TANGIBLE INTERFACE TO SUPPORT THE EMOTIONAL DEVELOPMENT IN A DOMOTIC ENVIRONMENT

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TANGIBLE INTERFACE TO SUPPORT THE EMOTIONAL DEVELOPMENT IN A DOMOTIC ENVIRONMENT

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ABSTRACT

Observing the growing diffusion of personal quantification devices, the research aims to deepen an area within which it is possible to derive real added value through the acquisition of data. Starting from a theoretical approach regarding the analysis of the emotional state of an adult in an automatic way, the paper comes to the definition of a system grounded on a theoretical knowledge using a tangible prototype in order to increase the emotional skills of a child in the age of development (social emotional learning - SEL). This system is based on two fundamental components. On the one hand, a tangible object able to silently detect different types of data during the interaction with the user. On the other hand, it is proposed to use the current home automation technologies present on the market, to create an immersive system able to generate a dynamic feedback, based on the data acquired by the tangible object. The definition and generation of both visual and audio feedback, aims to replicate and outsource the degree of emotional activation of the user, this should help in understanding and adjusting the degree with the support of professionals like teachers, psychologists, etc. The creation of a dynamic immersive context increases the ability to understand and engage children, compared to normal learning techniques; it can expand them also to passive participants of the experiment. The aim of the research is therefore twofold: to be able to quantify a qualitative data, such as the degree of activation; the creation of a system capable of emulating and responding to the user's unconscious stimuli and facilitate the self-expressing.

Keywords: Tangible interface, Interaction, emotional learning, self-expressing, wellbeing

INTRODUCTION

The main purpose of the research "tangible interface to support the emotional development in a domotic environment" was initially configured as the development of a tangible system for the quantification of data relating to the psychophysical health of a user. To influence this state, there are different factors including the environmental ones, which affect differently the state of well-being of an individual in a mechanism of action-reaction. To be able to understand the dynamics in a holistic way and to understand how this system of relations is articulated and functions, it is necessary to use a systemic approach.[1]

Through the creation of the system nodes, relationships and criticalities are immediately recognizable and the design team can intervene to create new virtuous relationships so as to strengthen their functioning or radically modify it. With the spread of consumer technology, the design universe gravitating around the human system [2] has certainly become more complex, but at the same time it has made accessible new nodes on which it is possible to implement improvement policies under multiple aspects, including sustainability[3]. Since interconnections in the digital age became a crucial topic to project, it is easy to see how even more than before, these relationships expand, they are not only limited to the human-environment dualism, but also include the human-human mediated relationship. Referring to this vision, the concept of well-being cannot be strictly individual, but rather involves the entire community and its environment. [4]

DATA GATHERING OVERVIEW

There is also an intangible system of interconnected information, a flow generated by our behaviours and habits that create a network of data that can describe us, even intimately, as people and individuals. We have only recently become aware of this flow of Big Data and use them to obtain a kind of added value, for example, a restitution in terms of simplification of daily activities, improvement of our state of physical health or of our sports performance. This basically happened because of the exponential spread of smart devices. Common objects, some of which have always been present in our homes, have been enriched with computational technologies such as sensors, communication devices, actuators, etc. [5] capable of perceiving the external environment, understanding their function in context and act on it. But it's not the only reason, because these objects also own the ability to connect with the outside world through the free access to the internet, they are also provided with the ability to communicate with each other in a completely new and amplified way. This information exchange network is called IoT, i.e. "a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers, and are able to collect, analyse and exchange data without explicit intervention" [6]. As regards the Smart Home area, the application sectors are mainly related to energy and service management (electricity, temperature, etc.), safety and media, through the use of connected objects and hubs capable of managing different objects and change their functioning [7]. The added value provided by Smart Objects such as the NEST thermostat [8], TADO [9] or smart locks like LOCKITRON [10] are often aimed at achieving cost savings, a greater sense of comfort and safety. There are also solutions that try to go beyond acting on the well-being of the inhabitants from the psychological point of view, working on Digital Relationships: Wheredial [11] and Goodnightlamp [12] are just two of the most significant examples. Both objects allow the users to tell their loved ones where they are or if they arrived home. [13] These examples are extremely important in their simplicity: they use few sensors, few data and an equally small number of actuators to reach an extremely complex goals such as strengthening interpersonal relationships. The research team considers them fully fledged related works. For the Wearables Tech sector, the question is more heterogeneous since functional and ergonomic level should be analysed in different ways.we can proceed with a distinction both at a. In recent years it has been quite clear that in the field of functions, objects designed for fitness had absolute dominance with the highest rate of use and annual growth. The detection of endogenous data (pulse, oxygen, hrv, etc.) and

