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Interactive system by observation and analysis of behavior for children with autism

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Abstract. In this paper we propose a system architecture in order to observe and analyze user's behaviors in the scope of educative games. It concerns the observation of autistic child's actions during a session. Thus we can extract conclusions relating to her/his behavior and provide in a real time personal way adequate activities, keeping in mind the expert's advice. Our proposition is based on the optimization of the extraction of information from heterogeneous data according to the context. We have applied our results on a software environment realized for children with autism according to the needs of a psychiatric team.

Keywords. Interactive system, architecture, educative games, behavior, Autism

1. Introduction

Interactive software are characterized by the presence of information from users and application domain experts. In this context, the fact that the interaction involved human users, raise the crucial question of the adequacy between services characteristics provided by the software, and individual characteristics of the user.

The context that we are interested in is related to *the education games* and *learning*. Several works have been developed on this context, propose systems that build the adapted activities to the user profile [3] [4]. These works do not consider the *comprehension of behavior* and *interactivity*. However, in several applications related to the educational and therapeutic software for children, these aspects are important for various reasons :

- Activities suggested by the system could become incoherent during the training session.
- The behavioral analysis is a key factor for therapists. Its interest concerns decription of indicators which can alert on the risk of decompensations or even of parasitic actions (like stereotypes).

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- This analysis makes it possible to improve the adequacy between the actions of the system and the children behaviors, in order to maintain them attentive and receptive to activities.

In this context, our objective consists in defining a system able to *understand* the behavior of children with autism and to react, in a real time personalized way, by providing special activities. These latest have to take into account the expert's directives.

This paper is organized as follows. In the next section, we outline the application. In the main Section 3, we describe the principle of general architecture of the system. Finally, we present the implementation in the application context.

2. Application Area : The Therapeutic Context - Autism

Autism is multifactorial disorder characterized by impaired social interaction and communication combined with repetitive and stereotyped patterns of behavior. We are interested in interactive environments as learning and teaching tools for the rehabilitation of children with autism. Several robotic platforms are developed as interactive playmates for children ([11], [1], [2]). [12] uses virtual environments in teaching strategy, ([7]) is interested in the design of Human-computer Interfaces for children with autism.

The project that we carry out, called *Autism Project*, is in partnership with the psychiatric service for children with autism of *La Rochelle* hospital. Our objective is to implement a software and hardware system that could help the children with autism during the rehabilitation process. It consists in establishing a multimode and multimedia dialogue between the assisted child and the system. The role of such a system is to provide to the children the personalized activities in the form of educational games. During a session, the system collects by various devices (camera, touch screen, mouse, keyboard...) the child reactions, in order to *understand* her/his behavior and response to it, in real time, by adequate actions considering the expert's **directives**.

These directives concern rupture, avoidance, stereotype gestures... for instance, the system may attract child's attention by posting of a familiar image, or by launching a characteristic music.

3. System architecture

Each child is characterized by particular competences and preferences, so he requires an adapted treatment. It is impossible to generalize activities without precaution, but we have to favour adaptability of system to take into account specific deficits observed for each child. It is important to locate and interpret carefully these intrinsic behaviors, in order to help him/her to rehabilitate.

We think that the extraction of information on an analysis level of sequence of treatment must be optimized thanks to the information extracted in other levels. Figure 1 gives the strategy that we adopt. It is centred on the optimization of the extraction of information according to the context, as well as the interaction and the collaboration of these information to take a decision.

In the application context, our architecture aims to bring flexibility and modularity in the individualized rehabilitation of children with autism. Accordingly, we propose a system architecture which allows:

