

Summary of Doctoral Dissertation

Title of Doctoral Dissertation: Research on an Intelligent Transformable Phone Robot: BaBi

Name: **LIU Jiansheng**

Robots are becoming more widespread. In recent years, products and researches that utilize smartphones as parts of robots have been actively promoted. With the increases in the interface boards and sensing, a smartphone with great computing power can perform complex tasks, and it has been a familiar device in our life. However, the availability of humanoid robotics which provide multimodal interactions and varied express, lags behind the smartphones. Therefore, we can use smartphones to facilitate the robot applications development and reduce hardware costs.

This paper proposes an intelligent transformable phone robot named BaBi and develops its prototype. BaBi equips a smart phone, transforms from the smart phone to a movable robot when calling, “open”, and performs more varied express to extend current smart phone functionality to be far-field, context-driven and multimodal interactions. This paper proposes a new robot form that can establish both autonomous mobility and portability, and presents the implementation of the proposed transformable robot. We have developed a semiconductor chip that controls wheels and servomotors of the proposed robot shape to reduce the robot footprint about the same as a smartphone. A preliminary questionnaire survey has been conducted to investigate the effectiveness of the proposed robot form. BaBi is a portable, transformable, movable, intelligent partner.

This paper also presents an interactive method for designing robot facial expressions and motions of the phone robot BaBi. Designing an objective function to evaluate facial expressions and motions suitable for BaBi with an original structure is quite hard although users can easily imagine favorite motions. Therefore, the proposed method employs Interactive Evolutionary Computation (IEC) in addition to general optimization. It is an IEC process when users make candidate selections, while it is a non-Evolutionary Computation (non-IEC) process when users do not make any selection, resulting in being a fusion of IEC and non-IEC. Experimental results have shown that the proposed method produces the robot motions effectively.

Chapter 1 presents the background of this paper and the target problems. The features, originality, and main contributions of the proposed robot compared to existing phone robots are described. The differences between the previous methods and the IEC and non-IEC fusion method for designing the facial expressions and motions of the robot are also described.

Chapter 2 begins with the related research. First, it gives a brief outline of the related research for the phone robots. Then, IEC methods used in previous studies and this study are explained.

In Chapter 3, the key idea and design for the proposed robot BaBi are described.

Chapter 4 presents the implementation. First, the implementation architecture of the proposed robot is presented. Then, the functions of the robot are described, where we prototyped a set of interactions and scenarios that users would be able to engage with.

Chapter 5 describes the IEC and non-IEC fusion method for designing the facial expressions and motions of the robot, where the basic ideas of the proposed method, the structure and process flow, chromosome representations, estimation of user evaluation value by case-based reasoning, and user interface are presented.

Chapter 6 presents the evaluation results. The evaluated usability results show a high tendency of positive results, where 67% - 90% of the participants very agree or agree with the scenarios. For ICE and no-ICE fusion method, experimental results have shown that the proposed method helps users to design robot motions with less workload.

In Chapter 7, the results of this study were summarized for Chapters 1 to 6 described so far.