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► **To cite this version:**

Sébastien Saint-Aimé, Brigitte Le Pévédic, Dominique Duhaut. EmotiRob: an emotional interaction model. Robot and Human interactive Communication, 2008. RO-MAN 2008. The 17th IEEE International Symposium on, Aug 2008, Munich, Germany. pp.89–94, 10.1109/ROMAN.2008.4600648 . hal-00507533

HAL Id: hal-00507533

<https://hal.science/hal-00507533>

Submitted on 30 Jul 2010

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EmotiRob: an emotional interaction model

Sébastien Saint-Aimé, Brigitte Le Pévédic, and Dominique Duhaut

Abstract— This paper presents our work on the therapeutic robotics project EmotiRob which is the continuity of the MAPH (Active Media For the Handicap) project in emotion synthesis. Our aim is to maintain emotional interaction with children. For this, word, movement, and emotion synthesis are used. After defining a face for our robot, which is a compromise between the richness of expression and simplified mechanics, we propose the internal model of it in order to achieve and maintain emotional interaction.

I. INTRODUCTION

A NEW challenge for robotics is the domain of robots companions who are capable of performing complex tasks and provide a richer behavior by their interaction with human beings. The research is currently making these robots assistants for people sick or weakened.

The first experiments in this field of robotics have been made with the elderly in a retirement home, and Paro [2], directed by T. Shibata [3] [4]. In this context, we began an experiment [9] with robots Paro in two different places:

- Kerpape, where Paro was used by therapists with disabled children (6 to 12 years). Some were in wheelchairs.
- IEA, where Paro has been used with adolescents (12 to 14 years) with autism.

The goal of this project EmotiRob tends towards a robot that has the fundamental qualities: a stuffed animal, a pleasant contact, sensors, and so on. We also want to equip our robot capabilities of perception and understanding of natural language so that it can establish a formal representation of the emotional state of his interlocutor.

II. PROJECT PRESENTATION

A. Synoptic

Fig. 1 shows our synopsis, giving the different modules which will forward good development of our project:

- In our entry understanding module we find the

Manuscript received May 20, 2008. This work was supported in part by the regional council of Martinique, for the development of the emotional synthesis, the regional council of Bretagne for the language comprehension, and the ANR for the construction of the robot.

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information of processing prosody, video, as well as voice recognition. These factors will enable us to gather the utterances of the child, as well as his emotional state.

- Once the entries are processed, this information will be forwarded to the emotional interaction module via a semantics emotional structure (see section IV).
- A portion of the information handled by the entry module will allow the cognitive interaction module to determine an appropriate reaction to the behavior and discourse of the child.
- The output will transcribe the interaction and emotion of the robot through small sounds, body movements and facial expressions.

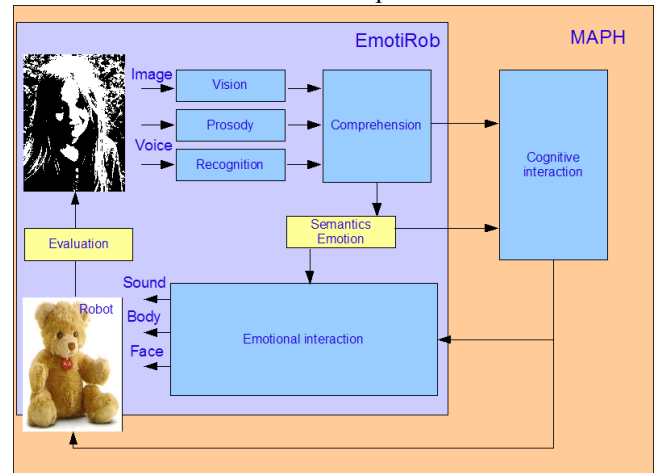


Fig. 1. Project synopsis

III. EMOTIONAL EXPERIENCES

One of the strengths of our project lies in its emotional interaction. The first question where on the use of emotions rather than the feelings and vice versa.

Many studies have already been made on these various areas, including their role in the life of a human person. According to some psychologists, even if they are equivalent, there is a difference between them and different expression. The feelings or emotional experiences are emotional statements accompanied by bodily sensations while strong emotions are intense internal reactions characterized by strong intensity [14].

