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Executive Summary of the Thesis

Oceania: exploring social interactions and creativity through a multi-sensory environment game application

Laurea Magistrale in Computer Science and Engineering - Ingegneria Informatica

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1. Introduction

The Autism Spectrum Disorder (ASD) is a neuro-developmental condition characterized, among other symptoms, by difficulties in social interaction and communication.
One of the most common issues associated with ASD is the social struggle that children and teenagers alike experience as a result of their inability to properly interpret other people's emotions.
In recent years, treatments to this condition have found a significant helping hand in the form of the various technology advancements: among other mediums, multi-sensory environments (MSE) have gained popularity as an effective therapeutic system that can be used by patients with varying disabilities.
Multi-sensory environments are adaptive and smart spaces, used to control the user's experiences through sensory stimulation. Their goal is to create a holistic, immersive experience that can be used for a variety of purposes, including therapy.
We developed Oceania, a MSE based software that allows both children with ASD as well as neuro-typical children to play in an immersive and stimulating environment. This application is ran in the Magic Room, a smart space developed for children with neurodevelopmental disorder by I3Lab (Politecnico di Milano).
Oceania's aim is to provide users with a tool that can foster creativity, by letting children have control over their artistic expression. This is accomplished by presenting an interactive environment were users can move around and explore while interacting with the surroundings.

2. State of the Art

Multi-sensory environments (MSE) can include a variety of elements, such as lighting effects, music and interactive technologies, all of which work together to create an engaging sensory experience. MSEs are associated with a high degree of flexibility as a consequence of the wide range of tools that can be featured in them; this allows for the possibility to customize MSEs according to one's own needs and goals.
Originally, MSEs were developed as a medium to be integrated in therapy for individuals with severe disabilities, but over time their employment has seen adjustments that have lead to their inclusion in other neighbouring fields.
The customizability provided by MSEs has allowed them to be integrated, among other areas,

in treatment therapies for children with ASD: notable examples such as MEDIATE [2] have shown how the proper management of sensory stimuli could help individuals with ASD by providing them with a controllable and safe space. With regards to our work, the most relevant example of a MSE based software that should be analyzed is Magika [1], an interactive smart space targeted at children with special education needs, which integrates the wall-projection of a digital world with the use of smart physical objects to create a room that enables a wide range (tactile, auditory, visual, and olfactory) of stimuli. Magika's room is connected with an interface for educators that enables them to define and share a number of game-based learning activities and customize them based on the evolving needs of each child. Oceania has been developed as one of such activities, with the aim of complementing the already vast suit of games available.

3. Implementation

3.1. General Approach

The core idea behind Oceania is to provide its users -young children being the primary stakeholders- with an interactive environment that can be employed to enhance connections between children, fostering their curiosity and creativity. We aimed to achieve this by presenting an interactive environment filled with elements that appear as visually engaging. Through a process of exploration and discovery, the user should be incentivized to learn what results can be yielded by interacting with the surroundings. The following list describes in greater detail the flow envisioned for our activity:

- **Exploration:** The user, who is initially oblivious to the mechanics that the surrounding environment is regulated by, can interact with in-game elements in order to learn about the results associated with each game action.
- **Creation:** Once the player learns about the tools offered by the system, he/she could choose to employ them in order to create visually stimulating pieces of art. This process incentivizes cooperation between multiple players, as the final displayed art is itself a combination of the actions taken by each child.
- **Emotion Connection:** Upon generating visual stimuli, users are expected to be influenced by them. We strive to analyze the behavior that children have as a result of said stimuli.

3.2. Game Concept

We designed Oceania's game concept starting from the flow shown in the previous section: in order to create an environment that could stimulate creativity and artistic expression, we focused on interactivity and immersiveness as the two key conceptual factors.
The chosen setting is that of an underwater space, which is complemented with calming visual and auditory pieces, such us coral wildlife and background music.
The Magic Room, which is equipped with two projectors, allowed for the creation of a space that could make use of both the frontal and bottom screens, which have been employed in order to represent the underwater environment from the perspective of someone cruising on the seabed of the ocean.
Additionally, in order to exploit the concepts of immersiveness and exploration, Oceania has been based on a full-body interaction system that uses the kinect to track players' body movements. The kinect provides a virtual mapping of users' body motions, which are transposed in the game world: with this system, players can move around the room and interact with the environments changing body posture and location.
Finally, the underwater setting has then been complemented with the inclusion of an additional major conceptual factor: *Colors* as a mean to represent emotions. We were in search for a medium to visually connect users in scenarios of emotional synchrony, and the use of colors was introduced as a way to represent a child's current emotion, in order to display his/her state of mind, while having the possibility to compare it with other users. To do so, our team's designer developed a mapping scheme that matches 7 possible mind states that a user can have, each with a different color.

