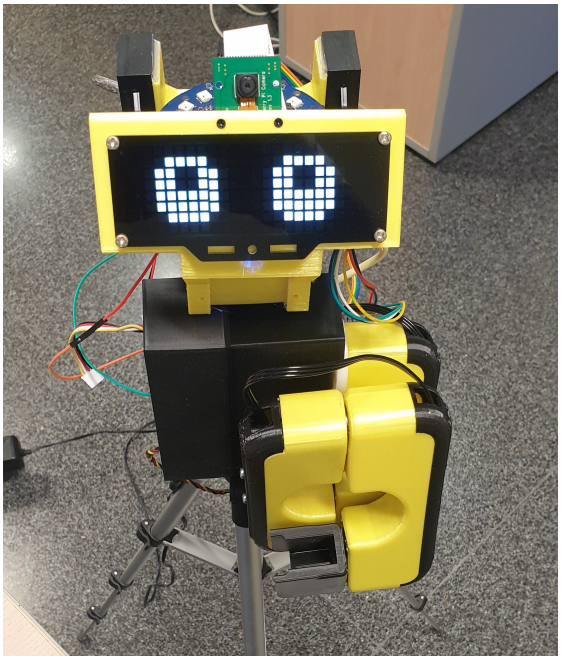


Fig. 2: A general view of the robot trading assistant

a subscription to the topics offered by each node. This subscription is the way to manage the flow of information between nodes, achieving a decentralized execution of the system. The robot described below was built using low-cost devices. The robot was built with a Raspberry pi 3, to which several sensors have been connected to allow the perception of the environment. Specifically, the sensors allow the robot to recognize the user's speech, using a hat with 6 MEMS microphones. At the same time, the robot also includes a camera, which helps the robot to capture images in order to classify objects.

The use of a Raspberry pi as a computing system poses a problem, since it cannot be upgraded. This is a problem when trying to use applications that involve the integration of deep learning models. Fortunately, in recent years companies like Google and Intel, have developed specific hardware that allow the integration of these models in devices with low power performance. In our case, we used the Intel device as an external system to optimize object classification using the Raspberry Pi 3B+. In this way, the robot was able to classify objects from the CIFAR-10 database in a relatively short time. As the main purpose of the robot is to interact with a person, it was necessary to incorporate LED arrays. These arrays allow the robot's eyes to be displayed, which helps to improve the interaction with the human. The robot can represent up to five expressions (see Figure 3).

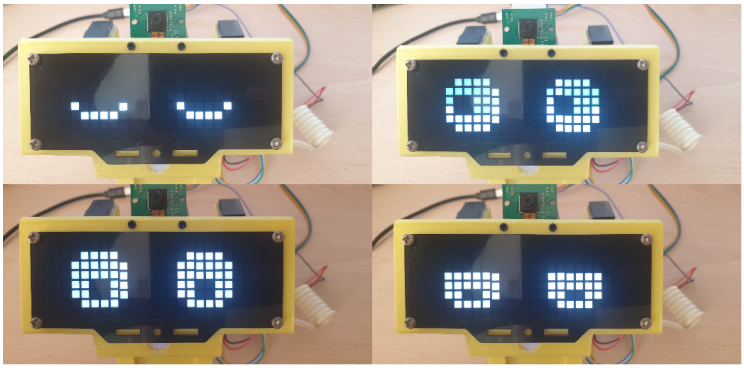


Fig. 3: An overview of the different robot expressions.

3 Conclusions and future work

This paper explores the use of physical presence, via a robot, in a system with human interaction. This physical presence that facilitates the interaction is carried out by a low-cost robot described along the paper. The prototype has been used in a negotiation process for trading objects with humans. In the current stage, the robot is engaged to sell the user the object he chooses and shows to the robot. During the negotiation process, both negotiate the price to reach an agreement.

Experiments with real users have shown that using the robot and an speech-based dialogue system to interact with it, makes the user more comfortable and more interested in participate in the negotiation process than if this negotiation is made by a system with a more typical interface.

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