Even if the definitions between psychologists do not always coincide, we have distinguished two characteristics in this differentiation. The first is the length of expression: the emotion is often defined as timely as the feeling is sustainable. The second is the fact that emotional experience

may be composed of several simple emotions. These notions of time and form of expression will not only improve the behavior of the robot but also learning.

We distinguish four types of emotional experiences [14]:

- Simple emotions: *“these are the emotions themselves, in their simplest form. To learn more about what is important to us, it is necessary to feel them”*.
- Mixed emotions: *“they are composed of several emotional experiences. They usually contain one or two emotions and other types of experiments that are used to protect oneself from one of these emotions. To be properly informed, we must break down mixed emotion to be able to feel each emotion to correctly process the other experiences from which it comes”*.
- Rejected emotions: *“these are experiences usually dominated by one’s body. They take place when an emotion is rejected or to prohibited. We must recall the repressed emotion”*.
- The pseudo-emotions: *“they have the appearance of emotion. Rather, they are “ways of saying things” that try to identify the emotion. We must identify the emotion they express”*.

IV. EMOTION SYNTHESIS

Emotion synthesis is an artificial reproduction of the way that human beings express their emotions in a social human context. Being able to express emotions is a way for a robot to communicate with a human. Without emotional expressions, users may interpret the interaction as a lack of interest from the robot and will then stop communication.

Robots (like Kismet, Paro, Necoro, Aibo, Asimo, etc.) capable of social interaction are then characterized by their ability to have behavior close to that of humans.

Emotion is an expression of one’s internal state. Joy and fear are different emotional states and can be characterized with physiological and psychological criteria. Through emotion synthesis, those criteria are imitated to bring about a believable artificial emotion. This artificial emotion is then used to reinforce communication: verbal or non verbal.

A. Facial Animation for EmotiRob

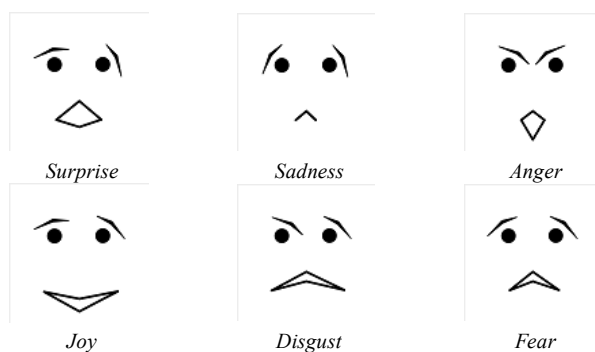


Fig 2. Face and examples of expressions for the robot

We have presented research on the question “how can an emotion be simply drawn?” In this evaluation, based on a specific set of faces having different degrees of freedom [9], it can be noticed that the one with the highest score is not the most complex one as in Fig. 2.

V. INTERNAL ARCHITECTURE OF THE ROBOT

After establishing the information necessary for proper interaction with the speaker, we were able to establish an internal model (Fig. 3) for our robot. In this model we describe:

- The interface between the understanding module and emotional interaction (inputs).
- The interface between the emotional interaction module and mechanics of the robot (outputs).
- The methods used in the emotional interaction module.

A. Inputs

The entries represent our synoptic interface for communication and data exchange between the modules of understanding and emotional interaction. We therefore find the data structure we can obtain the information needed for the best implementation of the process for good interaction between the child and his companion robot. The data structure will be as follows:

- Concepts "for children": these are the general themes (such as family, friends, school, etc.) in which the child will build his vocabulary [23]. These terms will be represented in the form of a hierarchical tree structure on one or more levels, in functions to the level of difficulty that we want to establish in the interaction.
- “Action for Children”: they represent the family of actions or words most commonly used in children [23]. These terms will also be represented as a tree structure.
- Speech act (question, affirmation, and so on.): it will allow us to adapt the robot’s behavior to the child’s discourse. Some types of sentences, such as interrogations, deserve more expression than others. This list currently being developed and will be given later.
- Tense: we are trying to identify the tense of the speech of the child: past, present and future.
- Emotional state: is the emotional state of the child. He will be represented by a vector of emotion information on the “affect” (positive or negative) of each primary emotion, as well as their level of involvement or recognition serving as a moderator which can vary on a scale of 0 to 4 (no emotion, not detected, a little, a lot).