3.3. Game Description

Once the setting and general concepts had been decided, we were left with the task of choosing

which elements would be filling the environment. Having one single entity that could bring together the experiences of multiple users was a necessary way to ensure connection and cooperation between players; for this reason a floating Jellyfish was introduced as the main game element.
The jellyfish, which is displayed on the front screen, connects with the users through a visual link: a flow of floating bubbles moves from the player's feet to the Jellyfish itself. Bubbles change color according to their user's current emotion; in order to keep track of emotion changes we developed a system that uses the tablet featured in the Magic Room which allows to manually set children's emotions (therefore changing their bubbles flow's color). This implies that Oceania's activity has to be monitored by a supervisor/caregiver, who would have the responsibility to keep track of users' emotions and update them.
Other game elements that were added to the application are interactive items that children could use in order to produce visual results together: the jellyfish, besides visually connecting children, has different pattern figures pictured on top of its cup. Each pattern is associated to a player, who has the possibility of impacting its appearance by interactive with the following elements:

- **Starfish:** These are items which appear in the floor screen and carry different patterns. By standing enough time on top of it, a child could capture a starfish and update his/her own associated pattern by replacing the old one with the one newly collected.
- **Power-Up:** These are static items that appear in the frontal screen and can be collected by holding a hand in front of them. Upon doing so, the power-up grants the player's pattern a permanent effect that modifies its appearance.

Players can combine the effects granted by various instances of the two aforementioned elements in order to change their own pattern's appearance, which being displayed on top of the jellyfish's cup can combine with other players' patterns in order to create artistic results.

4. Evaluation

Our work has then been complemented with an explorative study, conducted over 3 male, neurotypical children which have taken part in play-testing the application. All play-testing sessions have been supervised and audio/video recorded: the collection of data has been executed on the spot by keeping track of notable behavioral signals exhibited by participants. Results have then been gathered and examined through the exploration of possible correlations between the tracked variables, in order to try and answer the following 3 research questions:

- Does a correlation between social interaction and creativity exist?
- Does a correlation between creative thinking and creative action exist?
- Does a correlation between creativity and engagement exist?

Finally, the study has been complemented with an investigation of users' feedback through the submission of a questionnaire, which participants have answered after having taken part in the experiment. The questionnaire has been created by combining three existing user feedback forms, those being:

- **User Engagement Scale** (UES - Short Form)**:** Items from this form have been imported into our questionnaire in order to weigh users' overall interest in the application.
- **System Usability Scale** (SUS)**:** Some questions from this form have been omitted in order to make the questionnaire more understandable to the target young users. This form's contribute is that of evaluating the perceived system usability.
- **Net Promoter Score** (NET)**:** The item from this form has been included in our questionnaire in order to determine whether participants would recommend trying the application out to other people.

All questions have been translated in Italian and have been slightly reworked syntax-wise in order to be as easily usable as possible. Results have then been analyzed and presented in conjunction with the study's results.

5. Conclusions and Future Work

With this thesis we proposed our newly developed Magic Room activity, Oceania, and complemented it with an exploratory study on creativity and social interaction. A future-work priority should be to expand the collected data in order to add on the current low sample size and, in doing so, better understand the analyze data.

References

[1] Mirko Gelsomini, Giulia Cosentino, Micol Spitale, Mattia Gianotti, Davide Fisicaro, Giulia Leonardi, Fabiano Riccardi, Agnese Piselli, Eleonora Beccaluva, Barbara Bonadies, et al. Magika, a multisensory environment for play, education and inclusion. In *Extended abstracts of the 2019 CHI conference on human factors in computing systems*, pages 1–6, 2019.

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