MOCHA

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Introduction

The aim of this project was to utilise cheap imaging hardware to produce a simple machine vision system using Java. This was achieved through the implementation of a simple machine vision application - MOCHA or Minimal Optical Coffee Height Analysis. Three areas of machine vision were addressed in the project: image capture and display, digital image processing, and inference. Algorithms for manipulating digital images and inferring knowledge from them were investigated. The MOCHA application is simple to use and its source code is easy to understand and to adapt for future development. The project did not aim to address every area of, and approach to, machine vision but provides a basis for more advanced work.

Figure 1 : Coffee Pot Source Image

Image Filters

Many image filters [1][2] were implemented during the project. Image filters are useful for converting possibly poor quality images into input images for the Hough transform and coffee amount detection functions (Figures 1, 2, and 3). By using such functions as histogram equalisation it is possible to remove small lighting differences in the original scene. The skeletonise filter proved useful in producing shapes for detection. A skeleton function removes pixels that do not lie at the center of a line. It produces ”stick man” drawings. Processing over shapes is done on a per pixel basis, so skeletonising greatly reduces execution time whilst retaining the essential information of a shape.

Figure 2 : Equalise - Edge detect - Threshold

Finding the Amount of Coffee

The amount of coffee is calculated by a linear function between the area of black pixels in an empty pot and the area of black pixels in a full pot. The lid of the pot (which also shows up as black) is assumed to be mostly constant (Figure 3).

Figure 3 : Amount of Coffee

Detecting Coffee Pots

The general Hough transform [3] can be used to detect any arbitrary translated or scaled shape in an image. Here the shape we are looking for is made from the two sides of a coffee pot which were chosen because they are quite distinctive.

Figure 4 : General Hough Space. Indicates the likely presence of a shape at the center of the image

Figure 4 shows the general Hough space after shape detection. The Hough space is thresholded and any remaining points are taken as indicating the presence of a shape (Figure 5). The higher the threshold is, the more accurate the function becomes. The Hough transform can work with very noisy source images if the threshold limit is reduced. This, however, may lead to the detection of a shape that does not appear in the original captured image.

Figure 5 : Shape Detected

References

1. HIPR2, available at http://www.dai.ed.ac.uk/HIPR2
2. Digital Image Processing, Gonzalez, Rafael C., Addison-Wesley, 1993
3. CVonline, available at http://www.dai.ed.ac.uk/CVonline