**Image Processing Techniques**

**5.1 Introduction**

Image Processing is the breakdown of images or video frames in digital format to abstract useful data from them. In the case of this research, images are processed to abstract features for hand shape recognition.

These are image processing techniques such as Canny edge detection, background subtraction using Gaussian Mixture Models,face detection, adaptive skin detection, CAMShift tracking , hierarchical Chamfer matching, connected components analysis. Each of these techniques is discussed in a separate subcategory below.

**5.1.1 Canny Edge Detection**

Edge detection is the method of ﬁnding the edges within an image. An edge is deﬁned as a point in an image with a disjointedness in brightness, or, in simple relations, a sharp change in brightness [4]. In edge detection is simpliﬁes an image representation to that of only its structural vision-based information. Canny developed the Canny Edge detection technique [13] in 1986 and it is one of the most common and strong edge detection techniques [56]. The Canny algorithm attempts to satisfy the following three conditions:

1. A low error rate: The detection of edges should be as correct as possible. The edges found in a picture should not be falsely ignored because error of these edges could aﬀect a system’s performance.

2. Good localization: The detachment between detected edge pixels and the actual edge pixels must be minimalized.

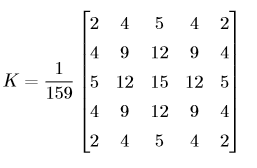
3. Minimal response: Multiple replies to an edge should be avoided by limiting detection to only a single response per edge.

The Canny edge detection algorithm contains four steps [37]. These are: the image smoothing via a Gaussian ﬁlter; calculation of the gradients in the image to highlight potential edges; applying non-maximum suppression to reach thin edges; and double thresholding to conquer edge lines. These steps are described in the below subsections

**5.1.1.1 the Image Smoothing Using a Gaussian Filter**

The primary step of Canny edge detection involves qualifying any extra noise in an image. Images normally hold some amount of noise. These sources of noise can simply, but incorrectly, be detected as edges–sharp changes in intensity–within the image.

As such, the image is smoothed using a Gaussian ﬁlter [67]. This includes convolving a Gaussian kernel K with the image I. Below is an instance of a Gaussian kernel of size 5×5 using a standard deviation of σ = 1.4 which can be used, but higher kernels can be used as well.



**3.1.1.2 Computation of the Image Gradients**

Once the image has been smoothed and excess noise has been ﬁltered out from it, the next step is to determine the intensity gradients of the image. These gradients are computed because they give an indication of the strength of edges in the image. At each pixel in the smoothed image, the gradients are determined using the Sobel operator as follows.

The gradients are approximated using a pair of 3×3 convolution masks, Sx and Sy. Sx highlights the edges in the x-direction while Sy highlights the edges in the y-direction. These convolution masks are given as: