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Prototype of an Interactive Toy from Lego Robotics Kits for Children with Autism

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***Abstract*---**This paper is the development of a concept of the man/robot interaction. More accurately in developing of an autistic child that have more troubles with interaction, here offers an efficient solution, even though simple; however, less studied for this public. This concept is based on code applied thought out the Lego NXT kit, built for the interpretation of the robot, thereby can create this interaction in a constructive way for children suffering with Autism.

***Keywords*---**Lego NXT, autism, ANN (Artificial Neural Network), Backpropagation.

I. Introduction

AUTIST children suffer with several difficulties in social interaction. There are several researches working with tools, equipment and systems geared to the cognitive ability of these children but little is about research that encourage social interaction. Many countries simply don't offer appropriate support for them; this can result in the future being a people slightly dependent, generally with troubles in studying, learning, and working. Experts in the field confirm that if the autism receive the appropriate attention and is treated, the individual can have a normal life.

The treatment with them lead time, patience, and with children can be tiring, and results are slow to appear.

The overall aim of this project includes the development of assistive technology for children with autism and aims to help improve your chances of interaction / communication and, indirectly, their quality of life. The technologies to be developed span various areas of knowledge among themselves and thus operate in interdisciplinary, involving at least the areas of robotics, Processing Natural Language and Special Education Language.

The project brings together employees of the above areas targeting results in efficient processes:

1) requirements analysis in the interaction/ communication of children with autism process,
2) implementing control software for mobile interactive toy
3) computational representation of information for recognizing the presence of people and playback of voice synthesis,
4) capture and analysis of results achieved by the interaction between toys and autistic children and
5) Linguistic, educational and computational results for partial improvement of technical adjustments.

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It is important to emphasize that both the mobility equipment such as voice synthesis function from criteria that conform to the standards and guidelines established by the state government and / or federal involved.

A. Objective

The objective of this paper is to present the preliminary results obtained in the initial phase of the overall project.

This article presents the results of initial tests with children without special needs of autistic because the direct interaction with these must be free of any technical and accompanied by a teaching staff failures to prevent possible damage communication and socialization.

B. Related Work

Some related work could be found in the literature but with different emphases that come enriching the knowledge base of the project team.

The doctoral thesis of [1], presents an analysis and comparison of three different techniques for speech recognition: Hidden Markov Models, Multilayer Perceptron Networks and Hybrid Systems, he concludes, in his thesis, that the choice of the best algorithms depends the application you want to use the recognizer, and that there is a solution that is optimal for all cases.

Other jobs working with Artificial Neural Networks (ANN's) are: [2] that works with the touch of a robot Lego Mindstorms by voice commands; [3] who developed a neural handle voice commands built into a robot Lego and [4] depicting a summary of the recognition of spoken words using RNA's.

Already with a different emphasis, but so important to the project and the other is the dissertation [5] states that jobs involving child audiences, need special care of the voice frequency to be recognized because it has a lot of variation in compared to the adult. The voice of children generally appears to be more acute, which makes recognition by the software. To reduce errors, and improve the effectiveness of the project, it uses the imposition of rules on sound capture process and uses sophisticated techniques to obtain the cepstral coefficients.

II. Theoretical Foundation

This section presents a brief review of the fundamental concepts involved in the project and necessary for the development of the preliminary results.

A. Autism

The term "autism" comes from the Greek autos, meaning "self" or self-isms and suffix that indicate action or state, having been first used in 1977 by a Swiss psychiatrist Eugen Bleuler, to describe the lack of contact with this in the context of schizophrenia [6] reality. It was subsequently reused by Kanner in 1943 to describe a symptom present in 11 children evaluated by it since 1938 [7]. This symptom has become the defining of a framework consisting of a set of specific characteristics, which was called Early Infantile Autism [8].

Currently, autism is defined as a disturbance of the overall child development, early onset of chronic and develops with age [9], presenting a lot of qualitative and quantitative variability [10]. According to [11], it is manifested before the age of 3 and lasts throughout life, and according to the United Nations (UN), about 70 million people worldwide are affected inconvenience, and, in children, is more common than cancer, AIDS and diabetes.

People with autism have "delays or abnormal functioning" to some degree in the following three areas:

- Social interaction;
- Communication;
- Patterns of behavior that are manifested through interest or restricted and / or repetitive stereotyped activities.

Among them the most is the impaired social interaction, says [11] and there are different levels of severity ranging from the most severe that virtually isolate themselves in an impenetrable world, others who cannot socialize with anyone, and those which present difficulties very subtle, almost imperceptible to most people, including some professionals, and so end up not closing this diagnostic display only autistic traits .

Many children with autism may even seek social contacts, but do not know exactly what to do to keep them.

It is worth mentioning here that a person with autism feels looks and perceives the world very differently from our way. Thus, it is for the family, professionals, teachers and society delve into his private universe and perceive the world the way she sees it.

According [12], qualitative deficits in social interaction are manifested by:

- Marked difficulties in the use of nonverbal communication;
- Failures in developing appropriate interpersonal relationships to developmental level;
- Failure to seek spontaneously share interests or pleasurable activities with others;
- Lack of social or emotional reciprocity.

Autism can be subdivided into categories [11]:

1) traits of autism with very light characteristics;
2) Asperger's Syndrome;
3) Autism in people with high functioning;
4) Classic, severe autism, associated with mental retardation.

A question of motivation for the project is that many individual computerized and electronic games may exhibit characteristics of autism spectrum disorders, especially among autistic category "a".

The difference between the category "b" and "c", though both do not exhibit cognitive impairment (mental retardation), is that Asperger's does not have language delays and autistic people with high functioning, according to [11].

General symptoms of autism according to [13], the autistic individual tends to present half of the symptoms described below:

- Difficulty in relationships with other children;
- Bad Laugh;
- Little or no eye contact;
- Feels insensitivity to pain;
- Preference for solitude;
- Aloof modes;
- Rotating objects;
- Inappropriate attachment to objects (insistently groping them , bite them);
- Noticeable iterativity or extreme inactivity;
- Unresponsive to normal teaching methods;
- Emphasis on repetition, resistance to change in routine;
- No real fear of danger (awareness of situations involving danger);
- Procedure with bizarre poses (fix objects getting squatting; put yourself standing on one leg; prevent passage through a door, only releasing it after playing a certain way the Jambs);
- Echolalia (repeats words or phrases in place of normal language);
- Refusal lap or cuddles;
- Act as if you were deaf;
- Difficulty in expressing needs (uses gestures and pointing instead of words);
- Tantrum (shows extreme distress for no apparent reason);
- Uneven motor skills (may not want to kick a ball but can arrange blocks).

B. Lego Mindstorms NXT kits

The Lego Mindstorms kit consists of several traditional pieces of Lego and some special, NXT, sensors and actuators. These pieces allow you to create various structures quickly and easily, allowing the assembly of small robots.

Originally developed as an educational toy, this set has become a research tool and very versatile education [14]. LEGO MINDSTORMS NXT with, students can build and program robots based on real-life mechanisms and can apply their skills in various areas.

The use of the kit as well as allowing the practice and erecting small robots also has another major advantage: its parts do not possess highly complex systems the kit is available at an affordable price compared to other possible ways of using robots for testing involved this project.

The NXT allows easy programming and friendly manner from the use of sound sensors; a robot that was assembled would follow the child according to the sound. The schedule at the time was due BrickX IDE, new environments are being considered for the next stages of the project, such as having LEJOS based on the JAVA programming language.

C. Artificial Neural Networks

The RNA's are parallel distributed systems composed of simple processing units (artificial neurons) that calculate certain mathematical functions [14]. Such units are arranged in one or more layers and interconnected by a large number of connections generally unidirectional. In most models these connections are associated with weights, which store the knowledge acquired by the model and serve to balance the input received by each neuron network [15] .

