Vision-Based Fuzzy 8051 Surveillance Systems Design

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Abstract

This paper proposes a vision-based fuzzy 8051 surveillance system which emphasizes on designing the image processing function to detect the invaded states and the 8051 fuzzy servomotors controller to track the invader region. The techniques include discrete wavelet transformation (DWT) image data reducing, edge detection, motion detection, and fuzzy servomotor control. In this paper, image processing techniques are used for invader detection. Using a two-axis camera mount controlled by fuzzy controller, this system could make the camera exactly keeping the invader object on the center of scene. Also, the proposed tracking system has high potential in the guard of security management, the transaction authentication, the residential monitoring.

1. Introduction

Surveillance systems become an important role in load-traffic monitoring, products-quality management, school security prevention and other related applications. Challenges in the design of the vision-based surveillance system is how to extract features, analysis the treat pattern and start an appropriate control action. Several related researchers can be found in the Ref. [1]. Typical vision-based system with CCD camera are proposed to capture the on-line image video, then available image vision schemes, such as image segmentation, image reduction, edge detection, and motion detection, are usually applied to acquire the feature information for approaching the surveillance applications.

An 8-bit 8051 micro-controller is firstly designed by Intel that consist all required components to build on one processing scheme. The 8051 is known a popular controller unit in many embedded systems [2]. In this article, the 8051 fuzzy controller (C8051F120) at the platform (CPU speed 100MHz, 64K RAM and 128K Flash) is implemented with C Language to create an appropriate control signal for servomotor to actively track position of the invaded objects.

2. Architecture Of Surveillance System

In Figure 1, the architecture of the proposed vision based surveillance is shown as functional flow diagram. Main functionalities of this surveillance scheme can be divided into following two parts. Firstly, the invader detection mechanism creates acquired information from the captured images using machine vision based techniques to detect the correct invader position. Secondly, the generated 8051 fuzzy control rules in invader tracking scheme are used to control the servomotor on the two-axis camera mount.

![Figure 1. Block-diagram of surveillance system](image)

3. Fuzzy Invader Tracking Controller

The proposed fuzzy mechanism [3] is described as follows: The triangular membership function is selected as Fuzzifier, Inference Engine is taken as max-min operation. The Defuzzifier is the center average computation. Two parameters are considered to be the fuzzy variables, one is the difference of x-
axis between current position \((h_p)\) of the invader in the image and the image center point \((h_c)\), the other one is the difference of y-axis between current position \((v_p)\) of invader in the image and the image center point \((v_c)\). If both input variables are denoted as \(h\) and \(v\). Those are

\[
\hat{h} = h_c - h_p \quad \text{and} \quad \hat{v} = v_c - v_p.
\]

The fuzzy rules for x-axis controller are:
- Rule 1: if \(h = \text{NB}\), then output= LB (turn left big).
- Rule 2: if \(h = \text{NS}\), then output= LS (turn left small).
- Rule 3: if \(h = \text{ZE}\), then output= HS (no change).
- Rule 4: if \(h = \text{PS}\), then output= RS (turn right small).
- Rule 5: if \(h = \text{PB}\), then output = RB (turn right big).

The fuzzy rules for y-axis controller are:
- Rule 1: if \(v = \text{NB}\), then output= DB (turn down big).
- Rule 2: if \(v = \text{NS}\), then output= DS (turn down small).
- Rule 3: if \(v = \text{ZE}\), then output= HS (no change).
- Rule 4: if \(v = \text{PS}\), then output= US (turn up small).
- Rule 5: if \(v = \text{PB}\), then output= UB (turn up big).

4. Case Study and Conclusion

In our software simulation, the captured image with 640 x 480 pixels from the CCD camera will be completely extracting the invaded person’s center position within 1 second. The designed specification in 8051 microcontroller for server motor is C8051F120 with 64K RAM and 128K Flash, and the Keil C is used as the firmware developer. The developed MCU module and the CCD camera are shown in Figure 2. In Figure 3, it shows results of screen shots with the developed video surveillance system for an invader tracking example in real environment. Image captured. In our experiments, the system’s response time is about 0.2~0.25 sec for the proposed 8051 fuzzy controller at 100MHZ speed to send a control command for servomotors to move the camera mount toward the invader. It can be a suitable real-time system to controller the server motors in the real-world. From the experimental results, we constructed the simple fuzzy mechanism can effectively make the camera have a fast response in the invader detection and tracking task. Therefore, we believe that such a vision-based fuzzy tracking system has its high potential in video surveillance.

References