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EmI – my emotional cuddly companion

Sébastien Saint-Aimé, Brigitte Le Pévédic, Sabine Letellier-Zarshenas and Dominique Duhaut.

Abstract—This article presents the next experiments we will conduct on the interaction model [19] of EmotiRob project. It describes the first experimentation we had done, the experimental protocol and the evaluation grid.

I. INTRODUCTION

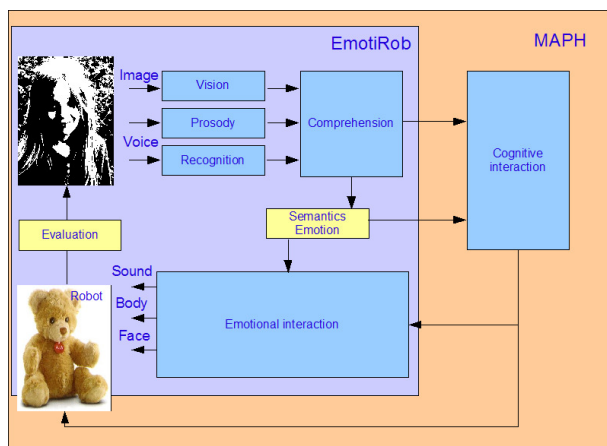


Fig. 1. Project synopsis

THE EmotiRob project [17] aims to design a robot companion for children of 4 to 8 years, with various disabilities, to comfort and accompany them in their daily life. The early stages of the project first allowed us to define the necessary degrees of freedom for the robot to express primary emotions, then to define an emotional model for non-verbal and emotional interaction with the interlocutor. We had to take into account the difficulties arising from the understanding of speech, do various manual annotations between emotions, emotional experiences, the words, speech and personality of the robot. The instantiation of the model ended, it was possible to start the first experiment to validate it and to check if the acceptance rate of the interaction was

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acceptable. This experiment was performed with an interface that simulated input and outputs of the system because we hadn't the robot at this time. The great question we were asked was whether the behavior linked to the speech was coherent, if the emotions expressed were recognized, and whether the dynamics of emotions seemed natural. In addition, we had to experience the speed of the expressions and the behavior length in order to include them in the robot. Now we have the robot, this future experiment will allow to compare results we had with the simulator and these with the robot. Another question is to know if EmI has a psychological effect on the children. We have started to reflect about this and give an evaluation description to make the experimentation with children.

II. ROBOTICS CONCEPTION

EmI (see Fig. 2) is still in integration phase. The robot's mechanics was manufactured by the CRIFF [25], but not its implementation. We are presenting robotics aspects and a brief description of the work already done. Currently, we have it completely covered with plush but not fully padded.



Fig. 2. Entire EmI picture.

In figure 3 we can see the robot head skeleton and its dressing. The motors used for the head expressions are Bioloid [27] Dynamixel AX-12+. These motors allow us have a numerical communication between the robot and the PC (see Fig. 5). We have developed an API to communicate with the motors by using an USB2Dynamixel convertor and the FTDI API [28].

For the facial expression, we use 6 motors for the 6 degrees of freedom. Four motors for the mouth and 2 for the eyebrows [18].

In the nose we can see the CMUCAM 3 camera we will

use to follow the head of the user and try to recognize his facial expression.



Fig. 3. Head Conception



Fig. 4. Body conception

The torso of the robot is characterized by an aluminum skeleton that allows the robot turns its head, bends, inclines and turns its bust. These movements will allow the robot to follow the user and keep his attention.



Fig. 5. Fit pc slim.

The PC used to treatment and motor movements is a fit pc slim [26]. It's equipped with a 500 MHz CPU, 512 Mo memory, 60 Go hard disk and Windows XP system. This computer embedded the emotional system for interaction and is connect with the different motors via an USB2Dynamixel adapter. We can also connect a keyboard, a mouse and a screen to configure, modify and recompile algorithms used

to make interaction.

