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Experimental Study of Human and Android Robot Communication

Bommagani Rohini

rohini.bommagani123@gmail.com

M-Tech, Department of ECE, St Mary College of Engineering and Technology

Abstract: Conduct or Appearance? This is principal issue in robot improvement. To be specific, the conduct as well as the presence of a robot impacts human-robot collaboration. There is, in any case, no examination way to deal with handling this issue. Keeping in mind the end goal to express the issue, we have built up an android robot that has comparative appearance as people and a few actuators creating miniaturized scale practices. This paper proposes another examination heading in light of the android robot.

1 Introduction

Lately, there has been much innovative work of astute accomplice robots that can collaborate with people in every day life, for example, Sony AIBO and Honda ASIMO. In this exploration, correspondence between the robots and people is stressed as opposed to mechanical robots performing particular errands. In the interim, the insight of a robot is a subjective wonder that develops amid human-robot collaboration. It is, in this way, fundamental to uncover a guideline of human-robot and human-human correspondence, that is, a standard of cooperation for building up a accomplice robot and understanding its insight. A few analysts have handled this issue. For instance, Kanda et al. [1] and Scheeff et al. [2] assessed how the conduct of their robots influences human-robot connection by watching their collaboration. These works have slowly uncovered the impacts of robot conduct on human-robot connection. There is, be that as it may, a plausibility that mechanical appearance twists our translation of its conduct. The presence of the robot is basically one of its capacities; thusly, the impact of appearance must be assessed autonomously. It is for the most part hard to segregate the impacts of a robot's conduct from those of the robot's appearance which is different from people. One approach to separate is building up a robot whose appearance is the same as people. This paper proposes another examination heading to handle a basic issue of a robot conduct and appearance utilizing a robot called an android which has comparative appearance to people. To express the issue, we shape an essential theory about the impact of a robot's conduct and appearance utilizing existing learning picked up from inquire about or viable experience. In addition, we configuration tests utilizing the created android. This examination is right now in advance and just preparatory exploratory

comes about have been acquired. In this paper we depict the speculations and the created android, lastly display brief aftereffects of preparatory examinations. Whatever is left of paper is sorted out as takes after. Segment 2 and 3 portray our exploration objective what's more, speculations. Segment 4 presents the android robot produced for this inquire about. Area 5 demonstrates brief consequences of the trials to watch conduct of subjects while collaborating with the android. At long last, Section 6 presents conclusions.

2 Purpose and Approach

We will probably make an outline strategy of robot conduct and appearance to acknowledge normal correspondence amongst robots and people. Our approach is to frame a theory about the impacts of conduct and appearance on cooperation and inspect the theory in a mental examination. Kanda et al. [1] researched the impacts of intuitive conduct utilizing a humanoid robot named "Robovie" [3]. It is, notwithstanding, conceivable that the outcomes rely upon the appearance of Robovie on the grounds that its automated appearance impacts the collaboration. In the mental field, Johnson et al. [4] revealed that babies took after the look of a novel question that had facial highlights and unexpected intelligence and did not take after an protest that did not have facial highlights or unforeseen intelligence. As per this confirm, obviously the impact of a robot's appearance can't be disregarded. There is a base up way to deal with handle the "conduct versus appearance issue," in which the cooperation is assessed while incrementally upgrading the conduct or then again appearance of the robot. In any case, there is likewise a best down approach, in which we at first form a robot which has an indistinguishable movement and appearance from people and assess the communication while expelling some part of conduct or appearance. To utilize the later approach, we present an android robot that has a comparable appearance as people. McBreen and Jack [5] assessed some human-like specialists which were made from human photorealistic pictures in an e-retail application (a home furniture benefit). The outcomes demonstrate that the discussion with the video specialist is thought to be more normal than the discussion with the other operator (e.g., a 3-D talking head, a still picture with outward appearances, a still picture). This work proposes that the nearby similarity to people evacuates the impact of the robot's divergent appearance and empowers an examination absolutely of the impact of conduct. Contrasting the outcomes with the android and other humanoid robots, the impacts of conduct also, appearance are removed freely. In conventional robot look into, the outline of a robot appearance has been depended to an imaginative creator and not had a building meaning. In any case, the robot's appearance can be outlined in light of the building philosophy from our outcome. In this exploration, it is important to assess human conduct in the communication with the android. There are subjective and quantitative strategies to assess. Kanda et al.

