論文の内容の要旨

論文題目　　　　Information Support for Assembly in Cell Production with Human-Robot
Collaboration
（人間・ロボット協調セル生産の組立情報支援）

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Cell Production, also known as cellular manufacturing, is a human-centered production unit that provides flexibility to the changing industrial requirements, which variety product designs in short production cycle is desired. Physical supports by automatic devices are introduced into this production system to improve the human operator's working performance. In this work, a mobile robot manipulators system is designed as a flexible physical support system to collaborate with human operator in a cell production assembly. However, a greater need in such human-centered production system is the support in term of information. Effective information support can enable the operator to act efficiently according to the assembly flow. Furthermore, in order to ensure effective human-robot collaboration in this work, information support act as a man-machine interface to coordinate the collaborative work between the human operator and the robot manipulators system.

The objective of this work is to develop an information support system to support assembly work in cell production. From literature reviews, the lack of study in support contents and support delivery design based on human understanding is discovered. Due to this reason, this work focuses on the improvement of support contents and support delivery development by the understanding of human operations in assembly and human information processing capability. The whole development of the support system is progressed in three main challenges, from the extraction of information, organization of information and finally practical implementation of the information support system in actual production system. This thesis describes the entire development in the following seven chapters.

Chapter 1 introduces the research background of cell production with the involvement of human-robot collaboration and the related research issues. Literature reviews on four related works have made understand of current developments and research potentials. The objective of this work is set to development an information support system with the development deliveries

of extraction of information, organization of information and practical implementation in human-centered approach.

Chapter 2 begins with the concept of information support and followed by the information scopes in the research areas. Theoretical backgrounds on human information processing, multiple resources theory and multimedia learning are reviewed to relate human-centered approach in information support development.

Chapter 3 presented the core study in this work to extract information by a study on human operation using task-based analysis. By this approach, the whole assembly process is divided into simple tasks related to each other in a hierarchical goal and sub goal structure. In the collaboration relationship study, human-robot collaboration is analyzed into assembly operation for collaboration information extraction. Information on performance and safety are important information to the main operation.

Chapter 4 continues from the task analysis development to organize the information in a task modeling platform. The requirements of task modeling are set to develop a task modeling platform to represent task model with the integration of information and media data. In the modeling, each task node consists of a set of properties as information. The flexible properties system allows various information types to be incorporated into the task units.

Chapter 5 discusses the development of the information support system in both hardware and support information developments. Several experimental studies on information supports were conducted to gather the required reasoning in designing and development of the support system. Based on human factors in information handling, a system to develop the support information from the task modeling is proposed, including representation of main description by human language structure and then enhancement by multimedia.

Chapter 6 contains the detailed information on the implementation of this work in a human-robot collaborative cellular manufacturing prototype system for cable harness assembly. The chapter begins with the prototype system and overview on the support system. The analysis, the models and finally the support information are generated for actual operation. Prototype system evaluation is done with positive outcome. The chapter ends with three main discussions on the overall system evaluations.

Chapter 7 concludes the work, presents the contributions and suggestions for future work.