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Child oriented storytelling with NAO robot in hospital environment: preliminary application results

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Abstract: *The paper presents a novel approach to design of robot-child interaction scenarios for hospital settings based on comparative observations of the emotional reactions of children to humanoid robot NAO behavior. We compared the emotional reactions of three target groups – children with cancer in the hospital 4-14 years old, children of 5-7 years of age in a school environment and children in a day care center with different types of developmental problems. In all cases the emotional reaction to humanoid robots are positive and improving the overall conditions of children according to the opinions of all involved teachers and caregivers.*

Keywords: *NAO humanoid robot, storytelling, robot-child interaction*

1. Introduction

The rates of incidence of childhood cancer are globally increasing, as well as the survival rates [1], [2]. This means a longer stay in the hospital for those children, which implies a disruption in the social activities both in the family and in the school. Those stays suppose a major stressor and give a general overall feeling of isolation,

particularly in children being physically isolated because of low immunity/resistance [3].

To improve this situation and reach to these children, we focus in designing and employing social robots as a social mediator. Social robots have provided being a reliable communication tool on different occasions [4-6], and suppose a lower level of infection risk for the patient than a human or pet. Particularly, we focus in the storytelling, which paradigm is used in different forms to support the development of a wide spectrum of cognitive functions and skills in children from early childhood [7]. Moreover, it has proven to be a useful therapeutic tool in both adults and children [8], [9].

The intended contribution of the paper is the proposed novel approach to design of robot-child interaction scenarios for hospital settings based on comparative observations of the emotional reactions of children of similar age to humanoid robot NAO behavior. We compared the emotional reactions of three target groups – children with cancer in the hospital 4-14 years old, children of 5-7 years of age in a school environment and children in a day care center with different types of developmental problems. In all cases the emotional reaction to humanoid robots are positive and improving the overall conditions of children according to the opinions of all involved teachers and caregivers.

In the present paper, we are presenting some preliminary observations from the activities carried out during the early development of the presented model of child-robot interaction.

The paper contents are as follows: Section 2 describes the application implemented in the robot. Section 3 comments the activities we realized during this previous stage. Section 4 provides observations collected on those activities. Section 5 gives some conclusions.

2. Application model of robot-child interaction

The idea is to provide the robot NAO [10] with a human-like interaction, where the behaviors are requested, not selected, and the robot provides a sense of self-awareness. For this, we created a dialogue-controlled process from where the several options can be launched. We used Choreograph and the tools provided by Aldebaran, as it provides a dialogue process in addition to the text-to-speech conversion and the voice recognition in different languages.

As seen in Figure 1, the process starts with the robot's presentation where it refers to itself and the features it has in an informal and childlike manner. Then the focus is redirected to the actual dialogue process of the NAO robot with simple questions and answers (i.e. how old are you?) and small talk. This dialogue is from where the rest of behaviors are called, via a switch in the robots OS, i.e. NAO qi's, focus. This implies the need to monitor when this focus is released, which elicits a memory event that triggers the previous dialogue, bypassing the presentation. This way of

processing implies that the robot has no long-term memory of the interactions, and only a short-term memory inside the dialogue. The behaviors that can be launched from the dialogue are the two stories described in 2.1 and 2.2, small animations to entertain the kids from the robots animation's library (i.e. air guitar playing), and a more lengthy animation with sound of a Tai Chi performance.

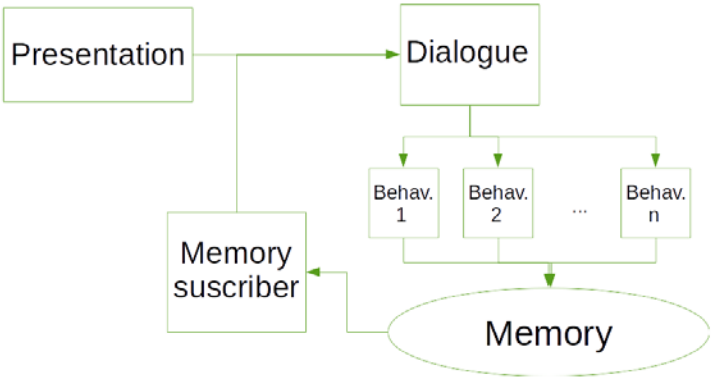

Figure 1. Scheme of the application with representation of focus switches

The stories are developed with an animation tagged text and a number of storytelling characteristics, as the objective is, not only to verbalize the story but also to "tell a tale" implying a multisensory input for the receiver that transform the process to a social communication [11]. The flow of the history is altered using pauses to resemble a human storyteller in order to break the possible monotone rhythm of the robot. In addition, each character is characterized by a personal voice, created using the changes in pitch and speed of the robot's speech, and a color in the robot's eyes. This way the children are able to detect differences associated to characters, as is usual in the traditional storytelling.