[6] utilized a subjective technique by estimating the mental states of mind of individuals.

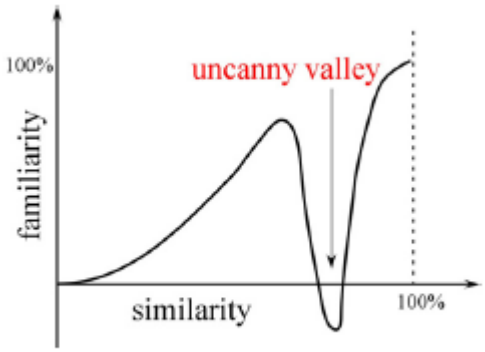

Fig. 1. uncanny valley

using the semantic differential method (SD). However, it is difficult to prepare opposite pairs of adjectives in a questionnaire to obtain a result that is explicable.Some researchers quantitatively evaluate human behaviors. For example, Matsuda

et al. [7] investigated the brain activities of people who were playing a video game using Near-Infrared Spectroscopy (NIR). Kanda et al. [8] quantitatively evaluated behaviors of people who were in communication with Robovie using the motion capture system and eye mark recorder. According to these studies, we employ the quantitative method using a motion capture system and eye mark recorder.

3 Hypotheses about Appearance and Behavior

Mori [9] said the connection amongst recognition and similitude of robot appearance what's more, movement to people. Recognition of a robot increments with its similitude of appearance and movement until a specific point, when an inconspicuous blemish of the appearance what's more, movement ends up terrible (Fig. 1). This sudden drop is called an "uncanny valley." In the figure, appearance and movement are assessed on a similar hub. It is, be that as it may, not generally the case that they are assessed in a similar way. We speculate that robot's appearance and conduct autonomously impact human-robot communication. In particular, an indistinguishable conduct can distinctively impact if the appearances are changed. As for robot's appearance, our theory is the accompanying: − The assessment of association increments with closeness of robot's appearance. At the purpose of nearly similarity to people, there is a valley like "uncanny valley" as appeared in Fig. 2 (a). The profundity of the valley diminishes with multifaceted nature of robot's conduct.

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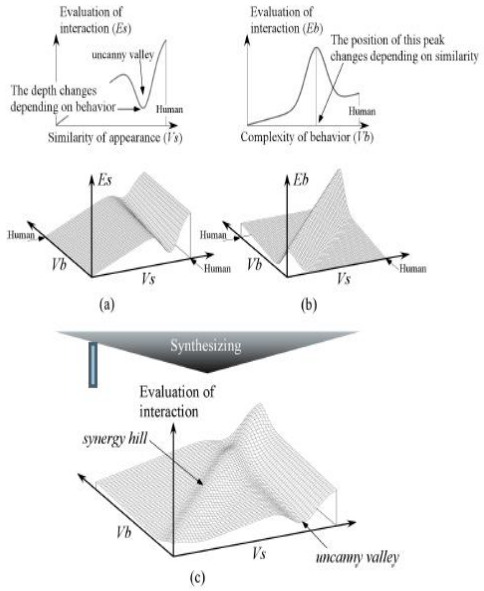

Fig. 2. There are two factors that influence interaction: behavior and appearance. (a) An evaluation of interaction plotted against similarity of appearance. There is uncanny valley. (b) An evaluation plotted against complexity of behavior. There is a peak means synergy effect of appearance and behavior. (c) Synthesized evaluation. There are two features: "uncanny valley" and "synergy hill." Actually, each variable cannot be represented in one axis.