These entries will be kept in a database enabling the robot to check whether his behavior has an effect on the child’s utterance. This comparison will help develop the robot’s acquired cognition and character. This will be our learning

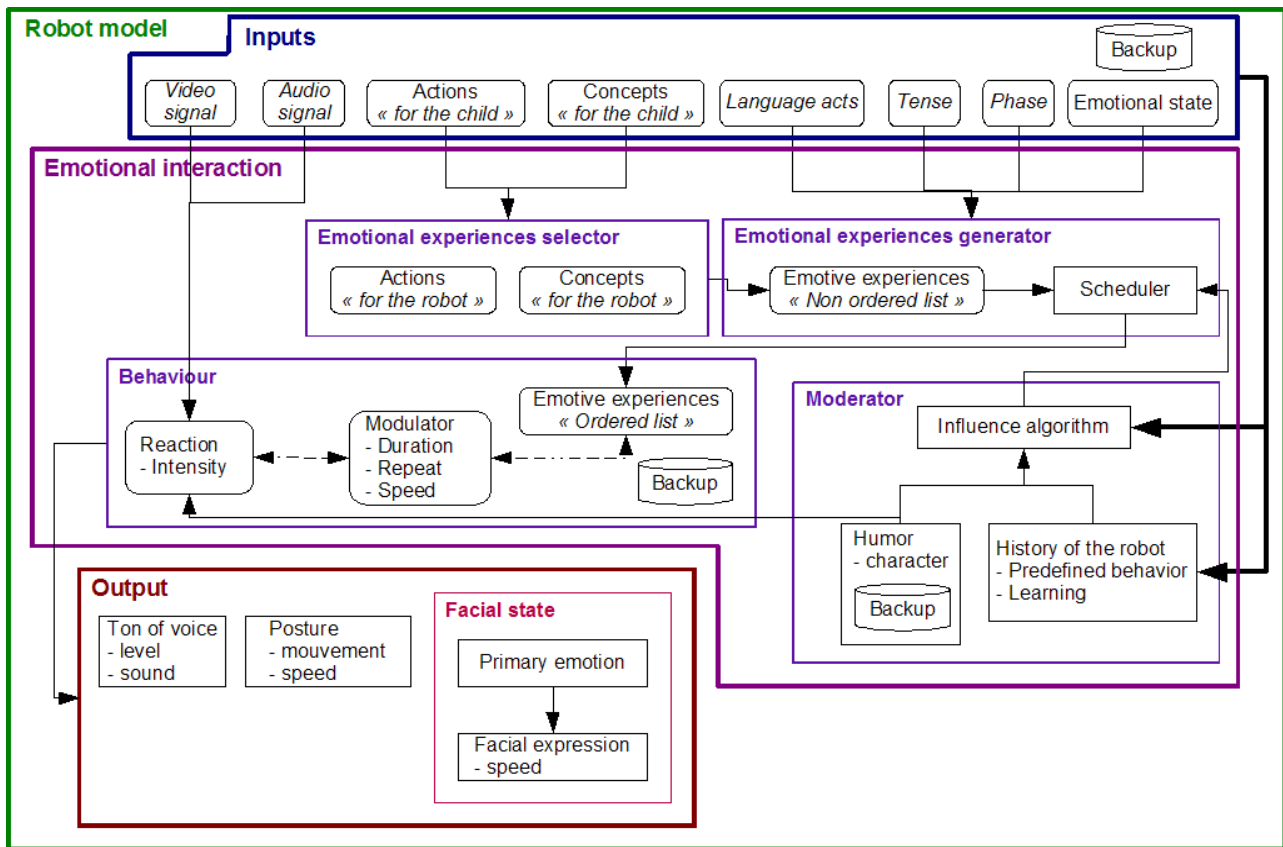


Fig. 3. Emotional interaction synopsis

phase

VI. EMOTIONAL INTERACTION

Emotional interaction is at the heart of our system of communication. With the recovered input elements (see above), we must be able to respond as naturally as possible to the utterance of the child. Knowing that facial expressions limit us to only the expression of “primary” emotions, to maintain non-verbal discourse, we will have to express ourselves with all the other parts of the human body. To do this we decided to integrate into our model the concepts of “emotional experiences” and “behavior” into our model. Four main elements of interaction can be found in the model:

- Emotional experience selector: each concept associated or not with each other through actions will enable us to define a list of experiences. These associations will be represented in the form of multidimensional matrix enabling the selection of an emotional experience (one or more) that will correspond to the meaning of the utterances. In our model, we gather keywords from the child’s discourse as well as his emotional state. The idea is to compare the child’s emotional state for those keywords to what the robot might feel for the same words. As a first step, the keywords listed for various concepts and actions will need to be

associated. This association will be made in the form of a single word (concept or action), partner (concept, action) or trinomial (concept, action, and concept) defined in the given matrix. The selector will therefore inform on the experiences associated with words from the discourse.

