The Geminoid Reality

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Abstract. Our society is on the borderline of information era, experiencing a transition towards a robotic one. Humanoid and android robots are entering with a steady pace into our everyday lives taking up roles related to companionship, partnership, wellness, healthcare, and education among others. The fusion of information technology, ubiquitous computing, robotics, and android science has generated the Geminoid Reality. The Geminoid is a teleoperated, connected to a computer network, android robot that works as a duplicate of an existing person. A motion-capture system tracks facial expressions, and head movements of the operator, and transmits them to the robot, overriding at run-time the preprogrammed configurations of the robots actuators. The Geminoid Reality is combining the Visual Reality (users' and robot's point of view) with an Augmented one (operator's point of view) into a new kind of mixed reality involving physical embodiment, and representation, causing the ownership transfer, and blended presence phenomena.

Keywords: geminoid, android, human-robot interaction, reality, presence, teleoperation.

1 Geminoid Android Robots

Androids, due to their anthropomorphic design, are used to facilitate social interaction, and to study the human nature, while geminoids are used as research tools to examine how the presence, the appearance, the behavior, and the personality traits of a robot affects the communication with human partners [1]. The geminoid, coined from the term "geminus" meaning "twin" or "double", and the suffix "-oides" which indicates similarity, is an android robot designed, and developed to resemble an existing person (the Original), envisioned and manufactured by Prof. Hiroshi Ishiguro, ATR Intelligent Robotics, and Kokoro Inc. [1-2]. A geminoid is mimicking the external appearance (the artificial body is of similar proportion), and the facial characteristics of its Original (Fig. 1). Facial characteristics include permanent wrinkles, skin texture, skin coloration, skin pigmentation, bone structure, facial hair, hair coloration, and hair style. It is remotely controlled, with no intelligence of its own, but able to execute pre-programmed sequences of movements (subtle expressed motions such as breathing, blinking emulating the human autonomous system to maintain natural behavior), overridden at run-time by the conscious behavior controller driven by a

Fig. 1. The Geminoid|DK (left side) with its Original (right side)

motion-capture system that tracks the facial expressions, and head movements of the operator [3-4]. Movement is executed by means of pneumatic actuators inside the robot in all the geminoid versions (HI-1, HI-2, F, DK) [5]. The speech of the operator is also transmitted through the computer network of the geminoid to a speaker located either inside, or around the robot.

1.1   Entering the Realm of Geminoid Reality

While Augmented Reality refers to a real-time direct, or indirect view of a physical real-world environment enhanced with virtual computer-generated sensory [6], and Visual Reality to a constructive process formulated by evolution to guide adaptive behavior [7], the Geminoid Reality (GR) is combining them into a new kind of mixed reality that encompasses physical embodiment, and representation (Fig.2). Being present means readiness to engage, cope, and deal with the surrounding environment, but also ability to witness subjects, objects, and actions, while keeping a record of the witnessed events [8]. In GR, all the intentionality from the surrounding environment is being directed towards the android, but witnessed by the operator through a telepresence system. As long as the GR is in effect, the geminoid with its operator form a symbiont unity which creates a situation akin to mirror-touch synesthesia; a tactile hallucination triggered by observing touch to another person which enables the observer to simulate another's experience by activating the same brain areas [9 – 11]. The illusion of body *ownership transfer* felt by the operator, occurs due to the synchronization between the operation of the robot, and the visual feedback of seeing the geminoid's motion [12].

Apart from the operator, interactions with a geminoid affect also the users. The anthropomorphic appearance of the geminoid tricks the human mind by taking advantage of the same brain mechanisms that human beings use to understand other humans [13]. This conflict inside the human mind describes the notion of the *blended presence*,where the brain fails to categorize an agent that appears human, but moves mechanically. The selectivity of the human action perception system for the appearance and/or motion of a perceived agent was explored using functional magnetic resonance imaging repetition suppression, confirming the blended presence phenomenon [14].
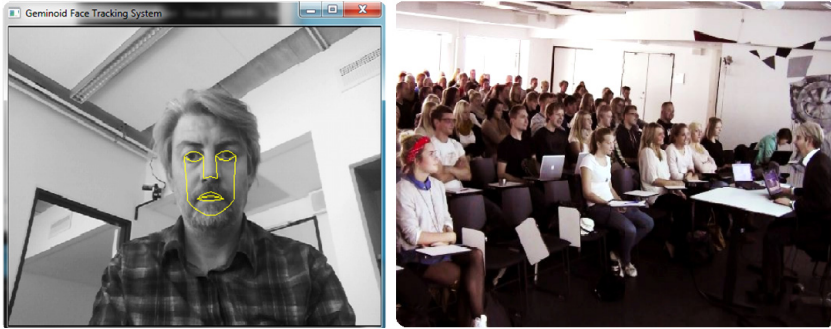
Fig. 2. Left: Augmented Reality (part of the operator's point of view). Right: Visual Reality (users' experience).

