Modelling Social Skills and Problem Solving Strategies used by Children with ASD through Cloud Connected Social Robots as Data Loggers: First Modelling Approach

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***Abstract*— In this paper, we present a set up of cloud-connected social robots to measure and model the effect of LEGO Engineering and its collaborative nature on the development of social skills in children with Autism Spectrum Disorder (ASD). Here we introduce the first approach to the modelling process designed.**

I. INTRODUCTION

There exists a growing body of research centered around robotics and autism, using a social robot as a data logger. Previous research includes children with ASD working with humanoid robots (e.g., NAO or KASPAR), working together to build robots [1], [2], talking to the robot and mimicking a robot [3]. Also, we present a cloud-based system to speed up the analysis of how therapies based on working in groups and building LEGO change their social skills, social network, and cognitive skills.

The project consists of an 8-week study (one two-hour session per week).The sessions have a format of a workshop on building LEGO Robotics with a Robot Companion (NAO Robot, AISOY Robot, or SAMSUNG Robot) that will be on the table as a helper, social mediator, and will remind the kids of the time schedule.

During the sessions, Children sit at a table with a laptop to program the LEGO robot and a complete LEGO MINDSTORM EV3 set (The LEGO Robot). Children work in groups of 2 selected at random, and they keep the same group for all sessions. A Social Robot (NAO Robot, AISOY Robot, or SAMSUNG Robot) is on the table as a helper, social mediator, and remember the time schedule.

In each of these sessions, we collect information that allows us to create a reliable model of how these children socialise with each other and with the adults in the classroom, and how these children solve engineering problems (see Figure 1). While the children with ASD social skills model has been studied since a long time ago, the engineering thinking skills is not approached by the community. Previous studies showed that only people in the field of science and technology were trained in engineering skills. However, it has been proved that engineering skills are needed in very day life, bringing clear benefits to the quality of living for those children who can acquire and use them [4], [5]. Do children with ASD follow the same strategies that neurotypical children? How they are dealing with this problem?. The model obtained should give an answer to these two questions and see if we can redesign their educational and training system [6]. Furthermore, in [7] is claimed that there is a connection between engineering thinking and human sensitivity that makes the quality of live better.

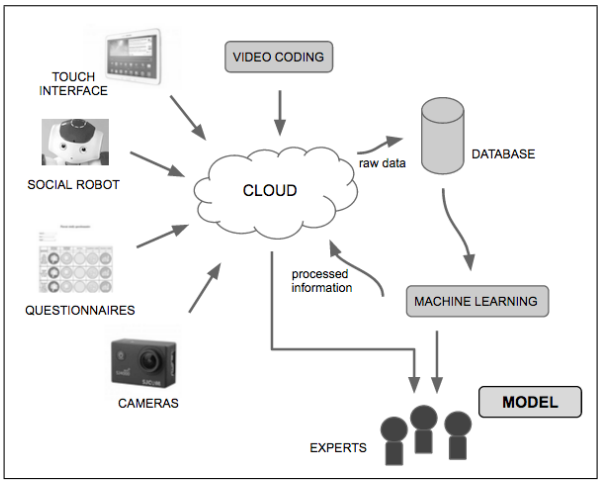

Fig. 1. Schematic of how data flow through the cloud until the model is obtained.

II. MODELLING PROCESS

The modelling process is divided into two paths according to the two outcomes mentioned in the introduction of this paper. On the one hand we model how children with ASD deal with the social situation, and, on the other hand, we are modelling how they solve engineering problems (see Figure 2).

Through the video observation, the quantitative data obtained from the interactive systems, and the descriptors obtained after processing the information through the machine learning algorithm we can identify the interactive behaviors and their quality in terms of intensity and duration.

The system is supposed to identify interactive behaviors and to measure the amount of social engagement children are experiencing.

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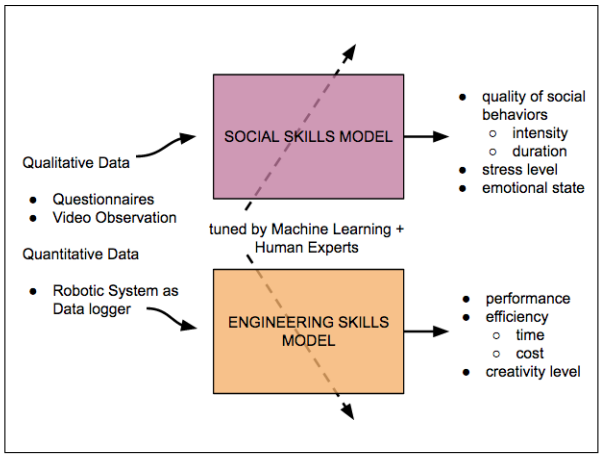

Fig. 2. Modelling description process

A. Human Experts

Through video observation (video coding) and questionnaires to the students, parents, and teacher, we are going to collect qualitative data. Through a web-based tactile interface to interact with the robot and the video recordings we are going to extract quantitative data. The qualitative data that we are going to measure is detailed in the VIDEO CODING document and the attached questionnaires. The quantitative data that we are going to analyze from the touch screens includes the number of times they are using the touch screen, what they are touching, and at what time during the session. The quantitative data we are going to obtain from the videos are:

- The number of times and how long every kid is talking during all sessions.
- The distance between kids during all sessions
- Eye tracking and facial states during all sessions

B. Machine Learning as Descriptor Mining and Rule Extractor

The main purpose of the Machine Learning algorithm is to classify all information to extract a set of rules that will define the model. In this project, we have data from two different kinds: qualitative and quantitative.

1) Modelling quantitative data: Similar to [8], we have Children Assitant Agents (CAA) placed in the cloud system and connected to its individual Social Robot. All CAAs are linked to an Information Management Agent (IMA) that receive all information from the CAAs to build the model. Because the model is scalable to different cloud sites, we can have multiples IMAs.

Because we are searching for two different models, IMA's functionality is based two strategies:

- The social skills model rules are better predictable, so we are based in [9] UCS, accuracy-based Michigan-style LCS that takes advantage of knowing the class of the training instances. UCS evolves a population of classifiers based on rules. Once the quality of the rules is proved the model can be extracted from the collection of rules and each classifier.
- For the engineering skills model we have a greater level of uncertainty, so we decided to use first use a system to classify and then a system to extract rules [10], [11]

2) Modelling qualitative data: We have used multicriteria decision-making systems, which would be the second part of modeling, as to the assessment models or from different experts [12]

III. RESULTS AND CONCLUSIONS

Can be the model used only with the data obtained from the social robot as data logger? Because we had only four children in all sessions during the first workshop, this is a hard hypothesis to answer. Results showed that the quantitative data we obtained was potentially good. However because we used different robotic platforms (AISOY, NAO, and a custom robot), and because the number of children was small the results were inconsistent. In any case, we tested the technology, and it shows us that we need to mix the qualitative data with the quantitative data in a more integrated way.

We expect to get a consistent model as long as we are using only one platform with more children.

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