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Vision Based Tracking for Unmanned Aerial Vehicle

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Abstract

This project aims at a system for an Unmanned Aerial Vehicle (UAV) following moving targets on ground. The UAV has physical constraints on airspeed and maneuverability. The target however can move freely and in any general pattern. We assume minimum knowledge about the target while navigating the aircraft. The system includes visual tracking of the target with a camera mounted on the UAV. The camera is also controlled by the closed loop algorithm according to the position and orientation of the aircraft and the position of the target. Aircraft stabilization and interpretation is performed using an autopilot system "Piccolo" by Cloud Cap Technology. The navigation and visual processing is performed on computers at the ground, control commands from which are sent to the aircraft wirelessly. The figure shows our system architecture and pictures of the individual components.
Secondly, the project aims at design and implementation of a real-time computer vision system for a rotorcraft unmanned aerial vehicle to land onto a known landing target. This vision system consists of customized software and off-the-shelf hardware which perform image processing, segmentation, feature point extraction, camera pan/tilt control, and motion estimation. We introduce the design of a landing target which significantly simplifies the computer vision tasks such as corner detection and correspondence matching.
While UAVs have been widely used in the West for policing, oil pipeline inspection and detecting illegal immigrants, in India, they are mainly used by the armed forces (Eg. Lakashya, Nishant) for intelligence gathering and surveillance. But this is changing.

Increasingly, they're being used for civilian purposes and are akin to God's eye in the sky. The earliest attempt to use the UAVs was as aerial targets in 1915. The first operational usage began in 1959 when the US Air Force (USAF) officers commenced planning for unmanned flights to avoid losing trained pilots over hostile territory.

Keywords: Unmanned Aerial Vehicle (UAV), Visual Tracking, Image processing, Real Time Tracking.

1. Introduction

Biological visual systems exhibit an amazing robustness to complex visual events. The human visual system, for example, is able to adapt to or recover from many unexpected visual circumstances. On one hand, it can acquire partial information about an object if it is at all visible; on the other hand, it can reacquire an object that is temporarily lost from view. Thus, athletes can still catch, hit, or kick a ball by knowing its approximate position even when it is spinning rapidly, and motorists can quickly recover track of the vehicle ahead of them, even after a glance in the mirrors.

Remotely controlled mobile robots have been a subject of interest for many years. They have a wide range of applications in science and in industries such as aerospace, marine, forestry, construction and mining. A key requirement of such control is the full and precise knowledge of the location and motion of the mobile robot at each moment of time.

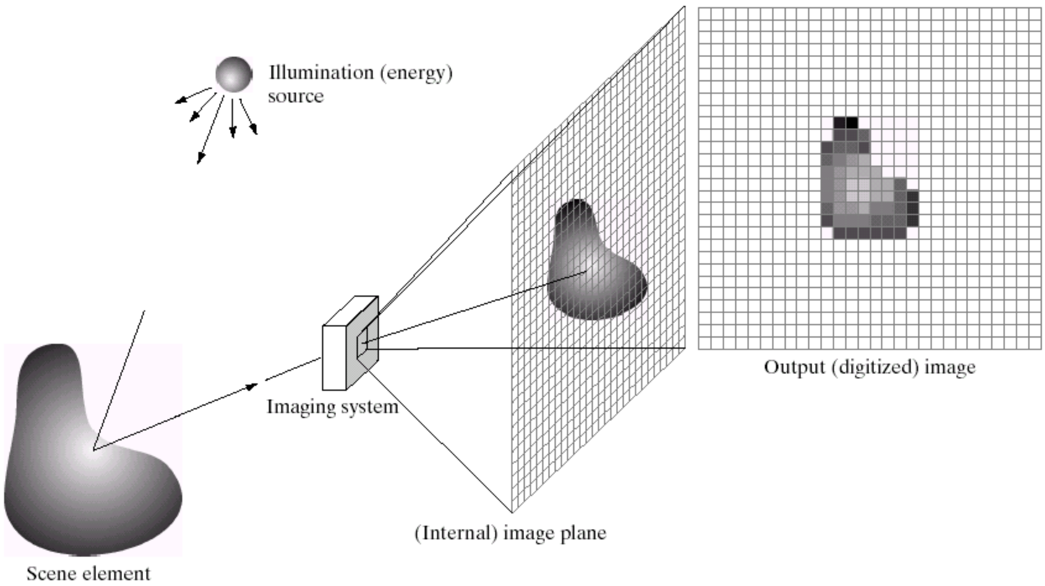
This paper describes on the problem of real-time purely vision-based 3D trajectory estimation for outdoor and unknown environments. The system includes an inexpensive camera that can be mounted anywhere on the UAV. It employs existing scene information and requires no prior map, nor any modification to be made in the scene. Special attention is paid to the problems of reliability in different environmental and imaging conditions. The main assumptions here are that the scene provides enough features for matching and that most of the scene objects are static. Moreover, it is assumed that the velocity of the robot is limited in such a way that there is some overlap between each two consecutive frames. The system is mainly designed for use in autonomous navigation in natural environments where a map or prior information about the scene is either impossible or impractical to acquire.

