

ZyboCopter Research Platform

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Agenda

- Introduction
- Motivation
- Overview
- Design Challenges
- Future Work

Introduction

- Unmanned Systems, especially UAVS, are populating many sectors of industry
 - Recreational, Agriculture, Military, Industrial Services
- The rapid adoption provokes a need to explore unmanned systems with respect to:
 - Adaptivity, Dependability, Security, and Control
- UAVs as a platform also make for interesting research with regards to:
 - Autonomous navigation, Multi-agent systems, and the integrated management local and global system intelligence

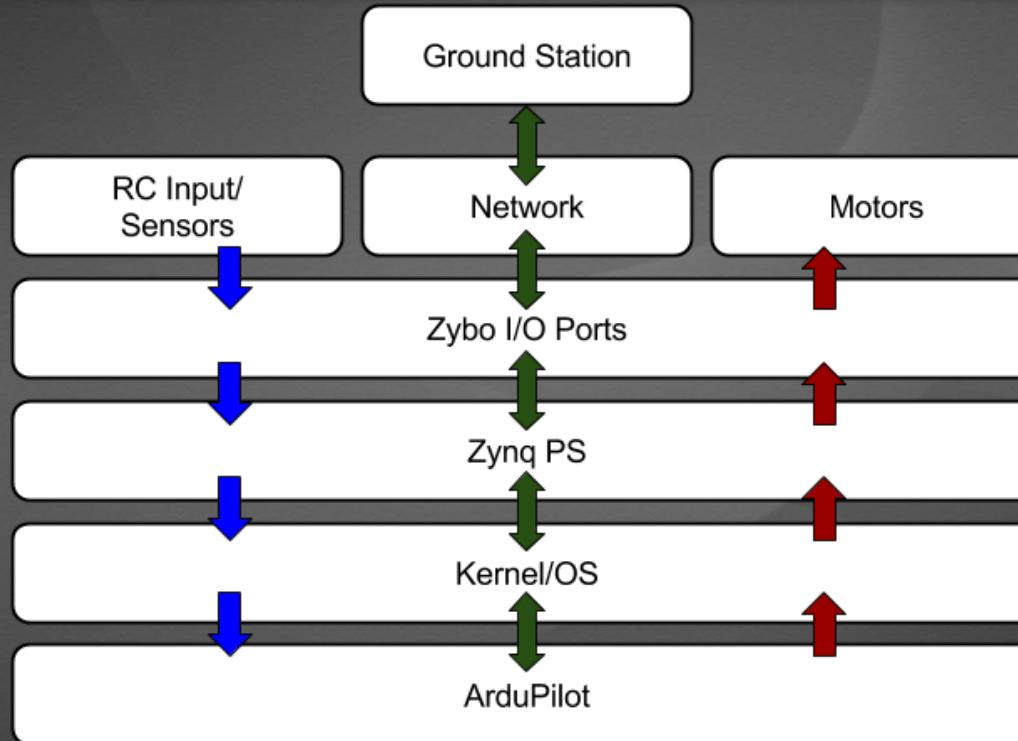
Motivation

- Provide a robust system to cover a wide range of applications on a variety of unmanned platforms
- To further collaboration opportunities with industry research partners and within the department

Overview

- ZyboCopter Research Platform is the prototype system featuring a hexa-copter body and FPGA brain
- Provides avenues for exploration into all system levels
 - Software, OS, Kernel, Hardware
- Sub-platforms
 - ArduPilot, Debian OS, Linux Kernel, Zybo FPGA

Overview



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ArduPilot

- ArduPilot is an open-source autopilot solution
 - 5+ years of community development
 - Multi-copters, Planes, Rovers, and Subs
- ArduPilot was well-fit considering it allows the possibility for:
 - Various vehicle classes
 - Integration with Mission Planner ground station software for guided control of one or many vehicles