exogenous data (speed, geolocation, etc.) become extremely widespread and easy to insert into wearable devices [14]. Despite this, recent efforts by large companies, such as Apple, to produce wearable devices certified for use in the Healthcare sector [15] show that this sector is of particular interest and in which large investments will be concentrated in the future [16] [17]. From the ergonomic point of view, at the moment there are 3 main uses located in two distinct points of the body: SmartWatch and SmartBand with 45.6% and 24.7% of the market (worn on the wrist) and earwear with 27.4% of the market. [18]

THE IDEAL STRUCTURE

We live within an intangible cloud of data, object systems that often speak different languages to each other and act on the environment in a more or less autonomous way, based on the data they acquire from our habits, sports performance or biometric values. The key to obtain added values with the best cost / benefit ratio is to understand the relationships between the elements. For example, it is interesting how Voutyras et al. [19] introduce the concept of Virtual Entities, which connect the physical and digital worlds: a projection of real objects in the virtual world, with the ability to access or use sensors to capture data and influence the environment in which they live through physical actuators. If objects can even establish a kind of intimate relation with the user, i.e. in a proxemics or emotional way, people can project themselves into the virtual world as abstract entities. Moreover, the concept of VE fits into a much more user centered drift of the IoT called SIoT, Social Internet of Thing. At the base of the SIoT there is the conviction that, as well as for people, they aggregate in communities based on common goals, interests, needs, trust, etc.; this must also happen with the smart objects that populate a specific environment. Biunivocal and specialized relations are set up and optimized to carry out a series of specific tasks: human-object relations, object-object capable of speaking the same language. Objects are a medium to allow or facilitate the interaction between man and his physical and social context [20]. This somewhat more limited and human-scale system allows the design team to better focus our needs and possible options to achieve the goals. Ss mentioned before, many of the smart objects have the ability to detect and process data by returning feedback. However, its functioning is recognizable only through the practical manifestation of their work, that is, the effect is visible but often the cause is not, as it happens, for example, with voice assistants. Users are getting used to living an experience disconnected from the interface where until now they used to visualize the data or the feedback. The so called Zero UI is slowly becoming established, a system within which the man-machine relations are tight to the point that there are continuous changes in the system, triggered by human movements, gestures or voice. In a natural and almost magical way [21]. A process of dematerialization that had already been hypothesized by Weiser in 1991, when he imagined that a world could exist in which humans were able to use thousands of computers connected to a network (smart objects) in an unconscious and automatic way, on the basis of their needs [22].

EMOTIONAL TRIGGERED SYSTEM

Therefore, people are learning to interface in a natural way with a community of virtual entities able to perceive and act on the environment in a physical way. An

environmental intelligence that has the sensitivity, capacity and availability of useful data to be able to perceive our needs (sensing) and provide a response accordingly (actuating) to them [23]. Hence, users may desire to derive an added value from this connection, which transcends the simplicity of economic savings and approaches, somehow, to the psychological and emotional sphere. Initially, the design work focused on the perception of an individual's (adult) emotional state so that the system could be adjusted according to it. Starting from the fundamental assumption that emotions are not only private expressions of oneself, but impersonal mechanisms that people share through empathic processes [24], therefore somehow common and transversal, we tried to identify which data and in which modality it was possible to relate them to each other.

