

V-REP Integrated Paparazzi Simulation

November 30, 2018





Overview

Introduction and Motivation

Architecture

Problems

Evaluation



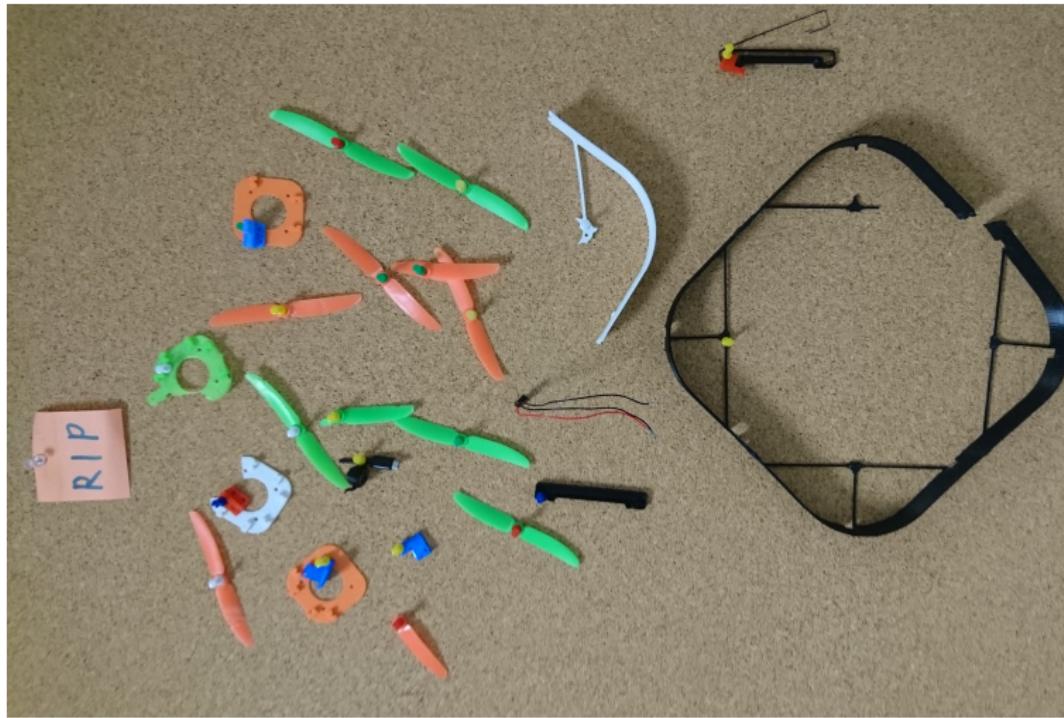
Project goals

- ▶ Creation of a simulation environment for the SwarmLab copters
- ▶ Use existing Paparazzi infrastructure
- ▶ Should be easy to use and extend



Why do we even need a Simulation?

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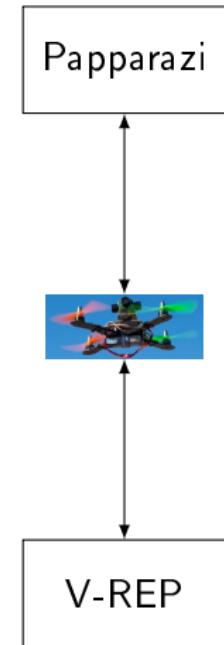


Why do we even need a Simulation?

- ▶ Simulation allows experiments without risking potentially expensive hardware
- ▶ Exploration of a wide range of potential environments and conditions
- ▶ Scalability

Project idea

- ▶ Idea: V-REP plugin providing communication between Paparazzi and V-REP
- ▶ V-REP provides the copter state, Paparazzi the corresponding commands
- ▶ Main advantage: same code and infrastructure usable on simulated and real copters



Why a new framework?