Goetz et al. [10] proposed the "matching hypothesis" that the appearance and social behavior of a robot should match the seriousness of the task and situation and examined it in a psychological experiment with the Nursebot robot, "Pearl." The result suggests that human-like behavior does not always make a good impression and that the robot's appearance determines what behavior is appropriate. We hypothesize that there is a synergy effect of a robot's appearance and behavior. − The evaluation increases with the complexity of the robot's behavior. At the point of matching robot's appearance, there is a synergy effect of appearance and behavior shown as a peak in Fig. 2 (b). Synthesizing two hypotheses, the evaluation of interaction is qualitatively represented as Fig. 2 (c). The robot's uncanny appearance is mitigated by its behavior if the behavior closely resembles that of humans.

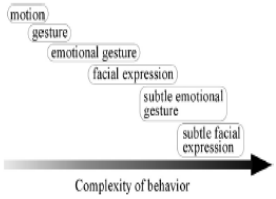

Fig. 3. Hypothesis about complexity of behavior. Subtle emotional behaviors including facial expressions are human-like behaviors.

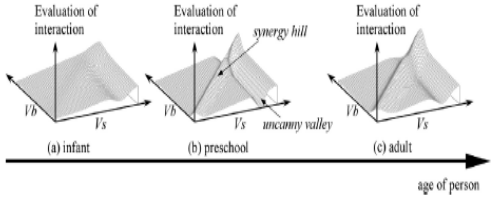

Fig. 4. Hypothesis about person's age.

Numerous elements impact the many-sided quality of conduct. One of them is feeling. In general, one feels disappointment in speaking with a man who keeps a straight confront. It appears to be uncontroversial to expect that enthusiastic conduct including facial articulations is human-like conduct. Fig. 3 demonstrates the theory about the many-sided quality of conduct. A basic movement purge of importance is less unpredictability, and an unpretentious enthusiastic signal and outward appearance have high many-sided quality and like human conduct. In the above, we center around the qualities of a robot. The properties of a man (e.g., age and sexual orientation) collaborating with a robot impact the association. To look at a subject's response at various ages, two or three newborn children under 13-months old and preschool youngsters from three to five

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years of age coordinated toward the created android. Thus, newborn children appeared to be pulled in by the android. Be that as it may, youngsters were apprehensive of the android initially and unwilling to confront it. The conduct of kids is clarified as far as Mori's "uncanny valley." The outcome recommends that the uncanny valley appears to change attributable to individual's age. As for individual's age, we guess as takes after:

− The uncanny valley becomes the deepest in early childhood and shallower in adulthood.

− A synergy hill (see Fig. 2) becomes the steepest at younger children and smoother at adults. Fig. 4 illustrates the hypothesis. We will next form hypothesis about other attributes.

Fig. 5. The developed android robot named "Repliee R1." Left: External appearance. Upper Right: Head appearance. Lower right: Head appearance with eyes closed.

Fig. 6. The skeleton of the android.

4 The Developed Android Robot

Fig. 5 demonstrates the android robot named "Repliee R1" that is created as a model. To show up nearly take after people, we made a shape of a young lady, what's more, we painstakingly picked a sort of silicon that would influence the skin to feel human-like. The appearance is a five-year-old Japanese young lady. The model has nine DOFs in the head (five for the eyes, one for the mouth and three for the neck) and numerous free joints to make a stance. The actuators (engines) are altogether implanted inside the body. The touch sensor utilized as a part of the android is a strain rate drive sensor. The system is like human touch seeing that it distinguishes touch quality while the skin is twisting. The android has four touch sensors under the skin of the left arm (Fig. 7). As it were four sensors can gauge the touch quality everywhere throughout the surface of the left arm. These material sensors empower different touch correspondences. The android appeared above is created as a model. Later on, we will actualize an android with an indistinguishable number of joints from people, material sensors covering the entire body, vision sensors, and sound-related sensors.

