Pivoting Object Tracking System

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Abstract

The main goal of this project is to develop an object tracking system that enable a camera, which is placed on a mobile robot platform, to track a moving object. This project combines software (in C) and hardware (in VHDL) design, together with the knowledge of computer vision and robotics control.

Keywords Tracking, Object Recognition, iRobot, Wiimote, DE2, Nios II

1. Introduction

Object recognition is a common application of computer vision, and can be used to track the position of a moving object with a camera. This project aims to implement this and also to extend it by allowing the camera to pivot at will, in order to always keep the object in question in view.

2. Main Deliverable

The main deliverable of this project will be a working system with a controlled (by keyboard or Wiimote controller) camera that tracks moving objects and displays the tracked image on VGA. Since we have access to an iRobot Create robot, we will use it as a convenient platform for pivoting the camera horizontally. Depending on available resources, vertical pivoting might be implemented as well.

The user interface will allow the user to manually pan the camera and select a target object, at which point the platform will attempt to always keep the object in the center of its field of view. An ambitious feature we might want to include in our project is to use a Wiimote instead of a keyboard to choose an object for tracing. The difficulties lies in that Wiimote uses Bluetooth for its communication, which means that a Bluetooth USB dongle would need to be used and a device driver for it would need to be written.

3. Plan of Action

Developing this project will involve four main challenges: finding a way to pivot the camera, taking in video from the camera, recognizing a given object, and adding an interface to manually move the camera and designate an object.

Action 1

The iRobot Create will be used to pivot the camera horizontally (yaw). The camera will be placed on top of the robot, and the Altera DE2 will command the robot to turn using its RS-232 serial port. Vertical pivoting (pitch) will be more difficult, as the robot cannot do that on its own. The implementation of this will depend on whether we are able to find hardware that will accomplish this task.

Action 2

A digital camera will be used to capture video. The camera will output standard NTSC composite video. The DE2 has an Analog Devices ADV7181 TV decoder chip which can convert this to a digital format. We will need to find out how to interface the chip with the FPGA, configure it properly, and access the data with the Nios II.

Action 3

Object recognition will be accomplished through software on the Nios II. Although several computer vision methods can be utilized, the most promising seems to be scale-invariant feature transform (SIFT) in which the scales and relative distances of features on the target image are characterized and then compared to those on candidate images. The advantage of this method is that it can still recognize a given object if the distance and orientation change. If it turns out that this algorithm is too intensive to be carried out in real time on the Nios II, a simpler algorithm will need to be used.

Action 4

An interface will need to be developed to allow the user to select a target and to see what the camera is tracking. The DE2's VGA and PS/2 ports can be used to connect a monitor and keyboard respectively. If we decide to use a Wiimote, we will need to obtain a USB Bluetooth dongle, write a device driver for the dongle, and find out how to interface with the Wiimote using Bluetooth.

4. Milestones

Milestone 1(March 30)

The first milestone will define the architecture and interface of each component. The system will be able to display video from the camera. Additionally, it will be able to command the iRobot to move left and right, possibly by keyboard.

Milestone 2 (April 13)

By then, the system will have most of its features, including object recognition and controlling the iRobot Create to track the moving object.

Milestone 3 (April 29)

After the second milestone, we will try our best to implement two more interesting, though not essential, features. The first one is moving the camera up and down and not just left and right. Unfortunately, as of now we are not sure if there is such a device we can use. We will talk to Prof. Peter Allen next week and hopefully we will get any useful information from him. The second feature is to use a Wiimote instead of a keyboard for control. As mentioned previously, however, the work necessary to implement this is not trivial.

5. Reference

1. ADV7181 datasheet
2. Information on the iRobot Create
3. Introduction to SIFT