III. SIMULATOR EXPERIMENTATION

The robot having reached the phase of integration and testing, we had to conduct a test interface to begin the experiments. Not only can this interface enter the necessary information input, but it can also simulate the emotional state and behavior required of the robot according to the information it provides. This interface communicates with another application that is the heart of the system, or rather the application that will be mounted on the robot. It must be stressed that the test interface allows only one simulation input / output and not data processing.

A. Protocol

The first step was performed with a wide audience; it was not very difficult to find volunteers but we limited the sessions to 10 people because this public is not the final target and the objective wasn't to modify the interaction based on comments made by an adult audience. The first thing the participants were asked was to disregard the fact that the interface was the face and behavior of the robot, and that all the rest (input mode, ergonomics, etc.) was not evaluated. In addition, it was necessary for these people put themselves more or less in the place of the interlocutor in order to obtain valuable feedback.

We had previously defined a list of 4 phrases that should be the basic testers. For each, we associated the following language information:

- Action tense: present.
- Language act: affirmative.
- Context of speech: real life.

This system enabled us to save the valuable time each person would take up to make his choice. The sentences given were:

- Mummy, to cuddle, daddy.
- Tiger, to attack, grandma.
- Baby, to cry.
- I, to tickle, Sister.

B. Evaluation grid

After distribution and explanation of evaluation grids, each person was first asked to perform the following steps:

- 1) Give the affect (positive, negative or neutral) for each word of the speech.
- 2) Give their emotional state in reaction to the speech.
- 3) Predict the robot's emotional state in answer to this speech.

This step, although easy to implement took some time to grasp because some people had trouble expressing their feelings. After entering this information, we could start the simulation for each of the sentences. We asked users to pay attention to the expression of the robot because they could

not be repeated. After observing the behavior of the robot, users had to complete the following information:

- 1) What were the recognizable emotions in the robot's behavior; how would they assess its intensity: certainly not, a little, a lot, I don't know.
- 2) The average speed of expression and the behavior length.
- 3) Did you see a combination of emotions? Yes or no.
- 4) Did the emotional sequence seem natural? Yes or no.
- 5) Are you satisfied with the robot's behavior? Certainly not, a little, a lot.

C. Results

The objective of this experiment was to evaluate the recognition of emotions through the simulator, and especially to determine if the response the robot will give to the speech was satisfying or not.

As regards the rate of appreciation of the behavior for each speech, 54% for a lot of satisfaction and 46% for a little, we observed that all the users found the simulator's response coherent, and thereafter admitted that they would be fully satisfied if the robot was as they were expected. The fact that testers answered about the expected emotions had an influence on overall satisfaction.

For the rate of emotions recognition, 82% in average, the figures were very satisfactory and allowed us to prepare the next evaluation on the classification of facial expressions for each primary emotion. Not all emotions are on the graph because they bore no relation to the sentences chosen. We have also been able to see that even if the results were still rather high, there were some emotions which were recognized although they were not expressed. This confirms the need to classify, and especially the fact that each expression can be a combination of emotions. The next question is to know if the satisfaction rate will be the same with the robot after the integration of the emotional model.

The other results were useful for the integration of the model on the robot:

- Speed of expressions: *normal* with 63%
- Behavior length: *normal* with 63%
- Emotional combination: *yes* with 67%
- Natural sequences: *yes* with 71%

IV. ROBOT EXPERIMENTATION

This experiment is substantially identical to that achieved with the simulator in the first instance. Thereafter we will ask users to compare the facial expressions of the simulator to the robot to determine the difference in recognition that there is between the 2 methods and especially to confirm whether the expressions recognized with the simulator are also with the robot



Fig. 6. EmI surprise.



Fig. 7. EmI joy.

A. Protocol

For this experiment, we used the same principle as the older experiment. Users, for a series of sentences given, will determine the emotion data expressed as the robot. To facilitate our task, we recalled the same users for the previous one. They will not have to fill all of the first evaluation. Moreover, already knowing the principle, the explanation will also be faster. This is a time saver for us and also for our testers.