In this paper we address the problem of detecting and tracking people in natural environments in real-time. The person to be followed introduces itself to the system during a startup step. Without any predefined model of a person, the system builds an internal representation of the person which then enables it to track and follow the person in real-time even in dynamic environments. While following the person the representations are continuously adapted to account for changing illumination conditions and varying shapes of the person due to the non-rigidness of their body. The system is used to enhance the man-machine-interface of an autonomous mobile robot and to provide basic mechanisms to build applications in the field of service robotics, e.g. guiding persons through office buildings. These applications impose certain requirements on the implemented methods which include the use of moving cameras mounted on moving platforms, tracking of people differing in their looks and real-time operation in a changing environment.

2. Representation of Image in Digital Form

2.1 Digital Image

A digital image is a representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels.



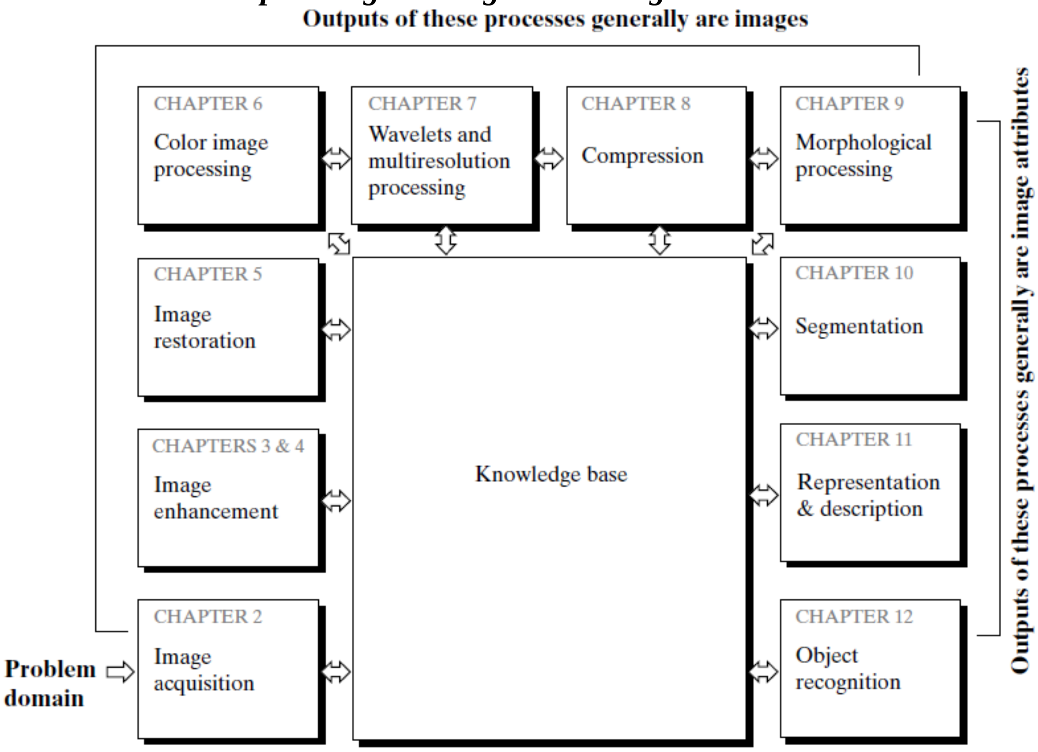
2.2 Digital Image Processing

An image may be defined as a two-dimensional function, F(x, y), where x and y are spatial (plane) coordinates, and the amplitude of F at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, we call the image a digital image .The field of digital image processing refers to processing digital images by means of a digital computer. Note that a digital image is composed of a finite number of elements, each of which has a particular location value. These elements are referred to as picture elements, image elements, pels, and pixels. Pixel is the term most widely used to denote the elements of a digital image.

Digital image processing focuses on two major tasks:

- Improvement of pictorial information for human interpretation.
- Processing of image data for storage, transmission and representation for autonomous machine perception.