- ▶ Multiple simulators for (swarm) robotics already exist
- ▶ None of them provide all needed functionality/convenience

JSBSim	Gazebo	ARGoS
no swarm capability	limited GUI / scene editing, no particle system	only 2D, limited physics capability

Base Architecture

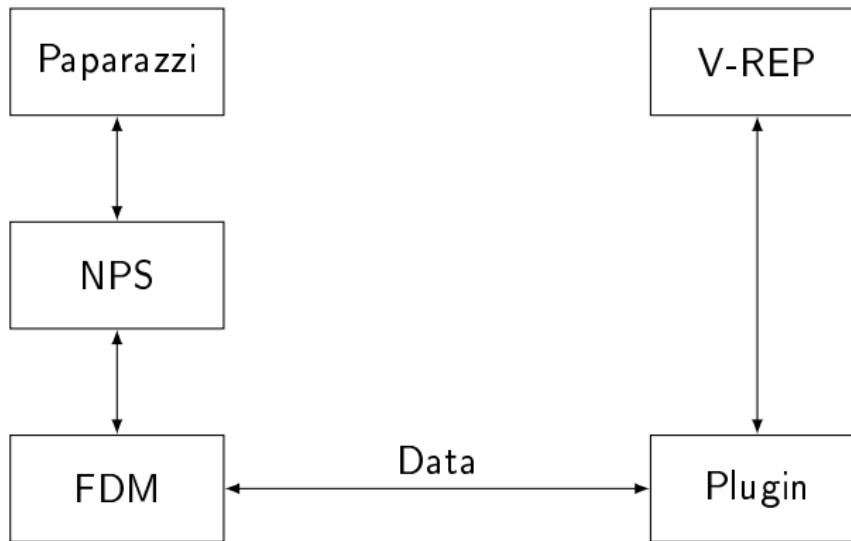
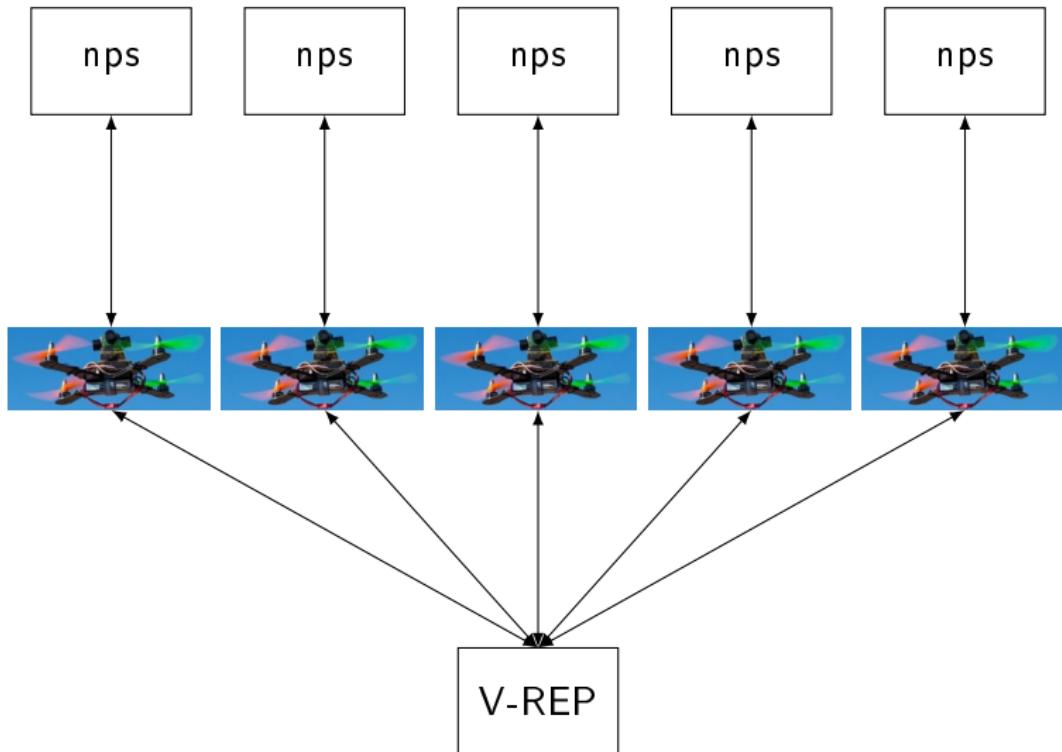