THE CHANGE OF TARGET

During the scenario phase many figures with specific experiences were involved and consulted in order to correctly approach psychological aspects and the parallel definition of the possible practical solutions that allowed this type of survey. To receive feedback and refine the project in different aspects, we created a small virtual dialogue network involving experts from Turin, Milan, Genoa and Padua. In total, we interviewed two Psychologists, a Professor of Philosophy and Theory of Language, a Psychologist of Sport, two Researchers in Educational Sciences, a Researcher in Didactics and special pedagogy, a Sociologist, a Professor in New Technologies for Applied Arts, an Informatics, a Professor and Researcher in Educational Robotics, a Professor and Researcher in Robotics and Bioengineering, two Developmental and Educational Psychologists, two Psychotherapists and an Information Engineer.

Starting from the first interviews, however, we realized that a system that aims to virtualize and externalize the emotional state of an individual, could be useful also, and above all, in the development of child's social and emotional skills. With emotional skills, we refer to the set of skills related to the expression and understanding of one's own and others' emotions, to their regulation. Becoming emotionally competent means, for example, being able to express one's emotional experiences through verbal and non-verbal communication channels, being able to decode the expressions of others, understanding the causes that produce specific emotional experiences, using adequate strategies to modulate the ongoing emotional experience [25] [26]. Working in the initial stages of development it is easier to recognize and intervene on any problems or to facilitate the healthy development of this type of skills and it is easier to analyse any evolutionary patterns useful for later working with older people.

Moreover, it has been amply demonstrated how a correct education to social and emotional competences has several positive implications including the increase of the relational abilities and the school performance [27] [28] [29].

EMOTIONAL SKILLS

Starting from the assumption that children begin to develop these skills independently from the first months of life, we can divide the processing process into 3 macro-steps:

The manifestation of emotional states in a verbal and non-verbal way:

- Understanding; understanding nature, the possible causes and strategies of emotion regulation
- Regulation; knowing how to monitor, evaluate and modify emotional reactions
- Each of them varies according to the evolutionary stage of the child.

The period on which we intend to focus, for the moment, is the preschool age, in which children already have sufficient knowledge of emotions and the ability to understand social norms and develop empathic experiences accompanied by pro-social behaviour. This development start between 2 and 6 years with the understanding of external and observable events as the main causes of emotions, which are recognized above all on the basis of expressive facial clues. In the same period, a phase of emotion regulation also develops, the role of the adult is still important as a support in intense emotional situations: social reference and attachment are taken into account. Physical avoidance strategies; and the importance of symbolic and fictional play emerges to rework and give meaning to emotional experiences [30] [31] [32].

Our goal is to capture and amplify this state so as to externalize it more clearly, making it possible to share the emotional state, triggering the possibility of discussion with a parent or teacher and at the same time work on the empathic abilities of the children involved activity.

THE GAME AND THE STORYTELLING

There are numerous approaches to the world of child education. One of the most used and effective is related to the game, which is particularly suited to the age group of our target, [33] [34] [35] [36] whether it is a free play, or guided gaming. [37] The game allows, for example, to play-pretend which helps to simulate situations, or in our case emotions, in a safe and simplified way. The role of a support figure, whose presence had already been supposed to be necessary, is fundamental whether we are talking about outside the flow or inside the flow [38]: so if he/she acts as a spectator, mediator and regulator of the game, if he/she is seen as a participant and a reference model of the game itself. For our purposes we will mainly focus on the aspects of the game that use objects (in our case, smart objects), and in the sociodramatic" play. The latter is especially common from the age of 3 and consists of pretending and playing a role in a story, understanding its dynamics and playing according to the prescribed rules [39]. In order to do this, it will be necessary to subsequently create a simple narrative structure capable of guiding the activity, determining certain limits, eliciting a single emotion at a time.

IMMERSIVE LEARNING

Setting the goal of making explicit an emotional state through an active and guided storytelling process, we come into contact with the need to create engagement with the users involved. Looking at the pyramid related to learning & retention we find that, through an active type of involvement, with Real Experience simulation, dramatic

presentation and learning by doing, for example, leads to a retention rate of 90% [40]. The effectiveness of this type of approach can be found in several researches where immersive / virtual environments are used to facilitate learning [41] [42] [43]. The widespread of home automation objects suggest the possibility of developing a system able to exploit the faculty to connect objects into a system following the principles of SIoT.