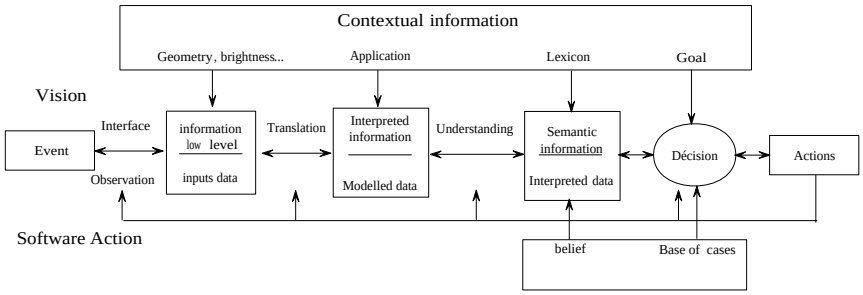

Figure 1. System methodology

- To build a sequence of activities, called ***Protocol***, that satisfies the educational goals that the child wants/must reach by taking into account his/her profile.
- To observe the child's actions during the session in order to *understand* his behavior. The observation is made on the actions carried out on the peripherals : mouse, touch screen, keyboard... and by cameras for the gestures, movements, eyes orientations, emotions...
- By observing the child's behavior, the system detects cases where the activities suggested do not answer to standard gait and updates the Protocol.

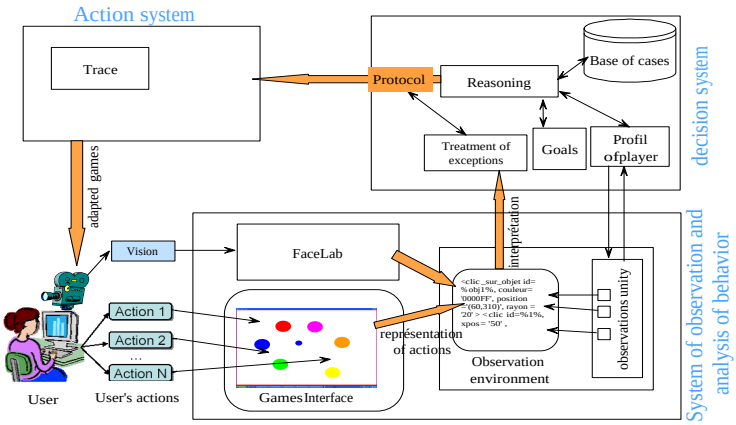

Figure 2. General architecture

Figure 2 gives the general architecture of the system. We listed three systems : System of observation and analysis of behavior, Decision system and Action system. The remainder of this section presents the principle of each system.

System of observation and analysis of behavior : Mainly inspired by results of studies on Natural Language Interaction [13] [14], in particular of *the theory of affordances* [5] [6] and *the theory of Procedural Semantics* [16] [9] [17]. This system recover the child's actions and associate to them some states words that characterize behaviors. The observation is based on two approaches, *Software action* and *Vision*. The first one, re-

covering the child's actions carried out on the peripherals : mouse, touch screen, keyboard... The second one, ensured by the software/hardware system **FaceLab**, it consists in measuring the characteristics concerning the 3D representation of the face and the orientation of the gaze.

Decision system : This system uses Case-Based Reasoning (CBR)[10], to generate Protocol adapted to child's profile. The Protocols generated by this system can be modified during the training session if they are incoherent with child behavior. This is ensured by the *exceptions management* mechanism inspired by [15]. It consists in identifying, indicating and treating these special cases.

Action system : This system execute the activities provided by the decision system. Another important task of this system is to save the execution trace.

4. Implementation

In this section, we present the implementation of our architecture within the framework of *the Autism Project*. In first step, we have developed a platform which ensures the reasoning process and the treatment of exceptions. For the least one, we have developed an agent (with DIMA [8]) that observes the child's actions during the session and reacts in each exception by modifying the Protocol.

In second step, we have developed an interface that allows the expert to define the activities , the cases and directives. These informations as well as the profiles of children are stored in a data server.

5. conclusion

In this article, we have developed a system architecture which reacts in a dynamic way thanks to the observation and analysis of behavior. The principle of architecture lies on the optimization of the extraction of information according to the context. The observation and the analysis of behavior consists in determining the behavior of children from their actions, by taking into account the expert's directive. The approach that we have adopted is inspired from works on Natural Language Interaction.

We have used CBR for the decision-making. CBR provides a framework relevant to create Protocol adapted to the each child profile. In order to associate to the Decision system with a dynamic mechanism, we have used exceptions management. It consists in detecting particular behaviors, definite by the expert, and answering by actions on level of the Protocol.

The obtained results are interesting and promising. However, more experiments are needed to validate the proposed models and architecture. Moreover, the system we have developed is currently tested in the service of psychiatric of *La Rochelle* hospital.

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