Neural networks are adaptive systems, in which the flow of internal or external to the network information alters its structure.

Regarded as one of the most common representations of RNA's, the multi-layer perceptron (MLP) is divided into three parts: input neurons, hidden neurons and output neurons. A group of neurons is called a layer, where the number of neurons in the input layer is equal to the number of input variables and the number of neurons in the output layer is equal to the number of output variables [16].

The number of neurons in hidden layers can be chosen arbitrarily, but [17]-[19] suggest the use of a relationship between the number of neurons in the input layers (Ni) and exit (In) to determine the optimum number of neurons in a hidden layer (NH) , according to (1):

$$N_h = \sqrt{N_i * N_o} \quad (1)$$

Initial tests of RNA will be in the scope of the project using the backpropagation algorithm, which is supervised learning algorithm more popularly used in MLP's.

The supervised learning assumes the presence of a teacher who has the task of judging whether the network response is correct and, if not, please provide an expected response. According [15], this characteristic is represented using a pair of desired input and output. These pairs are used for error correction mechanism, which after processing the input patterns, compares the network output with the desired output, in order to help the synaptic weights of all computational neurons.

III. Preliminary Results

The assembly of the robot to the initial tests of interaction was based on a busy per wheel structure, to be more agile and easy to handle. The structure makes use of 3wheels, 2 being larger in front and one in back of centralized and coordinated. On the front of the ultrasonic sensor and centralized.

Initial tests have been developed for small interactions with children, Figs. 1 and 2 show the interactions already implemented in the project.

Some care was taken to ensure that the toy becomes friendlier with the young audience, for example, with the use of voice of other children of equivalent age and next of kin for interaction via robot.

The interaction with the child starts with a search around the room repeating the phrase "Are you there?" Until the robot to find the child. Here he repeats the phrase "My names is RoBob" while going towards the child.

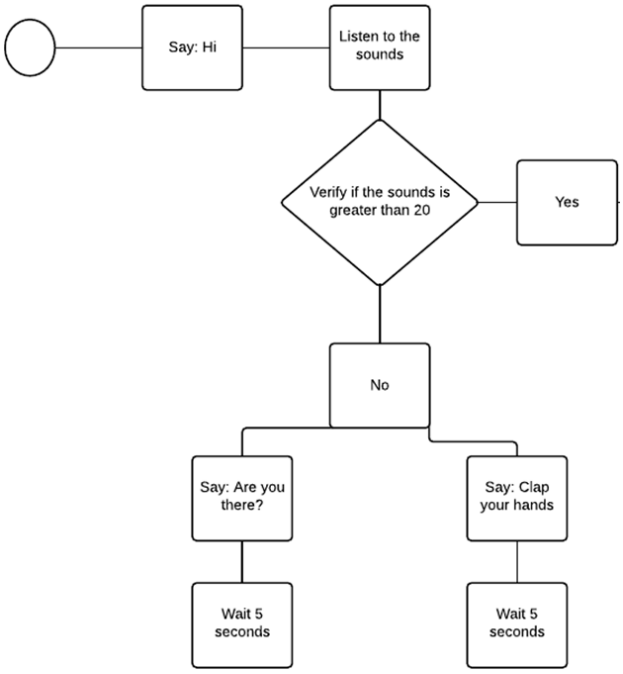

Fig. 1 Flowchart of interaction between robot and child (Part I)

Other phrases are produced to interact and draw the attention of the child, RoBob repeat "Clap your hands" while searching. It is noteworthy that the same should point "TRUE" the ultrasonic sensor to scroll the same distance to the child. The sound carried by the child will help the robot find her.

It is noteworthy that the initial tests were made with children without special needs of autistic for above reasons. The presentation for these children was received positively, how the robot interacted with children is assimilated with a toy.