DATA DETECTION

From the research carried out so far, the detection of an emotional state is feasible if done within a restricted range of emotions and can be performed through the analysis of two factors: endogenous and exogenous. The first are data related to the biological reactions of our body such as the ECG, HRV and GSR, widely used in numerous researches [44], while the latter are related to external factors such as non-verbal communication. Endogenous data sensors need a contact with the body to ensure a precise detection, exogenous data, instead, can be detected in different ways. Having the possibility to introduce the use of an object within our activity, we thought that using an external handleable object instead of a wearable one would be a better way to capture our data. One of the reasons is that the wearables devices are designed to gain and record data in a silent way and rarely through direct interaction. Working with children we decided to use something more friendly and easier for them to relate with. A toys, more specifically a puppet, looks to be the best choice because of its possibility to represent a character creating a stronger connection with the storytelling, because it's an object that was born to be manipulated and has the possibility to hide sensors inside itself in an easy way. Among the possibilities of measurements offered, we take into consideration the ones related to the quantity of movement and to the muscular activation, both acquired through the manipulation of an object. Although it is impossible to unambiguously decree the relationship with a precise emotion from these data, it is instead possible to perceive the amount of activation derived from one of them, as demonstrated in several studies [45] [46] [47]. Some studies have also shown how the ability to express and recognize emotions from the movements of others considerably develops starting from the age of 4-5 [48] [49]. At the hardware level this type of data can be detected through an accelerometer and a gyroscope that can precisely measure quantity and speed of movement. These data can, then, be sent to an external platform that processes them in real time and gives feedback using the possibilities offered by the domotic environment.

Given the reduced dimensions of the sensors, it is possible to insert them in any object designed to be handled to capture the desired data.

THE PHYSICAL OBJECT

In our case, the use of a puppet becomes an almost obligatory choice both in terms of the possibilities of interaction, data that can be acquired and, above all, due to the mediator role that it has to play, as confirmed with the psychological experts interviewed during the first phase. The presence of an external mediation element during any activity, especially with children, helps to facilitate expressive skills and facilitate communication [50] [51] [52]. The use of objects able to communicate not

only in a real way but also in a virtual way (thus creating that link between the physical and the digital) has proved particularly useful and successful, as the study and the development shows in the Avakai project [53].

DISCUSSION

Although the theoretical framework is structured and shared by experts in the psychological and educational fields, the result is far from obvious. First of all it is important to underline that with great probability it will be necessary to realize more than one character, possibly with different forms and references. Furthermore, the association with history will be of vital importance especially if those who conduct the activity will not have immediate familiarity with the system, in order to favour the process of "sociodramatization".

PROTOTYPE SETUP

The prototyping process involves the use of an ELEGOO Nano V3.0 main board with CH340 ATmega328P Chip, an Aukru GY-521 MPU-6050 accelerometer and gyroscope board, a module dedicated to haptic feedback and an ESP8266 module for ensuring communication with a device (fig.1). In the current phase the goal is to visualize the raw data of acceleration and movement and to cluster them in 3 macro-groups: slow, normal and fast, based on the data provided by the sensor. In a second phase these data will be transmitted to an automation service for the management of home automation environments and in our case the choice fell on IFTTT [54] for reasons of simplicity of management, breadth of services provided and free of charge. Through webhooks accesses it is possible to send data to the service and trigger events such as the chromatic variation of the lighting, in our case made possible by 3 smart QBOX light bulbs connected to the home network and synchronized through the "SmartLife" application in turn present in IFTTT. (fig. 2)

