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A.R Drone Navigation –

Application Requirements Document

Revision Control

Rev.	Detailed Description	Paragraph Reference	Approved by	Date
1.0	Original version			30.12.2011

Contents

Chapter 1 : Introduction

1.1 Vision

We'd like to perform jobs that currently consume a lot of time and manpower in an alternative low cost way, to achieve that we want to use the A.R Drone.

Currently our focus is on agricultural applications such as pollination and/or decease identification in plants but there are many use cases (e.g. using the drone for security purposes etc.).

Our motivation is to grant the AR Drone the ability to autonomously navigate a given path and recognizing special landmarks on the path.

Our main goal - to implement navigation and self-orientation capabilities for the A.R Drone.

1.2 The Problem Domain

One of the fundamental problems of mobile robotics is to autonomously navigate a given path,
Therefore the major part of getting the drone to perform a task autonomously is to enable it to navigate itself in the environment without any human interaction this will be accomplished using the video and navigation data that is sent from the AR Drone.

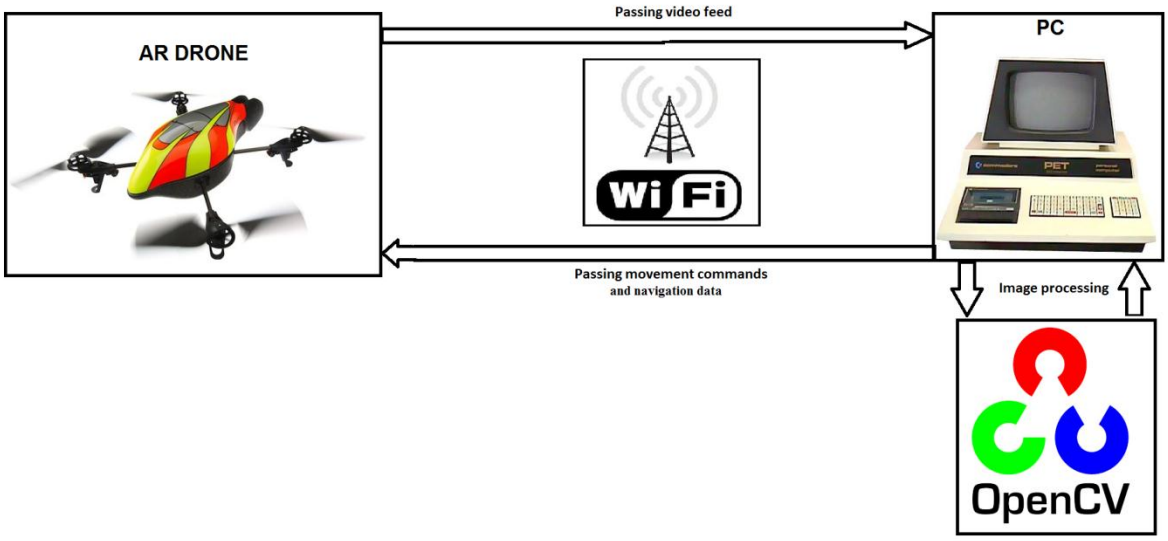
The major components in our system are:

Parrot A.R Drone:

We will need to interface with the craft in order to receive video and navigation data and to send orders. The drone comes with a complete API and an SDK with which we will need to work.

OpenCv:

We will use the OpenCv image processing library to process the video input from the drone and identify the navigation markers.



1.3 Stakeholders

- The university researchers team and students - the platform that we are making will give them a good starting point to use the AR Drone to do more specific research and complicated tasks using the autonomously nature of the modified AR Drone.
- As we are focusing on the agricultural applications of our project – farmers are important stakeholders.
- The benefiters of our project are all the hard workers that do routine work and all their employees – now that they will have something that will do the same thing.

1.4 Software Context

Inputs - video feed from the drone as well as data from other sensors (height, acceleration, gyro etc.).

Processing - We will analyze the data received from the drone in order to determine the route it should take and recognize landmarks.

Outputs - send back navigation directions.

The result will be the drone moving along a designated path and marking a pre marked landmarks.

A common use case scenario - the user (physically) marks a path for the drone and puts it at the starting point. Upon execution, the drone identifies the path markers and flies at a specified altitude along the path. The drone will be able to detect checkpoint markers long the route and take appropriate action whenever one is encountered.

Chapter 2 : Functional Requirements

Major functions to be handled by the software:

- Image analysis for detection of navigation and location markers taking in mind the navigation date received from the sensors of the AR Drone.
- Deduction of navigation directions from navigation markers.