2.1. First story - Peter and the wolf

The first implemented story is the one of Peter and the wolf. This is a traditional and widely known story for the children to whom it was oriented. It has a length of 2 minutes and is designed for younger children, with a message of not telling lies not particularly linked to the considered children's situation. However, we decided, due to simplicity and the familiar nature of the story that it was an ideal first contact story. It consists in four characters with three different voices and we provided two personalized animations to accompany the text, the call of Peter and the laughter.

2.2. Second story - Fearless John

In this case, the story is also a generally known story bun not so known in the Bulgarian settings. The length is of 8 minutes and is oriented to children of older age, i.e. 5-7. In this case, the story was selected specifically because of the message it provides, as it narrates the adventures of a fearless hero and the way he faces it in a

nonchalant way. We considered a proper message for children that found themselves in a situation of high stress and fear. It has nine characters with five voices, and we included sound effects for the monsters in the story and one personalized animation. In order to make the experience more holistic and provide the children with a sense of anticipation and a way of remembering, we created additional material: a video of the robot telling the story with puppets, a coloring book with the characters, and an Instagram account.

For the activities performed in Bulgaria, the system was changed due to the lack of Bulgarian text-to-speech conversion accompanying NAO. Recordings of a female human voice reading the story replaced the text. Moreover, the dialogue launch could not be used, therefore a manual launch of the behaviors was implemented with the previously presented behaviors replaced with a Bulgarian song with dance, the story of Fearless John, and the Tai Chi animation.

3. Activities

The aim of the preliminary work in this paper is to assess the effect of the storytelling in the children and take some first reactions to the interaction with the robot in a number of different settings. For that, we performed in four different situations: a children's hospital, a school group age 10-11, a Bulgarian school group age 5-7, and a Bulgarian daycare center.

3.1. Children's hospital

We realized two different trips to the hospital in differentiated dates with no overlap in the group of children of each date. The robot was included as part of a more extensive activity, with two other robot types, two Parrot's jumping sumos [12] and two Sony's [13] AIBO robot dogs, as seen in Figure 2. The age range in the general group was 4-14 and the rooms in which we performed were not segregated by age. The groups varied from 1 to 6 children per performance as we went from room to room in different hospital areas, from isolated children to daycare groups. The sessions conditions in both trips where similar, with no previous information provided to the children and a duration of 15-30 minutes in each setting before moving to the next room. The performance consisted in putting the robot on, giving the additional coloring book and paints, a small presentation, and free interaction. If the interaction did not naturally occur, we questioned about what they wanted the robot to do and encouraged siblings and caregivers to join.

Figure 2. Parrot's jumping sumo (left) and Sony's AIBO (right)

3.2. School group age 10-11

We realized a single trip to a school to interact with a group of children, age 10-11, that has had previous experience with the research group and, particularly, with small robots and drones. In this case, there was a previous work in class with the projection of the video of the Fearless John story. As the previous situation, we included the NAO robot in a more extensive activity with small drones and two AIBO robots. We divided the 30 children in 5 groups of 6 children and rotate activities every 15 minutes as seen in Figure 3. This way a group of children interacted with the NAO robot, another two - each one with one AIBO robot and the last two - with the drones. There was no directed interaction. The idea was to make them interact with each option regardless of preference in order for them to provide opinion in the different options based on interaction and not solely appearance or first impressions.

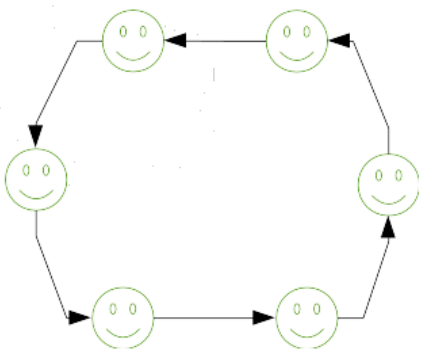

Figure 3. Rotative setting

3.3. School group age 5-7

We also realized a single trip to a Bulgarian school, with children of ages 5-7. The children were divided in two groups depending on age, one of 5-6 years old and other of 6-7 year olds. Each one of the groups interacted with the robot in a 30 minutes session that were made equal in all conditions. As you can see in Figure 4 the children sit around the robot, at a distance. The robot was presented and they were explained that it is programmable. Then they sang a song with NAO, listened to the Fearless John story, the robot preformed the Tai Chi animation, and finally they were invited in groups to touch it and play with it for a short while and voice their questions.

