A semantic VR cognitive system to promote social cohesion through cultural heritage

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Abstract. Based on studies related to the use of Virtual Reality (VR) to increase prosocial [1] and empathic [2;3] behaviors, and in line with the H2020 SPICE project[1] ("Social Cohesion, Participation and Inclusion through Cultural Engagement"), our research employs VR technology to encourage users to adopt an alternative point of view through a virtual embodiment, in order to increase social cohesion. To this aim we have built a virtual museum where different avatars (parameterized on age, gender and nationality) can interact with experimental subjects to discuss emotional and value-driven interpretations related to works of art, aiming at bootstrapping user's *intepretation-reflection loops* [4]. Based on the results of our pilot study, which show that a VR-driven methodology fosters a sense of embodiment and maximize the social cohesion among users, we are working on an innovative real-time system based on data semantics, in order to sensitize people to other interpretations.

Keywords: Virtual Reality; Data Semantics; Social Cohesion

1. Our research

1.1 Experimental Study

Technologies can facilitate social interactions by promoting the psychological well-being of people in social contexts. In particular, the use of immersive virtual environments has proved very useful in the field of psychology for social interactions [5;6], thanks to VR tools that allow subjects to experience real situations, perceiving their own body within a simulated environment [7]. Previous studies, for example, have used VR to promote empathic behavior [2;3] and reduce violent behavior [8] or prejudice [9]. Based on these studies, we used VR in order to promote social cohesion, encouraging the user to take a different point of view through virtual embodiment. We did a pilot study on a sample of N=44 subjects, dived into two groups of N=22, with an average of 26 years old in the first group and 27 years old in the second one. In our experimental design we have simulated a visit in a virtual Museum, using *Oculus Quest*

[1] https://spice-h2020.eu

2 and *Unity Engine 3D* as software, with *Art Dot Gallery* package. We have recorded the verbal response of the users and their psychophysiological response, related to the electrodermal activity using *BioSignal Plux Kit*. We asked the users to provide information about their feeling related to three specific artworks (time 0); to listen the interpretations provided by avatars that share the scene with him (time 1); to explain their feeling, again, dressing the shoes of the avatar (time 2); and to give a free answer to the avatar's interpretation (time 3). The time 2 and 3 were counterbalanced in the two experimental groups. For our analysis we compered the user interpretation at the time 0, when the user dresses his own body, and at the time 2/3 when the user dresses the shoes of the avatar. Our results can be synthetized in 4 points: First, from the dialogue analysis our results show that in both groups the percentage of empathic people (participants that change partially or totally their interpretation when they dress another body) is greater than non-empathic people (Chi-square Analysis experiment n.1 p-level 0.007; experiment n.2 p-level 0.016)- Table 1; Second, empathic people show a decrease of the verbal reaction time during the virtual embodiment (experiment n.2 t-test analysis p-level 0.036); Third, empathic people show an increase of the electrodermal activity during the virtual embodiment, that can be understood as an index of their emotional involvement (experiment n.1 one-way ANOVA p-level 0.049); Finally, using self-report questionnaires post the VR experience, our results show an increase of the affective empathy in relation to the haptic perception (Pearson correlation r 0.339; p-level 0.025); and an increase of the cognitive empathy in relation to the realism of the verbal input provided by the avatars (Pearson correlations r 0.375 p-level 0.012)

Table 1. the percentage of empathic and non-empathic people for each artwork.

Experimental Group	Artworks	Empathic people	Non-Empathic people
	1	77%	23%
1	2	64%	36%
	3	59%	41%
	1	72%	27%
2	2	50%	50%
	3	86%	14%

1.2 Real-Time System in Virtual Reality

Based on the results of our pilot study, we are implementing a system capable of recording verbal interpretations on an external Linked Data hub and analyzing and enriching them semantically in order to guide an avatar engine in choosing what avatar to present to the user. For the implementation of our system, we have created 27 avatars, representative of different physical characteristics of world population, distinguished by age, gender and nationality and we used two automatic language inference systems, one based on Zero-Shot learning[10] and FRED, based on hybrid knowledge-based

methods [11;12] to do an emotional-value detection on the verbal response of the users. Then we collected all the verbal interpretation that we recorded during the pilot study (N=396) and the avatars in the external Data Hub. In our final application the visitor can both explain his interpretation than choose a specific emotion and moral value, from a list inside the VR environment. Based on this, the VR communicate with the Data Hub in order to take a specific avatar-audio object and present it in the VR environment. Our system uses three methodologies, that are: i) AI-based methodology, here there is an emotion detection on the verbal speech of the visitor, using automatic language inference systems; ii) User-Based methodology, here the system records the explicit emotional-value choice of the visitor, thanks to the buttons within the virtual environment; iii) random choice, it works in the worst case in which the visitor is not able to choose any emotion and moral value. In this way, our real-time application allows to the visitor to interact with specific avatars with different physical characteristic as well as with a different emotional-value interpretation. The figure 1 show the use-case diagram of our real-time application.

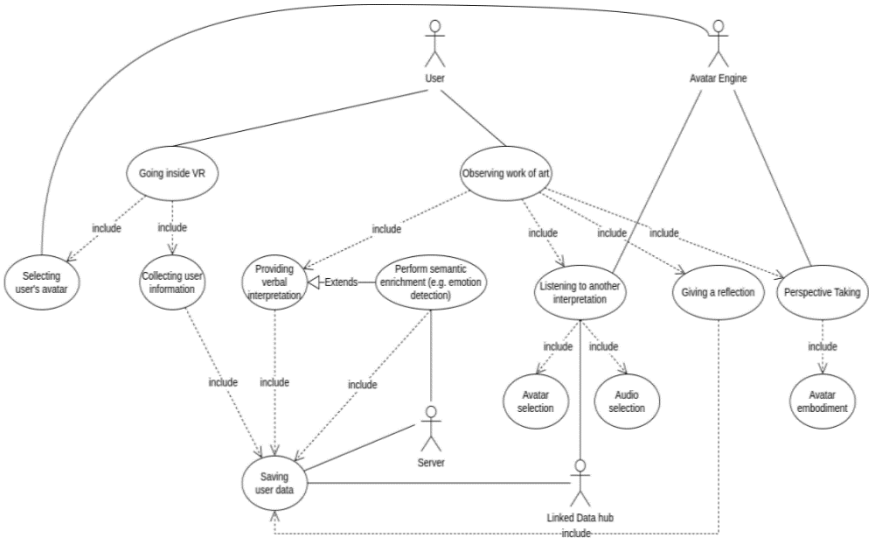

Fig. 1 Use-Case diagram of our real-time system in Virtual Reality

In conclusion, the results of our pilot study show that it is possible to use a virtual reality system, exploiting virtual embodiment, to promote social cohesion. In this line, our intelligent system could help people relate to users with different interpretations and/or different physical characteristics, trough the sharing of cultural heritage.

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