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Fig. 7. Skin, inside body, and tactile sensors. Space between skin and skeleton is filled with urethane foam, which can be replaced with other mechanism.

5 Preliminary Experiment

5.1 Study of Gaze Behavior

For a quantitative assessment of communication, we explored eye movement of individuals

amid a discussion with the android. An assessment of semi-oblivious conduct for example, eye movement can uncover actualities that don't show up in subjective assessments, such as a poll test. We anticipated that look conduct would change inferable from the similitude of a robot's appearance and the intricacy of its conduct amid correspondence. To test the expectation, three sorts of performers (conversationalists) were readied: (A1) a human young lady, (A2) the android with eye, mouth, and neck movements, (A3) the still android. The young lady was a five-year-old Japanese young lady and was not bashful with outsiders. Subjects were 18 Japanese undergrad and graduate understudies. There were 10 guys what's more, 8 females. A subject had a concise discussion with every performer in arbitrary request with substitutions aside from barring. To control the discussion, we composed the following content.

Conversation Script (an English translation)

Actor: Hi, I'm [name].
Subject: [answers]
Actor: Let's play together! I'll give you a quiz. Are you ready?
Actor: What is a word starting with [any alphabetic character]?
Subject: [answers]
Actor: That's right! Well, what is a word starting with [any alphabetic character]?
Subject: [answers]
Actor: No! Well, then, what is a word starting with [any alphabetic character]?
Subject: [answers]
Actor: That's right! That was fun! Bye-bye!
This is just an example content. The request of the robot's certain and negative reactions may contrast. The discussion was held in a little room parceled by a drape (Fig. 8.) The experimenter behind the blind controlled responses of the android. A speaker delivered the prerecorded voice of the android. A2 moved its mouth while

Fig. 8. Experimental room. A subject mounting an eye mark recorder has a brief conversation with the android (Left) and the girl (Right.)

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talking and once in a while flickered and moved its neck, however A3 was stationary notwithstanding when it was talking. An eye check recorder (NAC EMR-8) estimated the eye movement with the rate of 30 Hz. We characterized a look obsession as a look settled for in excess of four casings (133 msec) furthermore, tallied the recurrence that the subject focused on the performing artist's eyes (counting glabella), nose and mouth in every discussion. Toward the finish of the investigation, the subject addressed an open poll about his or her impression of the on-screen character.

5.2 Results

Fifty-four discussions (18 subjects × 3 performing artists) altogether were held. Ten information were discarded attributable to much location mistake. Table 1 demonstrates the mean frequencies of the subjects' obsession falling on the performing artists' eyes, nose, and mouth. A restricted ANOVA demonstrated that there was a critical distinction ($F = 3.32$, $p < 0.05$) between performing artists as for the recurrence of obsession falling on the eyes and no huge distinction regarding the nose and mouth. Moreover, a t-test demonstrated that there were noteworthy contrasts amongst A1 and A2 ($t = 3.10$, $p < 0.005$) and A1 and A3 ($t = 2.45$, $p < 0.05$) regarding eyes. Fig. 9 demonstrates the circulations of obsession focuses that fell on the substance of the android and young lady. Brighter focuses demonstrate high recurrence of obsession. The outcome demonstrates that subjects take a gander at the android's eyes more regularly than girl's, albeit Japanese individuals have a tendency to dodge eye to eye connection attributable to social reasons [11]. The subject's psychological state may clarify contrasts in look conduct [12, 13]. One plausibility is to expect that the subjects attempted to accomplish common comprehension.

Table 1. Mean frequencies of fixation per second (standard deviations in parentheses).