For the second part of our experimentation, we ask users to do an entirely different exercise. We will begin by expressing each primary emotion and ask the user what he acknowledged. This will enable us to verify that emotions are recognized without informing the user that is expressed in advance. Then we repeat the same exercise but by informing the user of the emotion to be expressed. We will be careful not to keep the same order in order not to have automatic recognition. Each person must complete a new

evaluation grid for this part.

B. Evaluation grid

The evaluation grid used for the first part is identical to the previous one. Users are the same, the part concerning their emotional state to the speech and the emotional state that they expect the robot will be resumed at the same. They will only tell us about:

- 1) What were the recognizable emotions in the robot's behavior; how would they assess its intensity: certainly not, a little, a lot, I don't know.
- 2) The average speed of expression and the behavior length.
- 3) Did you see a combination of emotions? Yes or no.
- 4) Did the emotional sequence seem natural? Yes or no.

Are you satisfied with the robot's behavior? Certainly not, a little, a lot.

For the second part, the evaluation grid for emotions to recognize, without informing the user, is that:

Recognized emotions	Certainly not	A little	A lot	Don't know
Joy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Surprise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sadness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Anger	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Disgust	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fear	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The table 1 is reproduced for each emotion to express, or 6 times. We plan to make only one expression for one emotion. The following table (see Table 2) will inform on the recognition of each emotion expressed by the robot, but with the user informed of the following.

Expressed emotions	Certainly not	A little	A lot	Don't know
Joy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Surprise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sadness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Anger	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Disgust	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fear	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C. Result

The results for the simulator experimentation will be given later because starting in April.

V. EVALUATION OF PSYCHOLOGICAL EFFECTS

After experimenting the behaviour of the robot (see previous chapters about experimentation), we will (1) evaluate the feelings of the children about the appearance of

the robot (do children like the look of the robot?) and about physical contacts with the robot (e.g. is the texture nice?) and we will (2) investigate the effects of the robot on the psychological state of the children. This chapter deals with point (2).

Studies have shown that robot-assisted therapy can have positive psychological effects on human beings: human-robot interaction can improve people's moods. Among research works in robot therapy, we have, for instance, the PARO robot [21] which is used with elderly people in health services and with children in paediatric hospitals. PARO has been experimented: it has psychological and social effects on hospitalized children and elderly people. Will our robot have positive psychological effects on children?

We present here the evaluation material we have defined.

A. A short-term individual experimentation

Different kinds of experimentation can be performed: short-term or long-term experimentation and collective or individual experimentation. Collective experimentation means that we let several children interact with the robot at the same time. Individual experimentation means that children meet the robot separately (there is just one child with the robot at a given time). In case of short-term experimentation, the robot is given, just one time, to children during about 20 minutes and then we immediately evaluate the effect of the robot. In case of long-term experimentation, we let children have the robot several times during a long period and we regularly evaluate the effect of the robot. In the near future, we will perform a short-term individual experimentation with different children.

The robot is introduced to each child before each experimentation: a therapist tells the story of the robot and explains what will happen.

B. Our evaluation material

We want to see if the robot has positive psychological effects:

- Are the children more happy after the interaction?
- Are the children more relaxed after the interaction?

To answer these two questions, we intend to collect data on:

- the psychological state of the children (before and after the interaction with the robot),
- the behaviour of children during the interaction thanks to a video-recording (by observation of the child-robot interaction).
- the opinion of children regarding their interaction with the robot (once the interaction is completed),

(1) Data collected about the psychological state of children are:

- Information from a self-evaluation: a simple face scale composed of 5 faces is shown to a child and then he has to point out the face that best expresses his actual state. These 5 faces express the following

states: very sad with tears, sad, neither sad nor smiling, smiling, very smiling.