- Moderator: it should define if the character/mood and the prior experience of the robot will affect its interpretation. This comparison will have a great amount of influence on the behavior he will have at time t_0 and in the future, and will forward, or not, the agreement or contradiction with the spirit of the child at that moment.
- Emotional experiences generator: should determine to what degree we should take the influence of the robot’s acquired cognition into
- account as compared to behavior expected by the child. This degree will determine preferential scheduling of emotional experiences to be expressed.
- Behavior: defined behavior that the robot will express according to the list of emotional experiences which will be given

A. Outputs

In output from our model, the companion robot will be able to express emotion according to its physical

characteristics: microphone/hp, motors. The behavior that results from the emotional interaction module will be broken down into 3 main sections:

- “Tone of voice”: characterized by a greater or lesser degree of the audible signal and choice of sound that will be produced by the robot. Unable to speak for the moment, the robot companion should be capable of emitting sounds on the same tone as the seal robot “Paro”.
- Posture: characterized by the speed and the type of movement of the various members of the robot’s body.
- Facial state: represents the facial expression that will be displayed on the robot’s face. At the beginning of our interaction study, we mainly work with “emotional experiences” which will be translated into primary emotions afterwards, and then into facial expressions. We know that emotional experience is made up of several primary emotions. The major part of the work will initially be to define them and represent them in the form of an emotional weighted vector (a vector for each defined “emotional experience”).

VII. MECHANICS OF THE ROBOT

The mechanics of EmotiRob can be separated into three modules. The first module is the head. It contains all of the motors in order to set in motion the eyebrows, jaws and corners of the mouth into motion. The second module is the neck, it contains two motors. The third module is the pelvis which also contains two motors

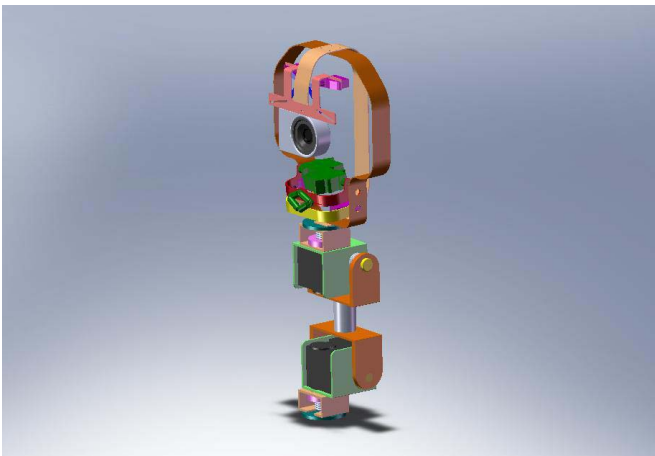


Fig 4. Complete system

A. Activation of the eyebrows

The eyebrows are operated independently by two servo-motors type BMS 303 (BlueBird). The actuator results in a rod-crank system guided by a groove in the structure. The groove is straight for the moment in Fig. 5, but it might also be curved to enhance the expression of the robot.

B. Activation of the jaws

The upper and lower jaws are independent from each other. Each is driven by a servo-motor type BMS 303 (BlueBird). The range of motion of the jaw should not be too large.

C. Activation of the lips

The corners of the lips are also independent from each other to increase the possibilities of facial expressions. Each is operated by a servo-type BMS 380 (BlueBird), which pull a cable on which two springs traction (upper and lower) are fixed. These springs allow for the various of the length of "lips" while playing the role of tendon from the mouth. The cables pass through rings along the upper jaw. This will transform the movement of rotation of the actuator movement in translation along the jaw. The BMS 380 servo-motors are sized to be able to stretch the springs.

D. Neck and pelvis mechanics

Both modules are treated the same for reasons of ease of implementation and since their features are the same. This module must be disengaged: the force on the rotation should not damage the motors. With force rotation, the compression spring shrinks as a result of a force that is applied along the axis of rotation. This contraction disassociates (disengagement) both toothed surfaces and thus the rotation takes place freely without damaging the mechanical actuator. The principle is the same for both axes. Once there is no more force on the rotation, the compression spring applies an effort (clutch), which goes put in touch toothed surfaces.

VII. CONCLUSION

Having successfully completed our studies on the face of the robot and his dynamics and the expression of his emotions, we still need to model all of the rest. We, therefore, propose a model of emotion which is not based on the unique representation of simple emotions emotional experiences.

Most of the work now is not only the association between these emotional experiences and keywords in the discourse but more importantly develop the process of generating emotions and behavior of the robot.

Our future work will focus on the development, as well as its evolution and improvement of the mechanical robot to increase its functionality.

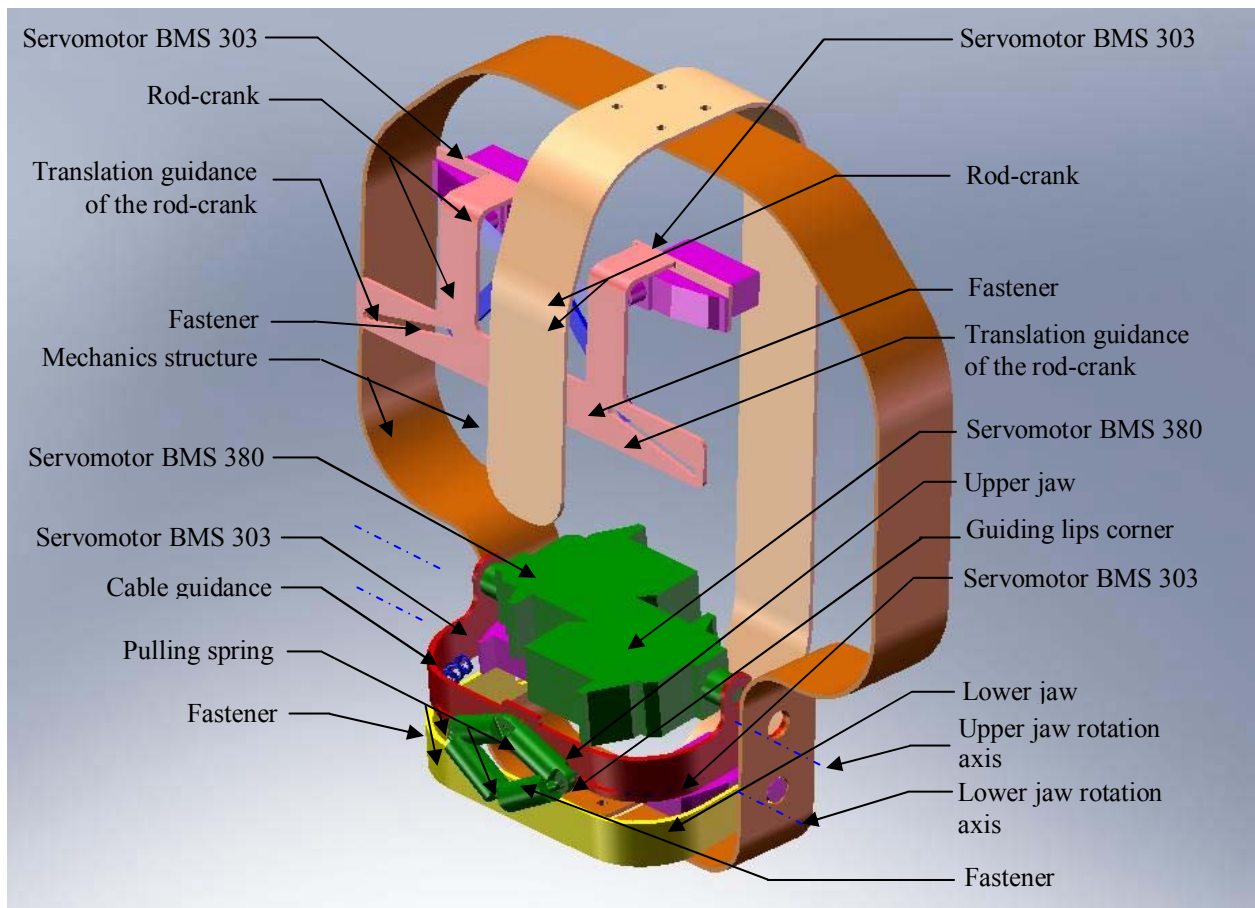


Fig 5. Head of EmotiRob

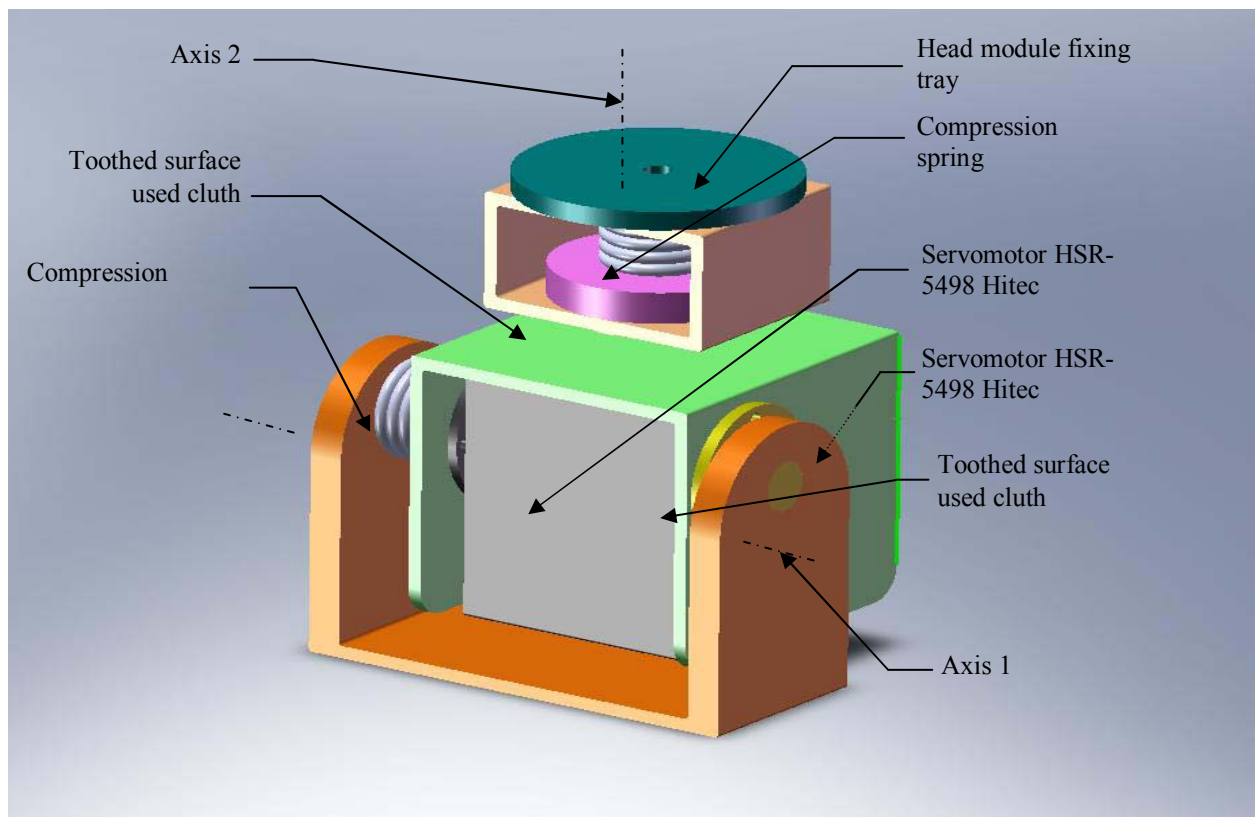


Fig 6. Neck and pelvis module

ACKNOWLEDGMENT

EmotiRob is currently financed by the regional council of Martinique, for the development of the emotional synthesis, the regional council of Bretagne for the language comprehension, and the ANR for the construction of the robot.

First of all, we would like to thank the regional council of Martinique, as well as the ANR for their collaboration and the financing of future work.

The authors would like to thank Claire PALLARD, pediatrician, for her contribution for the realization of an evaluation grid.

The authors would like to thank members of the center of Kerpape (Laurence TRIVIERE, Marcelle SAMSON, Sylvie LEMONNIER and Annie BERTRAND) for their cooperation with our experiment.

The authors would also like to thank members of the IEA "Le Bondon" (Florence CHARPENTIER and Olivier THUAU) for their cooperation with our experiment.

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