

Preface

As the world's population exponentially grows, consumption rates and the demand for new products also increase dramatically. As a consequence, a great number of end-of-life (EOL) products are continuously being disposed of, leading to a number of environmental problems. Responsible EOL treatment—which may include reusing, recycling or remanufacturing products or parts—is desirable in dealing with these disposed products. These processes can be beneficial both environmentally and economically. Waste is minimised, while valuable components and materials are recovered.

The *disassembly of products* is one of the primary steps of EOL treatment processes, and involves the extraction and segregation of the desired components, parts or materials from the product. Disassembly does not only input towards EOL treatment, but also allows the repair and maintenance of products. However, most of this process is economically infeasible due to time consumption, process difficulty and expensive labour costs. Consequently, the option of disassembly is often ignored in industry.

Replacement of human labour by automation has been successful in increasing the cost-effectiveness of many industries, especially manufacturing and production processes. Therefore, the implementation of an automated system in the disassembly process is considered as one possible solution. However, the disassembly process involves a number of challenging problems and cannot be considered as the reversal of the assembly process. A number of difficulties arise due to three main aspects: the physical uncertainties associated with the end-of-life product condition, the large variety within the one product category, and complexities in process planning and operation. Therefore, disassembly automation needs to be designed to be flexible and is robust enough to overcome these issues.

This book provides an overview of the design of disassembly automation, along with a case study example of the development of a new system based on the research, “Cognitive robotics in the disassembly of products”, conducted at *the University of New South Wales, Australia*. The general concept of product disassembly is introduced and a review of the existing disassembly automation systems is presented. After that, the book provides an overview of the general system

set-up, followed by detail into each primary operating module of the automated system. This book is organised as follows.

Chapter 1 describes the importance of product disassembly as a key step in the end-of-life treatment process. This chapter also presents an overview of the current research direction in the field of disassembly.

Chapter 2 provides an overview and literature review of the disassembly process. The literature shows that a number of techniques have already been developed at the planning and operational levels, typically for optimising the disassembly process for economic feasibility. These techniques can be implemented in both manual and autonomous disassembly.

Chapter 3 considers the disassembly system as the integration of a number of operating modules working together to achieve the goal. An overview of this configuration is described. Existing research regarding the development of a (semi-) autonomous disassembly system and disassembly tools is reviewed. In addition, the set-up of the workstation and system framework used in this research is explained.

Chapter 4 provides an overview of perception in the disassembly system. Detection techniques, in regard to hardware and software used in existing research, are reviewed. This chapter also describes the implementation of the vision system in this research, including the detection of components based on common features and coordinate mapping using the depth camera.

Chapter 5 explains the principle of cognitive robotics. The cognitive robotics agent is an intelligent planner that controls the behaviour of the system in order to overcome the variations and uncertainties in the disassembly process. The behaviour is influenced by four cognitive functions, namely reasoning, execution monitoring, learning and revision.

Chapter 6 describes the integration of the aforementioned operating modules into a complete disassembly system. The software system applies the vision system, operation plans and the principle of cognitive robotics to a disassembly cell specifically designed for disassembling LCD screens. The detailed configuration of the system and additional information specific to the case-study product are also explained.

Chapter 7 presents the conclusions developed as a result of this research in the development of a disassembly automation system. Technical perspectives of the system, its economic feasibility and the future work are also presented.

Disassembly Automation

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