An Augmented Reality based Approach for Worker Support System on Recycling of End of Life Product

Philjun Moon, Young-woo Kim and Jinwoo Park*

Department of Industrial Engineering, Seoul National University, Republic of Korea

Abstract

Product recycling, which aims to maximize lifecycle value creation and to conserve environment, becomes important. However, much of product recycling has been done by third party remanufacturers, which is complicated by the need to deal with the various models manufactured by various manufacturers. Furthermore, the working method can be varied depending on the recycling option that comes from lifecycle history, even in the same model. This characteristics impose a heavy burden on the worker, which results in problems of inefficiency caused by human errors. To deal with this problem, an augmented reality based approach for worker support on the complex remanufacturing shop floor, which considers efficiency of information delivery, is proposed in order to minimize human errors.

Keywords: Remanufacturing; Worker support; Augmented reality.

1. Introduction

Product recycling is beneficial not only to environmental conservation, but also to maximize value creation throughout product lifecycle. In this context, it seems to be the perfect solution, but in reality the results are yet significant. Problems of product recycling industries can be classified: absence of return system, poor quality of remanufactured items, covert.

There distribution network of remanufactured items, and premature remanufacturing techniques [5]. Problems for remanufacturing techniques are mainly caused by unsystematic remanufacturing process. Hence, imprudent shredding that shreds items can be remanufactured for material recovery has been executed due to the difficulty of remanufacturing, even though there exists efficiency in terms of cost and resource circulation both. One of the underlying conditions is complexity, which comes from the fact that: (1) much of recycling has been done by third party remanufacturers, (2) customized process is needed to respective items according to its condition, and (3) remanufacturers should handle various models manufactured from various manufacturers. Accordingly, the worker on the remanufacturing shop floor has to burden, thereby commits human errors. To avoid this problem, we propose the augmented reality (AR) based approach for worker support on the remanufacturing shop floor. By taking advantage of the AR instead of traditional document based information delivery, the proposed approach will be helpful for enhancing remanufacturing system by reducing human errors.

2. Related Works

Novel information technologies have been applied to support recycling process. For instance, unique identification based systems to offer complete recycling information were proposed. In particular, Gen2 RFID-based system framework, which supports workers by delivering maintenance logs and work instructions that predefined in the product design phase, was proposed [4] However, these approaches only deliver information in two-dimensions. Two-dimensional
information delivery is still widely used for various works including maintenance in various industrial sectors [2]. Furthermore, current two-dimensional approaches is inefficient for the complex environment such as remanufacturing [6]. Two-dimensional approaches have the limitation of inefficiency resulting from familiarity. However, AR is capable to solve this kind of limitation [3]. Moreover, unlike the virtual reality, which provides 3D overlaid contents in virtual environment, AR provides interactive 3D contents based on real environment [8]. Also, precautions can be flexibly provided, in forms of 3D videos, images, and graphs, to avoid human errors in the complex work environment [1]. Hence, it can be a basis for providing 3D contents on remanufacturing shop floor.

3. AR-based Approach

The proposed approach has 3-layered architecture which consists of <layer name 1>, <layer name 2>, and <layer name 3>, as depicted in Fig. 1.

![Figure 1. Framework for the proposed system](image)

In the first layer, decision whether to reuse, remanufacture, or dismantle will be made by decision support system based on lifecycle information through identification and grading process. Then list of jobs, which includes component ID and corresponding recycling option, to be executed is stored in WORK_LIST database.

The second layer, which consists of three steps, namely, data preprocessing, data augmentation, and data visualization, is to prepare 3D work instructions for each component and each recycling option from generic 2D instructions. In the first step, generic 2D instructions are transformed to images, videos, and texts. Preprocessed instructions are registered in Unity, AR-based application development software. In the Unity environment, two tasks are executed: (1) rendering 3D objects based on preprocessed instruction, and (2) tracking to overlay 3D objects for each component. A tracking method can be categorized into vision tracking and sensor tracking, according to what is a trigger for overlaying. We choose sensor tracking to develop an application because physical objects can be identified by RFID.

Finally, on the remanufacturing shop floor, when the application detects a component, rendered 3D instruction for the component will be overlaid through display equipment. A developed application by using the Unity can be executed in various information equipment such as tablets, mobile phones, and head mount displays (HMD). It can be chosen appropriately according to work environments.
As shown in Figure 2, concept of 3D instructions is presented by marker to help understanding. After System is established, it will be overlaid by sensor tracking.

![Figure 2. Concept of 3D Work Instruction](image)

4. Conclusion

We suggested an AR-based approach for worker support system on the remanufacturing shop floor, to avoid human errors and to maximize efficiency of whole remanufacturing process ultimately. The proposed approach provides 3D work instructions, which is overlaid on the component, rather than existing 2D instructions, which is not enough to deal with complex remanufacturing environment.

Acknowledgement

This work was supported by National Research Foundation of Korea (NRF) grant funded by the Korea government (Ministry of Science, ICT & Future Planning) (No. 2015R1A2A2A03008086)

References


