Chapter 5
A Study on Static Hand Gesture Recognition Using Type-1 Fuzzy Membership Function

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ABSTRACT

The idea of this chapter is the use of Gaussian type-1 fuzzy membership functions based approach for automatic hand gesture recognition. The process has been carried out in five stages starting with the use of skin color segmentation for the isolation of the hand from the background. Then Sobel edge detection technique is employed to extract the contour of the hand. The next stage comprises of the calculation of eight spatial distances by locating the center point of the boundary and all distances are normalized with respect to the maximum distance value. Finally, matching based on Gaussian fuzzy membership function is used for the recognition of unknown hand gestures. This simple and effective procedure produces highest accuracy of 91.23% for Gaussian membership function and a time complexity of 2.01s using Matlab R2011b run on an Intel Pentium Dual Core Processor.

INTRODUCTION

This section presents the notion of gesture recognition as well as introduces the existing literature in this area of hand gesture recognition.

What Is Gesture Recognition?

Among all the modes of communication, gestures play a pivotal role (Bolt 1980; Capirci et al. 2005; McNeill 2000; Melinger and Levelt 2004). Gestures have always been used as a complementary way of expressing ideas. It is so much implanted in communication that gesturing is often used while speak-

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ing. Recognition of meaningful gestures (Mitra and Acharya 2007) can be utilized to develop a suitable interface between machines and their users to achieve natural interaction with people.

What Is Its Utility in Day-to-Day Life?

Humans and computers have been known to interact with hardware devices like keyboard, mouse and other haptic devices (Clark and Mayer 2011; Gavrila 1999; Jaimes and Sebe 2007; Moeslund and Granum 2001; Rosenberg 2001). But these are not enough for human-computer interaction in some situations, like in the case of physically challenged people or to even in the manipulation of objects in a virtual environment. One of the ways for the elimination of the physical contact between operator and machine is automatic hand gesture recognition technology based on analyzing finger and hand movements for the operation of complex machines. The major areas of applications for hand gesture recognition are:

- Sign language detection (Liddell and Johnson 1989; Stokoe 1978).
- Interface between human and computer (Pavlovic, Sharma, and Huang 1997; Segen and Kumar 1998).
- Robot movement (Calinon and Billard 2007; Nickel and Stiefelhagen 2007).
- E-learning of dance (Kothari 1979, 1989).
- Clinical surgery (Graetzel et al. 2004; O'Hara et al. 2014).

Literature Survey

Some well-known hand gesture recognition techniques extract the hand region from the background using data glove. Fels and Hinton map of hand movements with speech using speech synthesizer using minor variations of the standard back propagation neural network (BPNN) (Fels and Hinton 1993). Wilson and Bobick use the Principal curve and dynamic time warping (DWT) for recognition of motion trajectories in various hand gestures in the limited background (A. F. Bobick and Wilson 1997). Starner *et al.* propose a technique to recognize of continuous ASL by the single camera using a color-based tracker (Starner, Weaver, and Pentland 1998). Black and Jepson model hand motions using temporal trajectories and match them using condensation algorithm by drawing random samples from the trajectories in an office environment (Black and Jepson 1998). Lien and Huang propose a vision based model using inverse kinematics to find a skeletal model for an input image by translating and rotating the hand model about x, y and z axes (Lien and Huang 1998). Lee and Kim extract the hand using skin color based segmentation and calculate likelihood threshold of an input pattern by thresholding (H.-K. Lee and Kim 1999). Recognition of known gestural patterns is done by hidden Markov model (HMM). In a similar study, Yoon *et al.* track hands in a gestural sequence by locating hand regions and connecting them for all frames (Yoon et al. 2001). Features are based on weighted position, angle, and velocity. Vogler and Metaxas break American Sign Language (ASL) into constituent phonemes and model them with parallel HMM (Vogler and Metaxas 2001). Yang *et al.* compute affine transformations to acquire pixel matches using multi-scale segmentation and obtain pixel-level motion trajectories using concatenation (M.-H. Yang, Ahuja, and Tabb 2002). Recognition is carried out using time delay neural network (TDNN). Ng and Ranganath represent hand shapes by Fourier descriptors, calculate pose likelihood vector by RBF network and classify pose using a combination of the recurrent neural network (RNN) (Ng and Ranga-