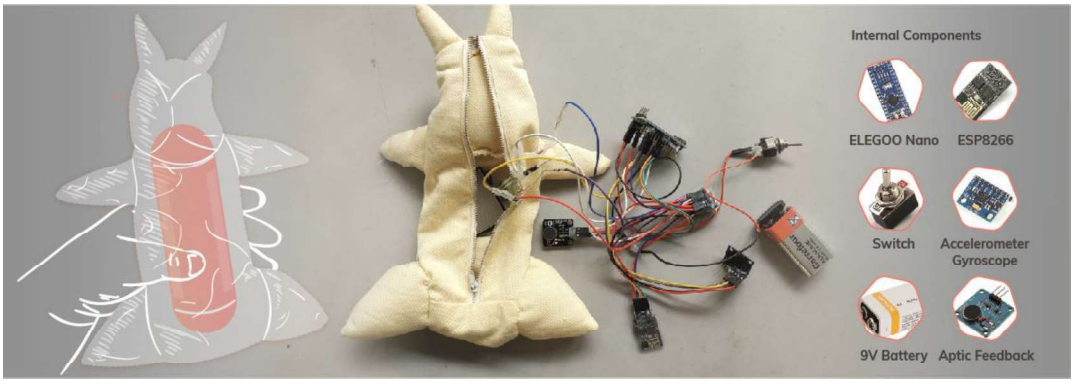

Figure 1 - The Prototype

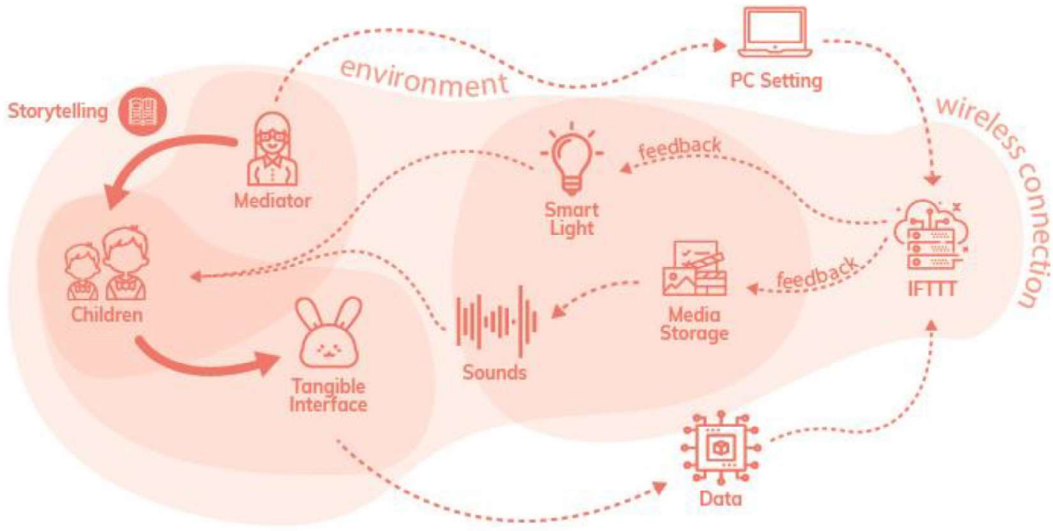

Figure 2 - The Systemic scheme

CONCLUSION and Future Work

With this type of setup, crossing the indications obtained during the interviews, we can define the general traits of the experimentation. This will take place at a school and will involve children aged between 4 and 6 in groups of up to 5 people. Since the presence of an external regulatory figure is, as we have seen, fundamental during the entire process and having already successfully involved some teacher during the interviews, we decided to involve them in a more active way giving them the part of mediators. Having immediately demonstrated a great interested in the project, for us they are the best choice since are able to know children in depth and allows us to correctly detect and interpret both the feedback of the users involved and the data collected on them.

Through this collaboration, we've been able to better define and validate some aspects of this activity, in order to test our project in a better way.

The purpose of the test is not explained in advance as the link between object manipulation and environmental variation: this happens in order to elicit and work in a genuine way on children's reactions. The activity, lasting about twenty minutes, initially includes a moment of storytelling aimed at arousing a specific emotion and subsequently the request to make explicit through the manipulation of the smart object its own emotions linked to the story and its characters. Some of the questions may be: "How does the character react in this case?" "How does it feel?" Or "What should he do?" These questions are not addressed to way the child would react, but to the intermediary subject, all the questions have the purpose of spurring the dramatization and therefore a natural response devoid of filters linked to the concept of "you should not do it". Many of the dynamics will be left free, just to make the experience as natural and simple as possible. Subsequently the feedback of the teachers will be collected in the form of questionnaires and interviews, to evaluate the effects and reactions of the children in relation also to the data collected.

From the preliminary tests, the data caught in this way leads to validate our theory and the methodology behind it. The feedback obtained from the manipulation of the object seems to actually increase the curiosity and the involvement of the children during the activity and simplify the approach to the emotional regulation.

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