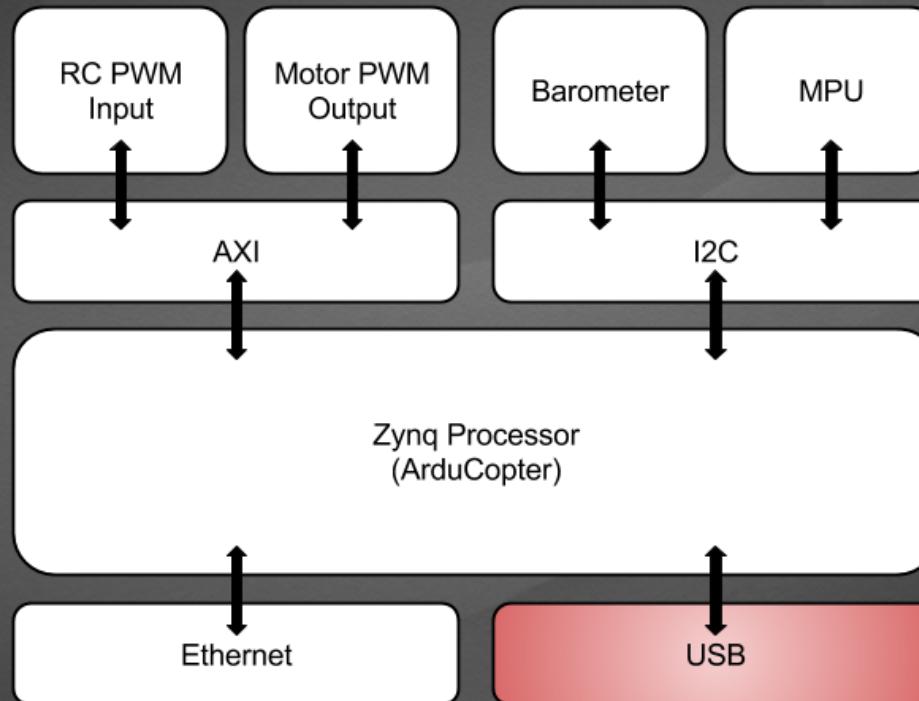
ArduCopter

- ArduCopter used as flight controller for hexa-copter
 - Manages all control algorithms for different flight modes
 - Interacts with Linux system devices for sending/receiving control signals
- Required hardware for basic flight
 - RC Transmitter/Receiver, Motors/ESCs, MPU, Barometer*
- Previous development for Zynq processing system laid a template for RC input and motor output
 - Did not account for PWM style RC inputs

OS/Kernel

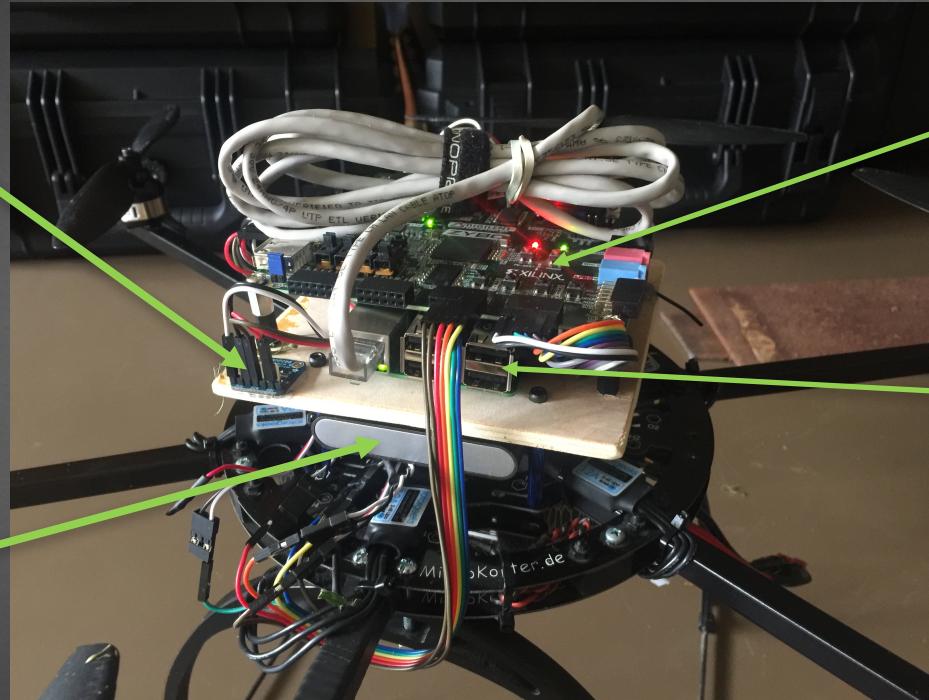
- Debian Stretch OS is used for hosting the ArduCopter software
 - Platform's OS can be modified as required by particular applications
- Xilinx Petalinux is used for generating kernel and filesystem for Zynq Arm processor
 - Default filesystem exchanged and updated to include commodities such as package managers

Zybo FPGA



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ZyboCopter



BMP280
(Baro, Therm)

