Automatic Breaking System for Large Rocks by Use of CCD Camera and Laser Pointer

Hiroshi TAKAHASHI
Dept. of Geoscience and Technology
Graduate School of Engineering
Tohoku University, Sendai 980-8579, Japan

Introduction

Most of the limestone mines in Japan have been using a vertical shaft to deliver the rock from the working face to the crusher. That is, rocks are usually carried by a dump truck from the working face to this shaft and they are dropped off into the vertical shaft. Then, they are crushed by the crusher. However, if the large rocks are delivered into the crusher, they will damage the crusher. Therefore, a grizzly bar is usually set above the crusher to catch the large rocks. Then, the large rocks on the grizzly bar are broken by the breaker. However, the working environment in the breaking room is not so good for workers because of much dust. Therefore, the automation of breaking system for large rocks is required.

The objectives of this study are to investigate the automatic detection procedure of large rocks in the rock pile by using the image processing and to obtain the three-dimensional information of large rocks by use of CCD camera and laser pointer.

Image Processing and Manipulation

Figure 1 shows the flowchart of the image processing. This image processing consists of three main procedures, that is 1)thresholding, 2)area analysis and 3)shape analysis. The first, thresholding is carried out based on the thresholding value which is determined from the standard deviation in the window of 16×11 pixels. Then, small areas less than the mesh of grizzly bar are eliminated in the area analysis because these areas are considered to be the small rocks. Then, the complicated shape areas will be eliminated in the shape analysis because these areas are considered to be the areas that many small rocks are connected together. Then, shrinking process is carried out to distinguish the small rocks from the large rocks.

Figure 2 shows the principle of the measuring method of the height of the large rock. In this system, CCD camera and laser pointer are used. CCD camera will detected the central gravity of the large rock areas. Then, the line between the central gravity and the center of the camera lens is obtained. The laser spot is shot until this spot coincides with the central gravity in the image by controlling the manipulator. Then, the line between the central gravity and laser pointer is obtained. The height of the rock is determined by the cross section of these two lines.

Experimental Apparatus

Figure 3 shows the schematic diagram of the experimental apparatus. The apparatus consists of the CCD camera, an image processing board, a personal computer, the laser pointer, light sources and manipulator. Four kinds of limestone with different color were used

in the experiment.

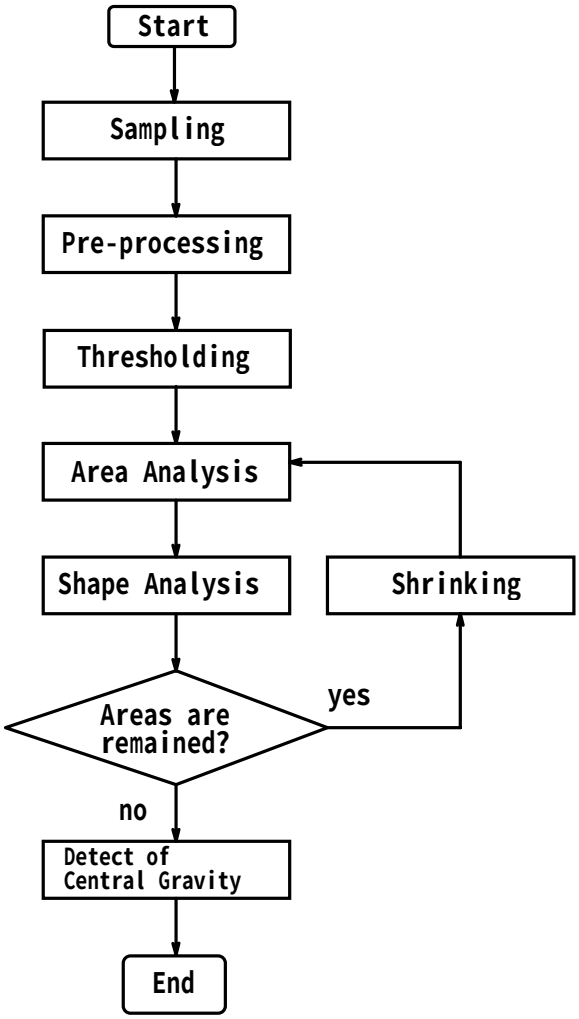

Fig.1 Flowchart of image processing

Results and Discussion

Figure 4 shows an example of large rock detection. The plus in this figure indicates the central gravity of the detected area. As shown in this figure, the algorithm proposed here works well to detect the large rocks. Furthermore, the experiment with using the simple shape object was carried out to confirm the algorithm to measure the object height. By comparing the estimated results with the actual height of the objects, it was confirmed that this algorithm also works well to measure the object height.

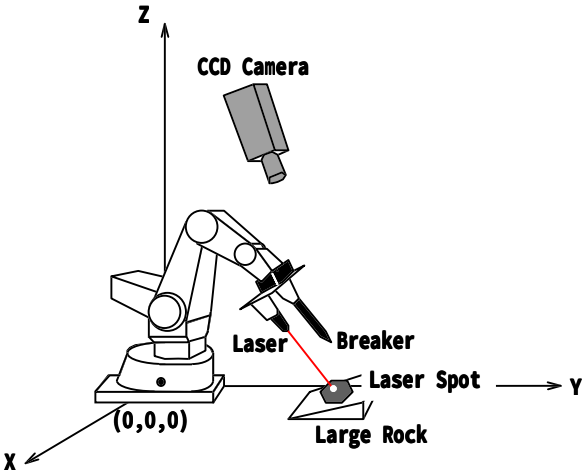

Fig.2 Principle of the measuring method of the height of the large rock

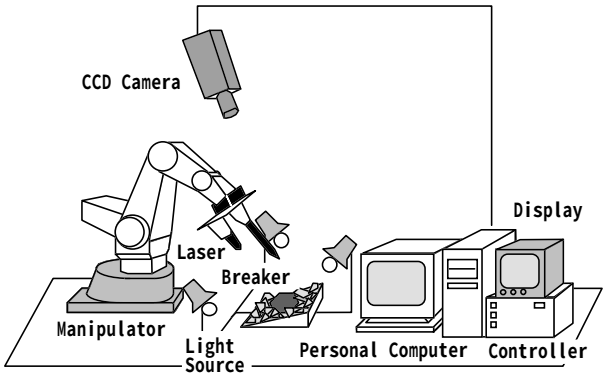

Fig.3 Outline of experimental apparatus

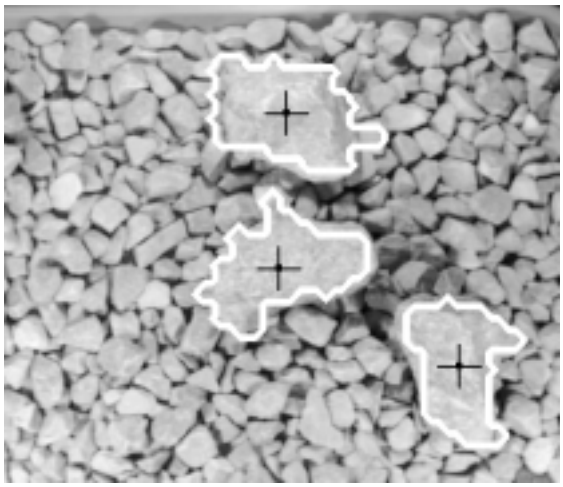

Fig.4 An example of large rock detection