For [20], establish a "joke" is critical to the child, whether it relates to an object, creating a relationship of meaning, not with the thing itself. Between line, it breaks with the subordination object, and the meaning attributed it expresses an active character in the course of development [21].

Basically, the child will be performing communication exercises, gaining freedom in speech or encouraging understanding of social aspects.

IV. Final Considerations

Based on initial experiments, we conclude that the tests with the interactive toy are welcomed to children in general. They feel much more comfortable and have an interest in interacting with the robot.

The initial results of the interactive toy project that aims to stimulate social interaction of autistic children are presented in the article. The overall project aims to develop a tool that can help improve the possibilities of interaction, communication and, indirectly, the quality of life of autistic children can be

simulated in a preliminary framework with children who do not have special needs in order to test their applications and consider future improvements.

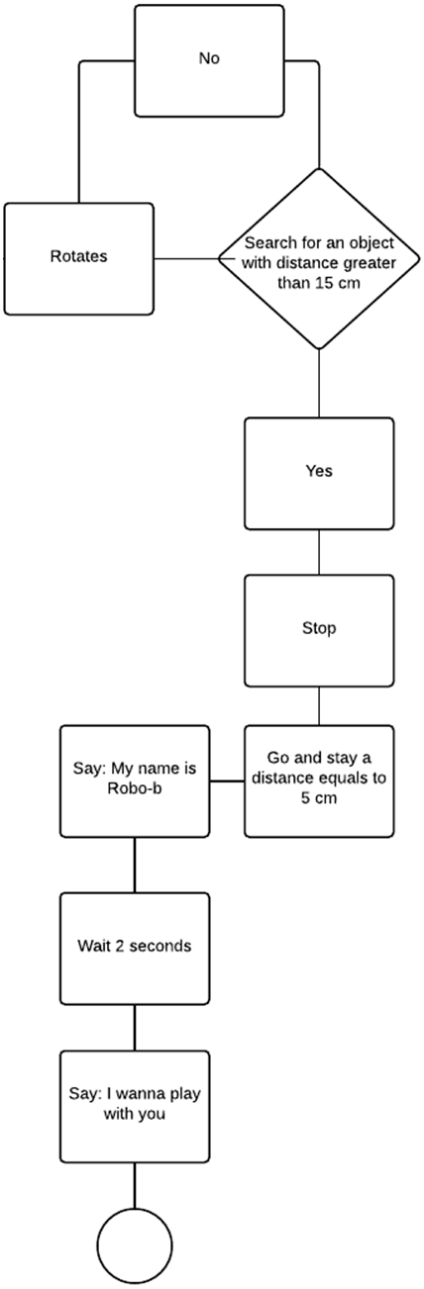

Fig. 2 Flowchart of interaction between robot and child (Part II)

A. Difficulties Found

One of the difficulties encountered was the use of the ultrasonic sensor that does not allow the analysis of the images, causing a limitation in the interpretation of the code by the robot, it can be concluded that the sound comes from the first object it finds.

Another problem encountered was to deploy the robot in an environment with many children due the noisy sound. Tests performed on room showed that it proved inefficient in achieving your goal, especially when there was a large movement of people. The robot was lost in their tests, and would always toward us stronger noise. But this problem has been found only in the initial phase of the project because when the simulation happens with autistic children, tests will be conducted individually, to comply with such specific characteristics of each child.

B. Future Works

The next phases of the project are to explore the interaction ability of the robot to test it later with autistic children. The main question that should be emphasized on using the LEGO NXT Mindstorms kits in this project is the concept of creating and using no great cost, it is critical to future use of the interactive toy in developing countries, such as the country where the project is being developed. For the implementation

The programming environment is already being changed to LEJOS because the programming is in Java and allows greater freedom in work schedule.

The backpropagation algorithm is used to process the commands received by the child and other techniques will also be considered in order to accelerate the processing time and communication between man and machine.

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