Chapter 3
Task Analysis and Motion Generation for Service Robots:
With Reference to Region Segregation and Path Generation for Robotic Ironing

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ABSTRACT

This chapter is to summarise research in the direction of domestic service robots particularly with reference to robotic implementation of ironing process. The chapter presents the garment handling and ironing from a procedural point of view and discusses the devices for handling. The handling is categorised into several steps with common handling operations, resulting in categorisation of gripping and handling devices with potential applications to domestic automation. Based on this, ironing paths are explored with an orientation-position representation. This is followed by the introduction of development of folding and unfolding and by the region segregation based garment folding. This involves path analysis, folding algorithms, and mechanisms review for ironing. The paths produced from the ironing process are presented with mathematical models to be possibly implemented in robotic automation and their orientation is presented, dependent on the regions of garment. The orientation analysis is useful in finding the similarity in motion to determine the effective and efficient way of ironing a garment with orientation region diagrams and workspace presentation.

INTRODUCTION

Though science fiction writers and optimistic marketing campaigns in the 1950s predicted that we would have robots helping us around the home, robots are only now becoming familiar to people. In particular, robots are set in the very near future to become increasingly familiar companions in homes and will help us out with cleaning, security, and entertainment.

Robots will take over tasks like mowing lawns, vacuuming, cleaning pools, and washing windows. As companions, robots will become net-based

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family ones completed with educational functions, home security, diary, entertainment, and message delivery capability. The former is developed by a number of small companies and can only carry out a simple and uncomplicated single task. The latter are developed in Japan and Korea as sophisticated humanoid robots.

These humanoids are expensive and at the extreme of the entertainment markets, little has been developed into a home market. Further, some special task-targeted robots do not have multitasking modes. The challenge is a domestic reconfigurable robot (Dai, et al., 2009a) or service robots that can handle most delicate work.

One of the major functions of service robots is to implement domestic automation and autonomy to generate smart home or intelligent home. With the fast expansion of computer technology and the enhancement of living standard, most domestic electrical appliances have been upgraded to an advanced and intelligent level, but for many hundreds of years, the conventional ironing has never been changed as a domestic chore. The domestic iron is still little more than a temperature-controlled flat iron, requiring time-consuming and sometimes strenuous manual operation.

Ironing is usually seen as an unavoidable task and the dullest chore in our domestic work. In a typical household, several hours are spent every week on ironing clothes. In an EPSRC (Engineering and Physical Science Research Council of UK) project of studying the feasibility of robotic ironing (Dai & Taylor, 2003; Taylor & Dai, 2003), focus groups were set up and a systematic survey was carried out (Stewardson, et al., 2003). 70% of the people cited it was an unavoidable chore whilst 90% among these strongly disliked ironing and 30% relied on some entertainment to distract them from the boring task. With the sluggish progress and superficial changes of ironing products, 85% of them look forward to the revolutionised automatic ironing devices. It is quite clear that there is a tremendous potential market.

There is a need (Dai, et al., 2004; Taylor, et al., 2004) to integrate these techniques and to investigate necessary ironing techniques for domestic use and a need to develop a domestic robotic ironing machine. Most tasks of ironing involve garment gripping and handling and require flexible mechanisms which shall complete all tasks. A consequence of this presents momentous challenges to ironing process and provides significant technological challenges for robotics.

In these tasks, there is a need for identifying garment items and for implementing folding algorithms, and a need for developing dexterous mechanisms for garment handling and manipulation.

This chapter is to reveal the garment handling and ironing process in a procedural point of view, to identify the ironing paths and to present the region segregation in folding analysis. The chapter presents a foundation for development of robotic ironing.

GARMENT HANDLING AND IRONING

Handling

Garment handling for ironing is a process of flattening garment panels and sharpening garment edges and pleats with the aid of heat, moisture (usually as steam) and pressure. The process is to deform or reform fibres and fabric in order to achieve the effect intended by the wearer (Paraschidis & Fahantidis, 2000). The main actions of the handling during the ironing process may include spreading out, aligning, turning inside out, and folding as follows:

- Fetching a garment;
- Stretching and spreading out the garment;
- Pre-aligning the seams;
- Placing one part of the garment on an ironing board;