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研究課題名（和文）Metamorph robot for deep study in social human robot interaction

研究課題名（英文）Metamorph robot for deep study in social human robot interaction

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研究成果の概要（和文）：ロボットの受容は、人間-ロボット相互作用（HRI）において極めて重要である。 受け入れのない相互作用は不可能であり、ロボットは役に立たない。 ロボットの設計と能力は受け入れにおいて重要な役割を果たすことが知られている。 HRI研究に使用されるフレームワークを提案する。 小さな人型ロボットを構築して、見た目や能力を簡単に変えることができ、ロボットは、超音波モーターによって駆動されるスケルトンと、3Dプリントされた変更可能なスキンまたはシェルで構成されている。 システムの単純な組み立てと高い運動能力は、HRI研究には十分適しており、広く受け入れられているソーシャルロボットの開発に貢献している。

研究成果の概要（英文）：Robot acceptance（受容）is crucial in Human-Robot Interaction （HRI）, Without acceptance interaction is not possible and robots are useless. It is known that robot’s design and ability play an important role in acceptance. In this project, we propose a framework to be used in HRI study. We build a small humanoid robot which ap-pearance and ability can be changed easily. The robot consists in a skeleton driven by ultra-sonic motors, and a 3D-printed changeable skin or shell. The simple assembly of the system and its high motion ability is perfectly adequate for HRI studies, and con-tributes to develop widely accepted social robots.

研究分野：　robotics

キーワード：　HRI　robot　design

１．研究開始当初の背景

Human-human social interactions often happens with some feeling of ambiguity, especially in a first encounter. In human-robot interaction (HRI), the question of social acceptance and “intui-tive” and “successful” interaction is crucial since the difference between humans and robots is fundamental. Yet, humans expect intuitive and easy exchanges when interacting with robots, even at first encounter. This is what defines the sociability of robots (Brayda and Chellali, Int. J. of Social Robotics (2012)).

The quality of an HRI depends strongly on the robot: its appearance, its abilities, its features and autonomy. Bartneck et al. (Int. Symp. on Robot and Human Interactive Communication (2009)) argue that further research is needed to understand and determine which aspects, degrees of likeability and of similarity between humans and robots are required to enable empathic and intuitive HRI. The variety in humans, in robots and in possible encounters, makes the study of HRI extremely complex and needed.

The concept of the uncanny valley described by Prof. Mori (Energy (1970)) and the concept of familiarity studied by Kamide et al. (European Congress of Psychology (2013)), are often used to evaluate the effect of robot design in HRI. However, their approaches were not conducted with real robots, but only by showing images of robots of different design and ability. This biases their results by the lack of realistic scenario and involvement of participants.

２．研究の目的

This project aimed at fabricating a small size “metamorph” humanoid robot: with changeable design and adjustable ability to provide a platform to study the effect of robot design and robot ability during HRI.

This robot consists in a mechanical skeleton (see Fig. 1) using super safe ultra-sonic motors, (see Fig. 2), developed by our colleague and partner Prof. Toyama (**特願** 2001-254243;**特願** 2001-372338). On top of this skeleton “skins” or “shells” of different design: color, material, shape are 3D-printed and assembled on the robot, allowing to change easily the design, just as changing a mask.

３．研究の方法

Our research plan was divided in three main tasks: design & assembly－design of the outer-shell. The design & assembly task consisted in building up the skeleton of the robot’s head and the motion controller. It was the task in which our co-investigator was mainly involved. The design of the outer-shell consisted in generating a design patterns that takes into account the skeleton and to create multiple outer designs and print them in 3D. Finally, the testing consists in trying our concept in HRI study on user acceptance of the robot depending on its design. One original and important part of our research plan was the transfer of competences from our co-investigator so that we can independently use the ultra-sonic motor technology to develop humanoid robots for HRI studies in the future.

４．研究成果

We built a robot head and tested different design and movements using ultra-sonic motors and 3D printed robot parts. We also used other design prototyping methods to guaranty lighter parts that could adequately work with the ultra-sonic motors low payload as can be seen in the *Figure 1* below. The different built systems were tested in a user experiments where participants were asked to rate their impression of the robot. The results show that the shape, the color, the movement influence the perception of the robot. Robot heads in bluish colors were more easily accepted than that of reddish colors. The first steps for constructing metamorph robots are now ready.

Figure 1: Example of robot head built

and mounted on the ultrasonic motor

In addition, we conducted experiments on HRI to study how people perceive a robot and how it is possible to predict the acceptance of a robot based on another robot with different robots. We also conducted experiments in robot's acceptance in kinder garden. Our experiments show that the robot perception of a commercial robot can be changed completely depending on the robot behaviors and its ability to convey life. The results also show that perception vary with age. Smaller kids tended to objectify more the robot while elder kids tended to more personalized it.

We also studied how participants reacted to the robot in different types of experimental conditions where the movement was changed, and we shoed that participants were significantly affected by the change of movement unconsciously. In particular when the robot was doing "sad" movement and "happy" movements. In particular their perception of the robot animacy and humanness as well has trust was changed. Finally, the distance to which the approach the robot when interacting with it was also changed.

Our findings support our idea that the robot design and movements both are of equal importance and that they cannot be decoupled. Further study to understand this coupling should be done.

５．主な発表論文等
（研究代表者、研究分担者及び連携研究者には下線）

〔雑誌論文〕（計　4 件）

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IV.

〔図書〕（計　0 件）

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○出願状況（計　0 件）

名称：
発明者：
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〔その他〕
ホームページ等

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