	A1	A2	A3
Eyes	0.30 (0.059)	0.92 (0.57)	0.82 (0.52)
Nose	0.085 (0.013)	0.15 (0.016)	0.13 (0.016)
Mouth	0.0014 (3.2×10^{-6})	0.0029 (1.3×10^{-5})	0.0017 (4.7×10^{-6})

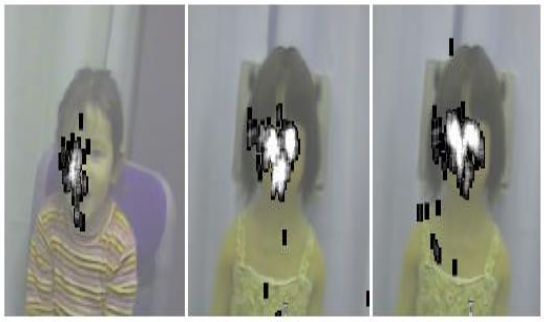

Fig. 9. Distribution of fixation point fell on the girl (Left), android A2 (Middle) and android A3 (Right). Brighter point means high frequency of fixation.

Numerous subjects felt imitation of the android's eye development instead of mouth development. It was found from the outcome that how subject's look at the android, particularly at its eyes, varies from that at people. This outcome is critical, on the grounds that it is conceivable that the distinction in the impact of the robot's appearance and conduct on human-robot correspondence is assessed by estimating the member's look point as well as the subjects' look point in human-human correspondence. A human look is a semi-oblivious conduct

and mirrors a shrouded factor which can't act naturally revealed. It is normal that estimating look conduct would discover an impact of a robot's appearance what's more, conduct that would not show up in the responses to a survey.

5.3 Discussion

We anticipated that there was a distinction in the subjects' look conduct between A2 what's more, A3. In opposition to our forecast, there was no critical distinction. The outcome demonstrated that the irregular eye covers and neck movement and mouth movement synchronized with voice did not impact the discussion with the android. It is viewed as that the test was inadequate in a few presumptions. This segment talks about further speculations about the android's appearance and conduct from the perceptions of look conduct and replies to the survey.

Uncanny valley

Numerous subjects said that simulation of the android's appearance, conduct what's more, unevenness amongst appearance and conduct on the poll. The phony of eye movement specifically may cause an expansion in the quantity of obsessions with the android's eyes. Moreover, the high recurrence of obsession could speak to the uncanny valley appeared in Fig. 2. To look at this forecast, it is important to learn regardless of whether subjects give less obsessions with a robot that has automated appearance, such as ASIMO. We speculate that the recurrence of obsession speaks to the assessment of correspondence, and the assessment fluctuates contrarily with the recurrence.

Eye contact

A few subjects said that they couldn't look at the android. It is viewed as that the absence of eye to eye connection causes the uncanniness. Some mental scientists demonstrate that eye to eye connection can serve an assortment of capacities (e.g., [12, 13]) in Fig. 9. Circulation of obsession point fell on the young lady (Left), android A2 (Middle) and android A3 (Right). Brighter point implies high recurrence of obsession.
human-human correspondence. It is assessed that eye to eye connection and the android's appearance work synergistically to improve correspondence. To find out this, we will contrast and a robot that has a mechanical appearance and no eye to eye connection conduct.

Contingent motion

One subject addressed that the android with movement (A2) was more uncanny than the still android (A3) in light of the fact that the movement was not unforeseen. Another subject specified that rehashing same conduct of the android was unnatural. It is conceivable that the absence of the unforeseen android's movement (A2) had no effect amongst A2 and A3 in the outcome. As portrayed in area 2, an unexpected movement of nonhuman question shifts a newborn child's state of mind [4]. It is assessed that an unexpected movement of the android gives an impact that works in cooperative energy with its human-like appearance.

Involuntary waving motion

One subject said that it was uncanny that the android (A2) was moving as it were the head however human questioner (A1) was continually moving the entire body marginally. Miyashita and Ishiguro [14] demonstrated that the slight automatic waving movement of a humanoid robot makes its conduct more normal. It is very likely that a slight automatic waving movement of the entire body appears to be vivify living. To express that the automatic movement gives a cooperative energy impact, be that as it may, it is important to think about the android and different robots.

