Automatic Fruits Identification System Using Hybrid Technique

A. M. Aibinu, M. J. E. Salami, A. A. Shafie, N. Hazali and N. Termidzi

Department of Mechatronics Engineering,
International Islamic University Malaysia (IIUM)
P O Box 10, 50728,Gombak, Malaysia.
E-mail: maibinu@gmail.com

Abstract—In this work, a combination of artificial neural network (ANN), Fourier descriptors (FD) and spatial domain analysis (SDA) has been proposed for the development of an automatic fruits identification and sorting system. Fruits images are captured using digital camera inclined at different angles to the horizontal. Segmentation is used for the classification of the preprocessed images into two non-overlapping clusters from which shape boundary and signatures are estimated using FD and SDA technique. Furthermore, color information obtained from the extracted red-green-blue color components of the fruits images during ANN training process is used in accurately detecting the color of such a fruit. The two independent paths are then combined for fruits sorting and identification purposes. The performance of the developed hybrid system has been evaluated at three different angles of camera inclination from which an accuracy of 99.1% was obtained.

Keywords—Artificial Neural Network (ANN); Fruits Images; Fourier Descriptors; Shape.

I. INTRODUCTION

Fruits recognition and classification plays an important role in pre-harvesting and post-harvesting operations. Various techniques have been presented in the literature for fruits recognition and classification and these may be classified into: shape based; color based; dielectric based; conductivity based and more recently magnetic resonance imaging techniques. The shape based technique using hybrid Fourier descriptors (FD) and spatial domain analysis (SDA) is proposed in this paper.

Shape based image analysis has been an area of keen research interest during the last few decades especially in the field of medical image diagnosis, machine vision, content retrieval system, surveillance, target recognition, industrial inspection, scene analysis [1]–[11].

Shape representation simply involves characterization of a given shape using certain features [2]. The given shape is normally represented by a finite sequence of complex or real numbers, symbols, bits, features etc and these are called shape signatures [2]–[4]. Several shape boundary representative schemes do exist and these can be categorized into complex-valued signature (CVS) or real-valued signature (RVS).

The CVS representation can further be divided into two types of representation, namely centered based complex coordinates and non-centered based complex coordinates [2]–[5], [8], [11]. The mathematically expression for the two types of CVS representation schemes are respectively given as:

\[ z_n = x_n + iy_n \]  
\[ z_n = (x_n - x_c) + i(y_n - y_c) \]

where \( x_c, y_c \) refer to the coordinates of the center pixel and \( x_n, y_n \) refer to the \( n^{th} \) boundary pixel of the shape. Similarly, RVS types include centroidal signature, farthest point signature, curvature signature, chord length etc [2]–[19]. Shape based techniques using centered-based CVS have been applied in the development of automatic fruit identification and sorting system in this work. The remaining part of this paper is organized as follows: review of some related work is covered in section II; the proposed technique is presented in section section III while results and conclusion is contained in section IV.

II. LITERATURE REVIEW

Ear identification using Generic Fourier Descriptor (GFD) has been proposed in [12]. This proposed technique has been found to be rotational and scale invariant. A three stage automatic teeth classification in bitewing images using Bayesian classification and FD of the contour of the molar and the premolar teeth was proposed in [20]. Contour of each of the individual teeth was obtained from the segmented images while the Bayesian and FD provided the initial classification. Spatial relationship between the images was then used for final classification. The maximum and minimum performance value obtained for pre-classification of molar or premolar (in mandible and maxilla) is 95.5% and 72% respectively. Ten low and high frequency components have been used to describe pedestrian and vehicle shapes in [17]. The application of the proposed algorithm on 500 pedestrians and 300 vehicles feature images shows that 20 coefficients is sufficient to represent all the necessary features from the acquired images.

An efficient two-stage shape based leaf image retrieval system has been proposed in [19]. Results obtained show that the proposed hybrid technique performs better than both the individual performance of the curvature scale space and the modified FD in identifying 1400 leaf images from 140 plants [19].