- Information from a hetero-evaluation (an evaluation made by a therapist who knows the child, stays with him for a few minutes and then give the psychological state of the child thanks to 2 verbal scales):
 - A verbal scale of 7 levels for the sadness/joy feeling (very sad with tears, very sad, sad, neither sad nor smiling, smiling, very smiling, very very smiling)
 - A verbal scale of 7 levels for the anxious/relaxed feeling (very very anxious, very anxious, anxious, neither anxious nor relaxed, relaxed, very relaxed, very very relaxed)

All these data are collected before the child-robot interaction and also after (the same scales are used before and after the interaction).

All these data will be analysed in order to see if the gap between the “state-before” and the “state-after” is rather positive or negative, if the gap is small or not. To do this, we will use a non parametric statistical hypothesis test: the Wilcoxon signed-rank test.

(2) Data on the behaviour of the children during the interaction (thanks to a video-recording). We want to see if the children interact or not with the robot, if they interact in a positive or a negative way, if they have fun or not. There is one video-recording per child. For each video-recording, we will have to answer the following questions:

- Questions about the behaviour of the child towards the robot:
 - Does the child have tender gestures towards the robot (does he cuddle, hug, stroke or kiss the robot) ? If yes, just one time or many times?
 - Does the child ill-treat the robot? If yes, just one time or many times?
 - Does the child say kind things to the robot? If yes, just one time or many times?
 - Does the child say hurtful things to the robot? If yes, just one time or many times?
- Questions about the way the child lives the interaction:
 - Does the child have facial expressions of pleasure? If yes, just one time or many times?
 - Does the child have expressions of boredom? If yes, just one time or many times?
 - Does the child verbally express his pleasure? If yes, just one time or many times?
 - Does the child verbally express his boredom? If yes, just one time or many times?
 - And, does the child seem upset when he left the robot? (Possible answers are: a lot, a little, not at all).

We will calculate descriptive statistics with these data. We will calculate the percentage of children who rather have a positive behaviour towards the robot, the percentage of

children who rather seem happy to be with the robot. We also want to measure the dependency between what we see (through the video-recording) and the psychological state assessed previously. We will build contingency tables to analyse the relationship between gaps calculated from face scales and behaviour (positive or negative) of the children.

(3) Data on the opinions of the children regarding their interaction with the robot (named *Emi*). These data are collected after the interaction. The following questions will be asked by a therapist to each child:

- Were you happy to be with Emi or not? (the children’s answers will then be reformulated as follows: very happy, happy, indifferent, not happy)
- Did you have fun or were you bored or neither? (the children’s answers will be reformulated as follows: a lot of fun, fun, indifferent, bored)
- Do you want to see Emi again or don’t you care? (the children’s answers will be reformulated as follows: yes, indifferent, no).

We will calculate descriptive statistics with these data. And then we will build contingency tables to analyse the relationship between the observed behaviour of children (from video-recording) and what children say.

C. Perspective: long-term experimentation

Once the short-term experimentation done, it will be interesting to conduct long-term experimentation. It will allow us to assess effects over a long period. After several interactions, the children know the robot. The robot is no longer a new “joy” (children are very interested in new things, new toys). Will the children be happy to see it again or will they tire of the robot? Why? Will the robot be a true companion which has psychological effects even in difficult times for the children?

VI. PERSPECTIVES

The first experiment with the simulator, allowed us to answer some partially unanswered questions, particularly on the speed of expressions and behavior length. But more importantly, it confirmed the choices we had made for information processing and the behavior that we associate with the speech of an interlocutor. However, the rate of emotion recognition, although very acceptable, is still improving. We know how imperative is the evaluation of the facial expressions we use. Furthermore, we have begun in-depth research on the dynamics of emotions, in order to increase the fluidity of movement and make the interaction more natural. The second experiment, with the robot, will enable us to know if his expression recognition will be as high as that of the simulator after integration.

The future experimentation with the robot will begin in May and will be conducted with schoolchildren from 4 to 8

years of age and not suffering from disabilities. For these tests, the robot will be used, but entries will still be simulated. We will use the Wizard of Oz experiment to capture data before the final integration of the voice recognition system, scheduled for late May. The results will be given in ROMAN conference.

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