Zybo FPGA

Control Systems
Battery

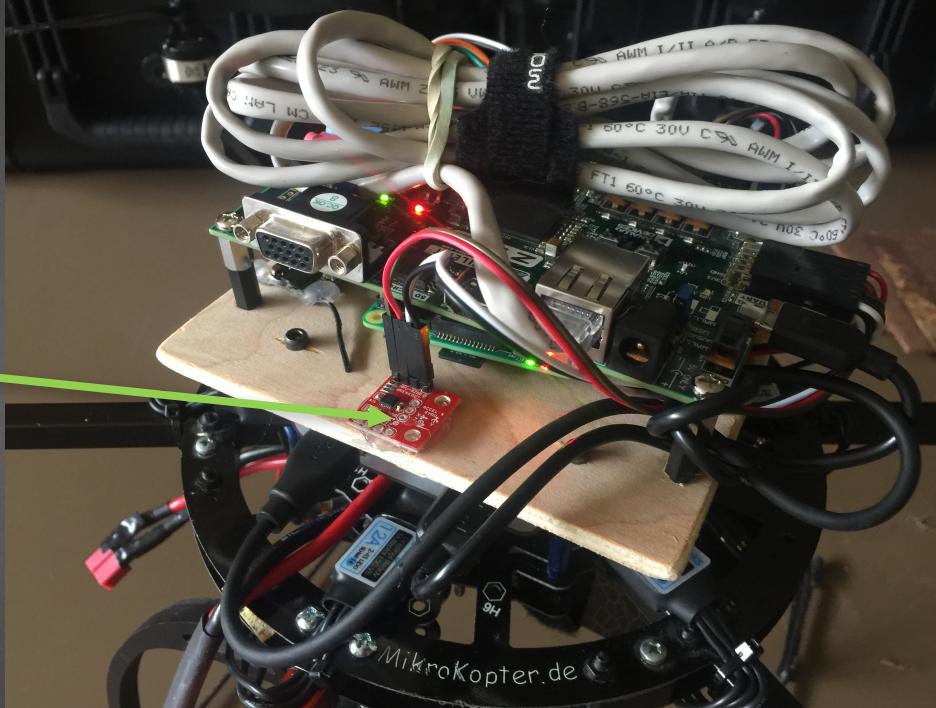
Raspberry Pi



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ZyboCopter

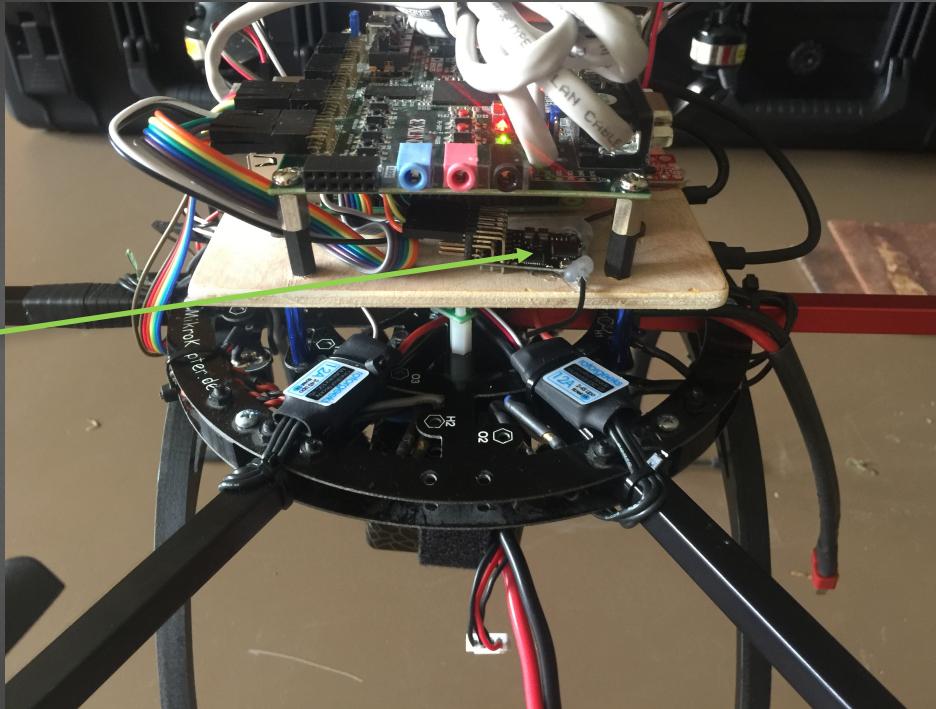
MPU-9250
(Gyro, Accel,
Compass)



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ZyboCopter

DSM
Receiver



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Flight!

- Video

Challenges

- Reading Radio Controls via PWM
 - PWM to Value Hardware IP - AXI
- Kernel Drivers
- Wireless
 - Zybo USB port bug (no 5V power)
 - Raspberry Pi used as bridge (iptables port forwarding)

Roadmap

- Adaptive Systems
 - Motor Reconfiguration
 - Control Models
- Embedded Hardware Application
 - 3D Vision and mapping
 - Sensing Applications
- Autonomous Navigation
- Swarm Systems
- Publications

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Questions



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