Detection and Tracking of Face by a Walking Robot*

Do Joon Jung¹, Chang Woo Lee², and Hang Joon Kim¹

¹ Department of Computer Engineering, Kyungpook National Univ., Korea
{djjung, hjkim}@ailab.knu.ac.kr
² Department of Computer Information, Kunsan National Univ., Korea
leecw@kunsan.ac.kr

Abstract. We propose a system for detection and tracking of face in dynamic and changing environments from a camera mounted on a walking robot. The proposed system is based on the principal component analysis (PCA) technique. For the detection of a face, first, we use a skin color information and motion information. Thereafter, we verify that the detected regions are indeed the face using the PCA technique. The tracking of a face is based on the Euclidian distance in eigenspace between the previously tracked face and the newly detected faces. Walking robot control for the face tracking is done in such a way that the detected face region is kept on the central region of the camera screen by controlling the robot motion. The proposed system is extensible to other walking robot systems and gesture recognition systems for human-robot interaction.

Keywords: Face Detection, Face Tracking, PCA, Walking Robot

1 Introduction

The mobile machines with wheels and crawlers assume simple works and their movable environment is limited. Because of the movable environment limitation, humanoid 2-leg walking robot has been produced such as ASIMO and SDR-4X and so on. One of the goals of building intelligent and interactive machines is to make them aware of the user’s presence. Detection and tracking of face from a walking robot is a much more challenging problem as the scene is much more dynamic because of both motion of the camera and that of the user.

In general, there are two kinds of grouping of tracking methods according to their views. Some people group tracking methods as recognition-based tracking and motion-based tracking and the others group them as edge-based tracking and region-based tracking [1].

Recognition-based tracking is really based on the object recognition technique and the performance of the tracking system is limited by the efficiency of

* This work is financially supported by the Ministry of Education and Human Resources Development(MOE) and the Ministry of Commerce, Industry and Energy(MOCIE) through the fostering project of the Industrial-Academic Cooperation Centered University.

© Springer-Verlag Berlin Heidelberg 2005
the recognition method. Motion-based tracking relies on the motion detection technique, which can be divided into the optical flow method and the motion-energy method.

Edge-based methods track the edges in an image sequence, which are usually boundaries of objects of interest. However, these methods suffer from the changes in color or illumination since boundaries of objects to be tracked have to show a strong edge variation in color or illumination. Moreover, it is difficult to provide reliable results in a case where the background of an image has strong edges. Most of the current work related to this type of method stems from the efforts of Kass et al. on snakes [2]. Many of the recent researches on face tracking are in trouble with the presence of background noise and apt to track an unverified face, for example, arms and hands.

In this paper, we propose a system for detection and tracking of face in dynamic and changing environments from a camera mounted on a walking robot using PCA technique. The proposed system consists of two main steps as depicted in Figure 1: face detection and face tracking. Using two consecutive frames, first, the candidate face regions are verified to determine which region is indeed the face using PCA. Thereafter, the verified face is tracked using the eigen-technique.

![Fig. 1. Architecture of the proposed system.](image)

2 Face Detection

In this section, the techniques used to detect faces in the proposed system are introduced. For improving the accuracy of the face detection, we combine several published techniques such as a skin color model [3] and PCA [4, 5].

2.1 Skin Color Classification

Detecting pixels with the skin color provides a reliable method for detecting and tracking faces. Since an RGB representation obtained by most video cameras not