Detailed function:

The designated path and landmarks will be identified as follows:

- The AR Drone will send via Wi-Fi the video feed and navigation data.
- The computer that will receive the data will identify the pre - located visual accessories using an image processing algorithms.
- Using the Navigation data received the computer will compute the next steps of the AR Drone
- The Computer will send the moments command to the AR Drone via Wi-Fi.

Chapter 3 : Non Functional Requirements

- Speed: the drone will advance at a speed of at least 0.25 m/second.
- Checkpoint detection: detection of at least 90% of check point markers.
- A tutorial will be written to make it easy for use to the average Joe.
- The AR Drone path could be set in any open space (minimal obstacles) fast.
- The code documentation will be written as clear and detailed as possible.

3.1 Performance Constraints

- Lighting and visibility conditions: the environment must be well lit and there must not be anything that might hurt visibility. Specific values TBD.
- Battery: according to manufacturer the drone battery can last 12 minutes of flight.
- Safe/clear route: the path marked for the drone must be completely free of obstacles.
- Controlled environment: the drone must be operated in a controlled environment, i.e. no wind/rain etc.
- Reliability: the system is not expected to handle any kind of failure except landing the drone safely in case of emergency.
- Usability: the system is expected to be very usable with almost no training. Anyone should be able to lay down navigation markers and just start the program.

3.2 Platform constraints

3.2.1 SE Project Constraints

- The system is not interactive. All input comes from camera/sensors built-in the drone and to which we have full access.
- We will not use any simulations; we will operate the actual drone.
- The hardware required is the A.R Drone it-self and a PC with Wi-Fi.
- Development will take place at home and at the university laboratories.
- The final presentation (as the testing) will be performed by marking a path and letting the drone fly along it.

Chapter 4 : Usage Scenarios

4.1 User Profiles — The Actors

As we have the definition of our project to be as minimal interaction with the humans as possible – we only have one external to the system actor and that is the operative of the AR Drone.

Usage Scenario Number 1

1. Name: Start-up

2. Pre-Conditions:
    a. A Path has been marked.
    b. The drone is placed at the starting point.

3. Steps:
    a. The user starts the program.
    b. The drone takes off.
    c. The drone detects the path markers.
    d. The drone flies along the path.
    e. The drone reaches the end of the path and lands.

4. Exceptions:
    a. If at any point the drone doesn't detect the path markers:
    b. The drone turns 360 degrees in attempt to locate the markers.
    c. If the marker is found the drone follows the path, otherwise it lands.

Usage Scenario Number 2

1. Name: Checkpoint detection

2. Pre-Conditions:
    a. Use case “Start-up” is on-going.

3. Steps:
    a. The drone detects a checkpoint marker.
    b. The drone sends a message to the system identifying the checkpoint.
    c. The drone performs the callback operation received from the system in response (currently - the drone hovers above the marker for a few seconds).

Chapter 5 : Risk assessment & Plan for the proof of concept

Risk Assessments:

Not been able identify the path and figure out to where to fly next.

Solution:

Landing safely and sending an alert that will pop up in the controlling computer.

Proof-of-concept prototype:

The proof-of-concept prototype will be making the AR Drone following a simple line that will be drowned on the floor and hovering over some unique visual identifiers that will be used as the landmarks.

The Proof-of-concept will give us the:

1. Better Understanding of the limitations of our project as we could try to fly the AR Drone In different environments (with a variety of obstacles).

2. Ability to assess design decisions early in the process and figure out how can rewrite simple navigation commands after we test some scenarios.

3. We could see that the main objective of the project is already working, we would be able to continue from there to do modifications to the functionality of the AR Drone so it would work in many other scenarios, environments and maybe even path and landmark tagging technics.

This of course would give the project the big idea that the project is in right path and the chances of project failure are low and will give us look-and-feel of the solution.

Appendices

Background about the project's main motivation:

Pollination of plants usually occurs naturally in nature through weather conditions and with the help of bee's wasps and other buzzing ultrasonic winged creatures, and some plants even self-pollinate themselves e.g. beans and don't require any extra help. Without successful pollination you will never get fruit on your plants so it's always a gardener's number one priority to get the most of their crop and this means successful pollination. Pollination is the transfer of pollen from the inside of the flower to the stigma of the same or different flower.

With bees disappearing, farmers are scrambling to find enough of the little guys to pollinate their crops.

Information on the AR Drone:

http://ardrone.parrot.com