

**Replicating Human-like Proxemics Behavior in
Approaching Mechanisms of a Domestic Service
Robot**

Samarakoon Mudiyanseleage Bhagya Prasangi Samarakoon

(178061N)

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

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Samarakoon Mudiyanseleage Bhagya Prasangi Samarakoon

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Thesis submitted in partial fulfillment of the requirements for the degree of
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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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S. M. B. P. Samarakoon

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Date:

The above candidate has carried out research for the MSc thesis under my supervision.

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Dr. A. G. B. P. Jayasekara

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Date:

Abstract

Development of intelligent service robots is a growing research area within the field of robotics. Service robots have been developed to enhance the living standard of people. Users of these service robots are not experts in robotic domain. Hence, they prefer to have human-friendly features in these service robots. These service robots often need to navigate toward their users when accomplishing service tasks demanded by users. Therefore, the ability of a service robot to approach a user in a human-friendly manner would increase the rapport between the user and the robot.

This thesis work has been conducted to enhance human-robot interaction by establishing novel approaching mechanisms that are capable of determining the proper termination distance and direction of a service robot with respect to a user based on the physical behavior of the user. The natural approaching behavior of humans has to be studied in order to implement such human-like navigation abilities in service robots. Therefore, a human study has been conducted for identifying the approaching behavior of a third person toward two persons who are having a conversation. According to the statistical outcomes, the interpersonal distance between the user and the robot at the termination position of an approach does not significantly depend on the positioning of the two persons who are having a conversation. The outcomes of this human study are used to develop the algorithm of the Approach Planner (AP) of the robot in such a way that it can replicate the identified human tendencies to a greater extent. This AP has been implemented on MIRob platform and experiments were conducted by a way of a user study in order to test and validate the behavior of the proposed AP. The experimental results validate that the proposed approaching method of the robot is capable of maintaining the satisfaction of the users during approaches.

The approaching proxemics of a service robot should depend on the physical behavior of a user. In this regard, the thesis proposes a method to decide the approaching proxemics based on the physical behavior of a user. A fuzzy interference system has been designed to decide the proxemics based on the user behavior identified through body parameters. This leads to an effective interaction mechanism initiated by a robot in such a way that the approaching scenario looks more human-like. Experiments were conducted in an artificially created domestic environment and experimental results of the proposed system have been compared with results of a human study. It was found out that the proposed concept is capable of adaptively deciding the approaching proxemics in a human-like manner by assessing the dynamic user behavior.

Keywords-Service robotics, Human-robot interaction, Human-centered robotics, Human-friendly robotics, Human-like behavior, Robot approaching, Proxemics

DEDICATION

To my family

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