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Year 2023	**Summary of Thesis**

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(Title)
Identification of Steel Surgical Instruments using Ortho-image with Dimensional Information by Depth Camera

Hospitals need to prepare for an increase in the number of surgeries due to the super-aging society. Currently, steel surgical instruments must be counted three times per surgery. This is to ensure that no instruments and supplies used in surgery remain in the body, and medical instruments must be carefully counted. Counting is a time-consuming and burdensome task, and reducing the time and labor required is a challenge.

Counting methods such as RFID and QR codes are available. However, because of the cost and time required, it is not realistic to install them on all medical devices in a hospital. There, this study proposed a method that uses image information from a camera. By using image information, it was expected that a simple identification and counting system for surgical instruments could be constructed.

The problem with image-based object recognition is that the size of objects in an image varies with the camera's imaging distance. Therefore, scaling according to the imaging distance is necessary. Recently, the practical application of depth cameras has been attracting attention. We believe that the three-dimensional information obtained by a depth camera can be used for simple scaling. To establish a simple identification method for steel surgical instruments, this study proposes a method to identify steel surgical instruments using image information obtained by a depth camera, and to verify the validity and effectiveness of the method.

The depth camera was an Intel REALSENSE DEPTH CAMERA D435i was used as the depth camera. Orthographic orthoimages of the surgical instruments were generated using orthographic projection transformation with the 3D point cloud information acquired from the D435i. Gray scaling, background-removal, and binarization were applied to obtain image of pixel structures.

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Faster R-CNN is used to detect the surgical instruments in the image of pixel structures. The faster R-CNN is a machine learning model that detects object regions directly from input images using a Region Proposal Network (RPN), a network for extracting candidate object regions. Bounding boxes are calculated for the detected pixel structures and their dimensions are calculated. The calculated height and width are multiplied to obtain area value. The type of steel surgical instrument is identified using the calculated area value and the area value registered in the database. The name of that identified steel surgical instrument is output.

The D435i is installed at a height of 700 mm so that the optical axis is perpendicular to the plane. The surgical instruments are placed on a black plate on a plane 900 mm wide and 600 mm long. To identify the surgical instruments, first, the surgical instruments are detected by the Faster R-CNN object detector trained to identify steel surgical instruments by category. Next, the area values of the detected steel surgical instruments are compared with the area values stored in databases A and B, which were constructed using two different methods, respectively, to identify the surgical instruments. Database 1 was constructed with measured area values, while database 2 was constructed with area information from template images.

The results of the detection by the Faster R-CNN object detector showed that the region of the surgical instruments was correctly detected by category learning of the surgical instruments. The results of the identification of the surgical instruments by Database 1 and Database 2 showed that the identification rate was 100% for Database 1. On the other hand, Database 2 was found to identify Pean and Kochel inversely. This was due to the fact that the dimensions of the Pean and the Kochel are almost the same. To identify the instruments with nearly identical dimensions, it is necessary to focus not only on the dimensions but also on the difference in color image information.

In the proposed method, the Faster R-CNN object detector with detection classes for each categories of steel surgical instruments is used for the first stage of detection. In the next second stage, detailed identification of surgical instruments by dimensional information is performed. By using the two-stage process, it is confirmed that the proposed method can correctly identify the surgical instruments, suggesting its usefulness.

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