MA “Gaussian Process Ultra-Wideband Localization Error Correction for Teach-and-Repeat UAV Flight ”

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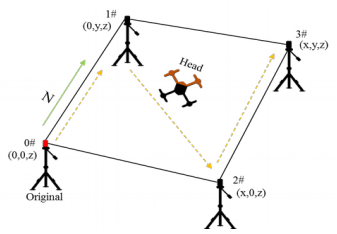
Place: ETH Institute for Pervasive Computing



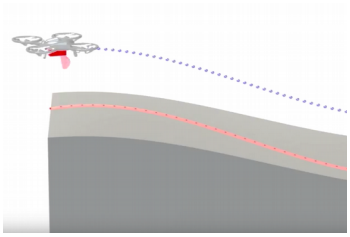
Introduction

Smooth shots have been a crucial demand in the media and entertainment industry ever since its first days. Creating spectacular images for sporting events or action movies, however, still requires heavy camera equipment such as dollies or cranes.

These methods are very expensive and inconvenient: Due to their size and weight, transportation is cost-intensive and the setup often requires two or more people and a lot of time. Additionally, there are limitations: For sports productions, available options offer hardly longer tracks than 20m and there are speed limits of about 40km/h.

Drones are famously known for their aerial videography capabilities. However, state-of-the-art drones face two major issues, preventing them from being used as a compelling replacement for dolly movements:

1. Filming often requires more than one take of the same shot. Therefore, drones need to be able to refly the exact same path several times. This is hardly possible with a manually controlled drone, and if so, it requires hours and hours of training.
2. Computer-controlled drones may solve this problem. However, their current positioning systems are not reliable enough yet, due to the lack of precision technology.



Thesis Description

The focus of the thesis is to implement, evaluate and test a novel indoor positioning system for drone media productions. The technology is based ultra wideband (UWB) beacons in combination with a differential GPS solution.

Requirements

The ideal candidate will have an INFK, MAVT or ITET background with a focus on Estimation and Control or general Robotics. Solid programming skills (Matlab and C/C++) and an interest in hands-on development and experimentation is also a requirement.
Programming languages: Matlab, C/C++.

Expected Project Work Packages (June – December 2019):

- **1. WP June** Paper and literature research, getting familiar with MATLAB code base and UWB firmware from Bitcraze
- **2. WP June** Setting up the flying environment:
  - designing a mount for the drone-fixed tag module
  - constructing standing poles for the anchor modules
- **3. WP July** Analyzing ranging capabilities of a tag/anchor pair
- **3. WP July** Further developing the module firmware for setting the mode (TAG/ANCHOR) of the modules with an UWB message, allowing ranging between anchors and self-calibration of their positions
- **4. WP July** Further developing the module firmware for receiving all ranging reports on the main computer over an additional connected module in SNIFFER mode
- **5. WP August** Basic positioning through triangulation with a handheld UWB tag as a proof of concept
- **6. WP August** Drone controller for pre-defined trajectory following
- **7. WP August** Basic constant velocity EKF for position and velocity estimation
- **8. WP September** Augmenting measurement model with (Sparse) Gaussian Process offset estimation to accommodate for ranging offset position and orientation dependency
- **9. WP September** Augmenting process model with drone dynamics
- **10. WP September** Accuracy comparison with VICON ground-truth data:
  - EKF localization without offset correction
  - EKF localization with offset correction
- **11. WP November-December** Writing thesis and preparing presentation

Thesis grading scheme – Grade description

- **6.0** Outstanding quality; significantly exceeds expectations, original contribution by the student: *New creative solution, publishable work.*
- **5.5** Problem solved in a very good way, student has expanded the original question. *Demonstrate system by a set of experiments.*
- **5.0** Problem has been solved,expectations are met but not surpassed:
- *Correct the position error with a calibration process.*
- **4.5** Problem solved with minor deficits, expectations fulfilled with deficits in some details.
- **4.0** Problem just solved (marginal solution), expectations only partially met, major deficits: I*mplementation of UWB based positioning in the LAB space.*