2.2.1 Fundamental Steps in Digital Image Processing



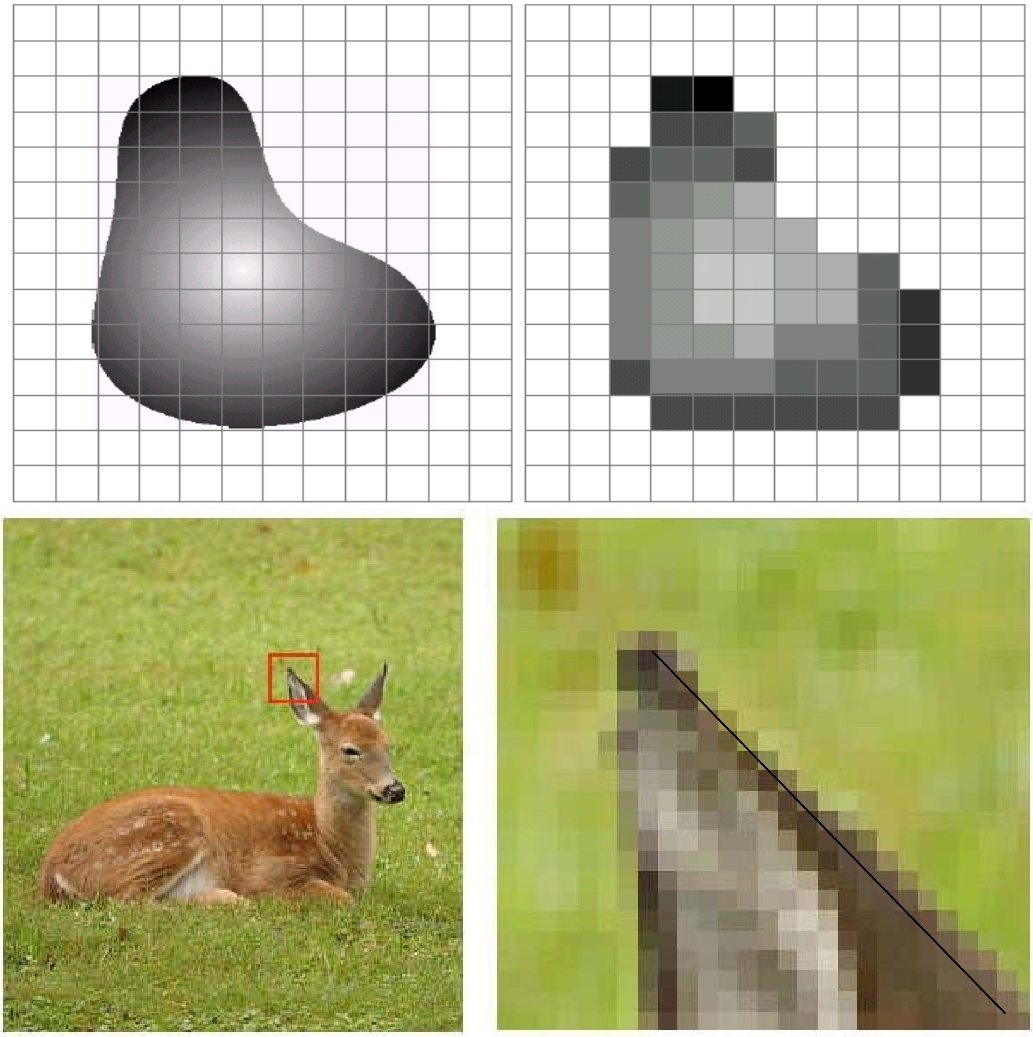
2.3 Image Sensing and Acquisition

The types of images in which we are interested are generated by the combination of an “illumination” source and the reflection or absorption of energy from that source by the elements of the “scene” being imaged. We enclose illumination and scene in quotes to emphasize the fact that they are considerably more general than the familiar situation in which a visible light source illuminates a common everyday 3-D (three-dimensional) scene. For example, the illumination may originate from a source of electromagnetic energy such as radar, infrared, or X-ray energy.

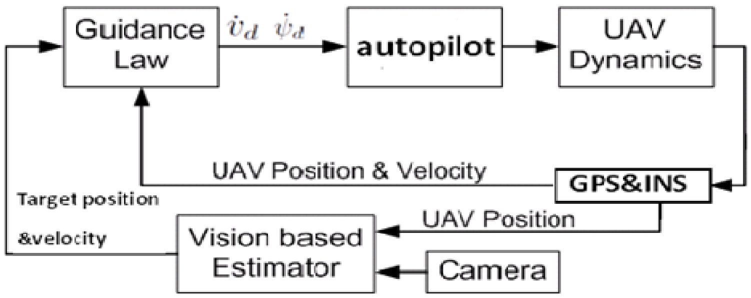
2.3.1 Pixels

Pixel values typically represent gray levels, colors, heights, opacities etc.

Short for Picture Element, a **pixel** is a single point in a graphic image. Graphics monitors display pictures by dividing the display screen into thousands (or millions) of pixels, arranged in rows and columns. The pixels are so close together that they appear connected. The number of bits used to represent each pixel determines how many colors or shades of gray can be displayed. For example, in 8-bit color mode, the color monitor uses 8 bits for each pixel, making it possible to display 2 to the 8th power (256) different colors or shades of gray.



APIXEL



System architecture for visionbased tracking of moving targetbyanunmanned aerial vehicle

3. Conclusion

This paper presented vision-based estimator and a new method for standofftrackingbyunmanned aerial vehicle(UAV). Digital image processing technique used to convert the analog image into discrete form. After digital image processing methods comparing the camera image to the registered image based on the vision based estimator then to control the guidance laws ad autopilots.

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