Figure 4. Children listening to the robot

3.4. Daycare center

We performed a single session in a daycare center in Bulgaria with a group of special needs children, as presented in Figure 5. The children were of different age, autonomy level, and disorder type. In this case, parents or caregivers accompanied most children in every moment by close proximity. The session lasted 45 minutes, and consisted in a first get in touch with the robot, singing a familiar song and dancing with the children twice, telling the story of Fearless John, and performing the Tai Chi animation twice. Then the children were encouraged to touch and get near the robot, with assistance when needed.

Figure 5. Children getting ready for the robot's performance

4. Observations

The reactions were significantly more negative in the hospital setting than in any other of the situations. In this context the younger, the child the more negative reactions toward the robot NAO were displayed, which did not occur with the AIBOs. Even the more grow up children reacted in a significantly neutral manner, whereas it was enthusiastically received in the rest of the situations.

Regarding the intention for interaction there was high interest in verbal and physical interaction in the school and daycare settings with the children spontaneously speaking to the robot or reaching to touch the hands and feet. In the hospital, however, the attempts to interact where generally weak and most often guided by the lead of a caretaker with a significant amount of children accepting or witnessing the action. However, it is to notice that the feedback received from caregivers was positive, which could imply the need of a different measurement of enjoyment in such situations.

Focusing on the verbal interaction, the interest was high but brief, as the children lost interest fast when the robot failed to recognize the words. This failure was more accentuated due to the enthusiasm of the children to speak to the robot in a fast, loud, and collective manner, with a number of questions and phrases sent at the same time.

The most significant observation, however, was the unexpected interest in the NAO robot's actual storytelling from the school group age 10-11. As previously stated, these children have already seen the story in a video online. We asked if the robot was the same as the one they saw and they requested to see it “live”. We ran the story and during the first 1-2 minutes of the story all, the other groups left the more interactive (drones), and other social (AIBOs) options to sit in front of the robot NAO. Even when the teacher tried to interrupt to allow them to have free playtime she was silenced in order to keep hearing the story.

5. Discussion and conclusions

We are interested in the robot-child communication in a context of emotional or psychological need. Our approach is to use the storytelling as a tool to interact with the child in a non-stressful and secure, yet meaningful way. More precisely, we are very interested in the possibility of giving these children psychological tools to better manage possible stressful situations using fun and non-threatening manner. The storytelling has been historically used with this same objective. In this paper, we provide some observations that show that hospitalized children are in need of a more proactive actor for a successful interaction, as there is a significant ignorance of the robot, which comes in tune with the ignorance of others listed as effect of major stressor in [3]. However, a more indirect approach might be necessary, as an aggressive start might maximize the negative first reactions reported in this work. In addition, the verbal interactions proved to be too rudimentary in this preliminary stage for the children's free-play. However, there was a good response to non-verbal communication in all the groups. On another note, the hard rejection of the robot could be linked to traces of emotional regression, which is a common consequence of a major stressor in children, as stated in [3]. We plan to improve the complexity of the system and to extend the dialogue and variety of options in order to improve the communication between child and robot. Finally, we will try to realize more controlled and elaborate activities to study in more depth the reactions and natural interactions of children and humanoid robots.

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Сценарии взаимодействия NAO робота и ребенка в больничных условиях: Предварительные результаты применении

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Аннотация: *В статье представлен новый подход к разработке сценариев взаимодействия робота и ребенка в больничных условиях на основе сравнительных наблюдений за эмоциональными реакциями детей на поведение гуманоидного робота NAO. Мы сравнили эмоциональные реакции трех целевых групп - детей с раком в возрасте 4-14 лет в больнице, детей в возрасте 5-7 лет в школьной среде и детей с различными типами проблем развития в дневном центре. Во всех случаях эмоциональная реакция на гуманоидных роботов была положительна и улучшала общее состояние детей по мнению всех вовлеченных учителей и родителей.*

Ключевые слова: *Гуманоидный робот NAO, рассказывание историй, взаимодействие робота и ребенка*