Can we understand people with the help of probabilistic methods?

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***Abstract*— By using verbal and non-verbal communication that the user unconsciously applies when interacting with a robot, we want to determine automatically what the user is trying to present.**

I. MOTIVATION

When people communicate and interact with others, a lot of non-verbal communication is produced that can help in the interpretation and understanding of the message. This non-verbal communication, among others, includes body language such as gestures, and the distance between interlocutors.

In the robotics world, one of the most challenging problems is to make robots able to understand humans. Therefore, if robots were able to interpret not only the verbal communication, but also the non-verbal one, robots would be more intelligent and would be able to disambiguate unclear situations that could happen during the interaction.

A previous study about Human-Robot Interaction, where people were presenting different rooms and items in an office environment, suggested that people generate some patterns while interacting with others that are different depending on the item that is being introduced or presented to the interlocutor. Furthermore, those patterns are quite common independently of the person that is communicating or interacting.

This led us to use probabilistic methods in order to automatically understand people when they are interacting with a robot, using all the patterns that are generated during the communication.

II. APPROACH

We want to analyse and test if we can understand people, with the help of probabilistic models, using all the patterns that people generate during the interaction. To do so, we have used all the data recorded in a previous study. These data are composed by manual annotations of the users' behaviour such as gestures, movements, instructions given to the robot, etc; and the robot sensor recordings.

Our approach stores from different sources of data all the user's behavioural features that occur around every item presentation to the robot, and it tries to recognise the item category using a probabilistic model (Bayesian Network).

We have divided all the items in three categories:

- **Workspace:** Specific positions/areas that can represent the position of large objects that are considered static. For example a coffee machine, a refrigerator or a printer.
- **Region:** Any portion of space that is large enough to allow for different workspaces in it, or at least large enough to navigate in it. Typically this would be rooms, corridors or parts of those.
- **Object:** Small items that can be handled by a human.

We also extract behavioural features from the movement detected by the sensor incorporated to the robot, this sensor is a laser scanner.

III. RESULTS

At around 70% of the cases, we succeeded understanding (or we were very close) what people presented, using as an input all the interaction patterns annotated in a manual analysis effort.

We got about 13% - 24% of mismatching cases that should be studied in more detail when trying to recognise between object/workspace or workspace/region. However, at least 50% of the mismatching cases were produced when classifying items that we previously did not have a clear classification for them.

What is a chair? Is it really an object or a workspace? We have realised during this study that there are a lot of objects/workspaces that we cannot really decide which is the most suitable category.

The extraction of behavioural features from the sensor on the robot worked as expected. However, the results obtained were different than the ones obtained in a manual effort.

Annotations from files are very subjective, even a small movement can be considered as a behavioural feature. That is not the case of our implementation, our algorithm is very rigid and only has two thresholds to detect movement features.

The results obtained are not perfect, but are very promising, and open a door to future research. Our approach has been designed considering future sources of data in order to easily extend this work.