Habituation effect

Every one of the subjects in the test were just the individuals who saw the android for the first time. At the end of the day, they were not acquainted with the android yet; in this manner, the habituation impact can't be disregarded. Some subject addressed that they were shocked at the android in the primary discussion yet acquainted with it in the second discussion. The greater part of their look conduct demonstrated that the recurrence with which obsession fell on the android's eyes in the second discussion diminished from that of the primary discussion. Habituation to the android appears to change the connection. In segment 3, we guessed that individual's age changes the human-robot collaboration. We should, in any case, explore the fleeting (request of minutes or hours) change of cooperation.

6 Conclusion

This paper has proposed another exploration bearing in light of the android robot to uncover a standard of human-robot communication. An assessment of this communication is obstructed by the trouble of confining the impact of conduct from that of appearance. The presence of the android, be that as it may, may diminish the impact of robot appearance. Moreover, this exploration gives a strategy for robot plan, which had already been endowed to a masterful creator. This paper has demonstrated the principal theories about the impacts of robot conduct what's more, appearance on human-robot association and the preparatory tests to watch human responses to the android. We are still in the advance of shaping more point by point theories and planning tests.

References

1. Kanda, T., Ishiguro, H., Ono, T., Imai, M., Mase, K.: Development and Evaluation of an Interactive Robot “Robovie”, *IEEE International Conference on Robotics and Automation* (2002) 1848-1855

2. Scheeff, M., Pinto, J., Rahardja, K., Snibbe, S., Tow, R.: Experiences with Sparky, a Social Robot. *Workshop on Interactive Robot Entertainment* (2000)

3. Ishiguro, H., Ono, T., Imai, M., Kanda, T., Nakatsu, R.: Robovie: an Interactive Humanoid Robot. *International Journal of Industrial Robot*, Vol. 28, No. 6 (2001) 498-503

4. Johnson, S.C., Slaughter, V., Carey, S.: Whose Gaze Will Infants Follow? Features that Elicit Gaze Following in 12-month-olds, *Developmental Science*, Vol. 1 (1998) 233-238

5. McBreen, H.M., Jack, M.A.: Evaluating Humanoid Synthetic Agents in E-Retail Applications,*IEEE Transactions on Systems, Man and Cybernetics-Part A: Systems and Humans,*Vol. 31, No. 5 (2001) 394-405
6. Kanda, T., Ishiguro, Ishida, T.: Psychological Analysis on Human-Robot Interaction, *IEEE International Conference on Robotics and Automation* (2001) 4166-4173
7. Matsuda, G., Hiraki, K.: Frontal Deactivation in Video Game Players, *Annual Conference of International Simulation and Gaming Association* (2003) 799-808
8. Kanda, T., Ishiguro, H., Imai, M., Ono, T.: Body Movement Analysis of Human-Robot Interaction, *International Joint Conference on Artificial Intelligence* (2003) 177-182
9. Mori, M.: *The Buddha in the Robot*, Charles E. Tuttle Co., Japan (1982)
10. Goetz, J., Kiesler, S., Powers, A.: Matching Robot Appearance and Behavior to Tasks to Improve Human-Robot Cooperation, *IEEE Workshop on Robot and Human Interactive Communication (2003)*
11. Axtell, R.E. (Ed.): *Do's and Taboos Around the World*, John Wiley & Sons, New York (1993)
12. Argyle, M.: *The Psychology of Interpersonal Behaviour*, Penguin Books, London (1967)
13. Argyle, M., Cook, M.: *Gaze and Mutual Gaze*, Cambridge University Press, London (1976)
14. Miyashita, T., Ishiguro, H.: Natural Behavior Generation for Humanoid Robots, *IEEE International Conference on Humanoid Robots* (2003)