2   Interaction Scenarios and Report Evaluation Results

Despite the fact that the GR has been studied mainly inside laboratories, and research environments, its scope is to be gradually integrated into a form of Ubiquitous Intelligence, where technology is deployed in such way that it becomes an invisible part of the fabric of everyday life [15]. Placement of geminoids in real life scenarios enriches our knowledge on human-robot communication, our experience on practical implications, our database on recorded reactions of interaction partners, and our understanding on how the robot is perceived. Extending the use of GR in the real world, an observational field study on unscripted interactions between humans and the Geminoid HI – 1 was conducted in a public café in Linz, Austria, where 43 participants (out of 98), either mistook the robot for a human, or did not notice it at all, as it seemed to appear human-like [16]. Another instance, is when the Geminoid-F was used as an actor in a play, performing live on stage in theatres around the world [17]. The results indicated that androids might be better poetry reciting agents than humans, and that they can span their usage beyond a practical media interface. An experiment on how touch can be used as a way of inducing trust when interacting with an android was conducted in a typical office room, where the Geminoid|DK (in business attire dress code) was proposing a business deal to the participants [18]. Trust towards the robot was increasing when subjects were touching it before the business proposal. The Geminoid|DK also took up the role of a university lecturer and delivered a 45 minute lecture in front of 150 students at Aalborg University [19]. Overall, the robot was accepted as a lecturer, but during the lecture a change of perception regarding the geminoid has been observed. There were strong indicators that females had higher expectation concerning the geminoid's communication skills, raising an issue on the role of the gender of the robot. A noticeable detail was that several students constructed the impression that the lecturer was human, and maintained it till the end of the lecture.

A fact that all experiments share, is that at first sight, and from a distance it is difficult to tell the Original, and the geminoid apart [20]. In a questionnaire for the

evaluation of Geminoid HI-1 and its Original, participants were able to distinguish between the human, and the android stimuli, but the ratings for likeability were not significantly different [21]. Additionally, a web-based survey for rating robots (40 robots-151 participants), claimed that the Geminoid|DK was considered to be among the highly likeable and less threatening ones [22].

Different geminoid versions present different limitations in expressing/mimicking/revealing emotions through their affective interface. The Geminoid-F was found to successfully produce facial expressions of Happiness, Sadness, and Neutral Face, but failed in expressing Surprise, Anger, and Fear [20]. Alike, the Geminoid|DK reproduced all six basic emotions, but Fear and Disgust [9]. Geminoid developers should cater to accommodate the need for more actuators around the areas of the nose, the mouth, and the eyes in future geminoid versions, for a more natural, and believable interaction.

3   Conclusion

The Geminoid Reality is a very recently conceived reality, with no formulated and pre-determined boundaries, still under development, since both the field of robotics is expanding, and we -as humans- have not yet unlocked the brain mechanisms that steer our thought, and action. To sum up, the main properties of the GR could be structured around the following two distinct phases towards the robot; ownership transfer from the perspective of the operator, and blended presence from the perspective of the interaction partner.

Whether, or not, the scenarios discussed in this paper will become applications is a matter left to be discovered in the imminent future. The teleoperated, semi-autonomous, portable facility of geminoids, paves the way for many potential uses, making them possible substitutes for clerks, for instance, that can be controlled by one human operator only when non-typical responses are required [2]. Today, we count very few geminoid robots, located in very few research laboratories around the world, scattered in different continents, facts that impose a very slow pace in the GR research in contrast to other kinds of reality.

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