Figure 1: Basic simulation architecture

Connection Architecture



Loop overview

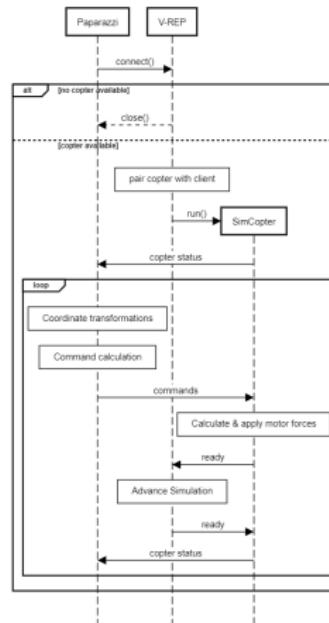


Figure 2: Simulation sequence overview

Exchanged data: V-REP

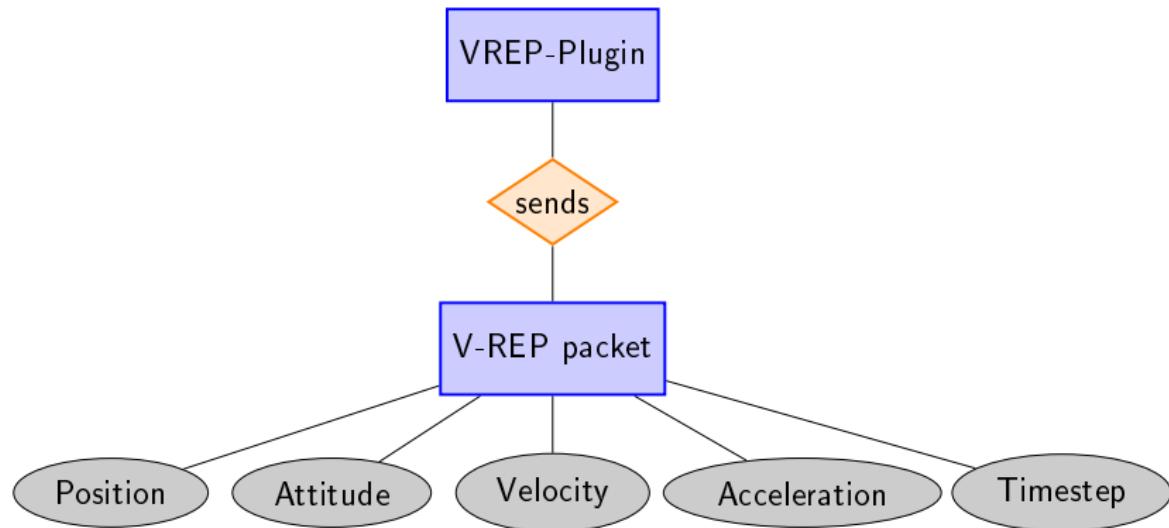


Figure 3: Data sent by V-REP to Paparazzi

Exchanged data: Paparazzi

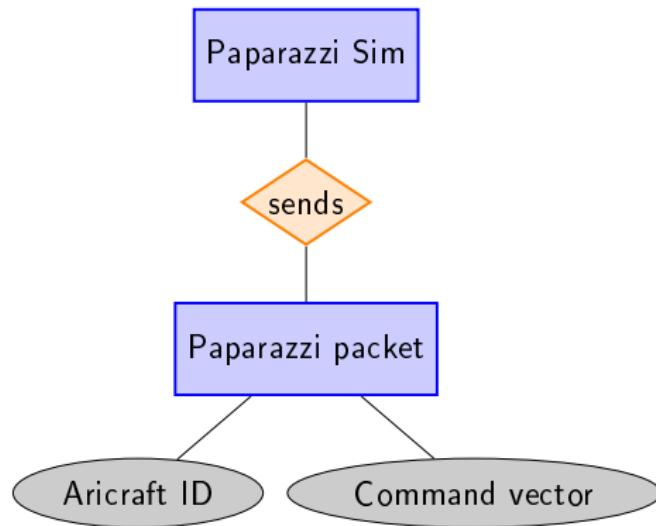


Figure 4: Data sent by Paparazzi to V-REP



Problems

- ▶ Coordinate transformations
- ▶ Connection stability



Coordinate transformations

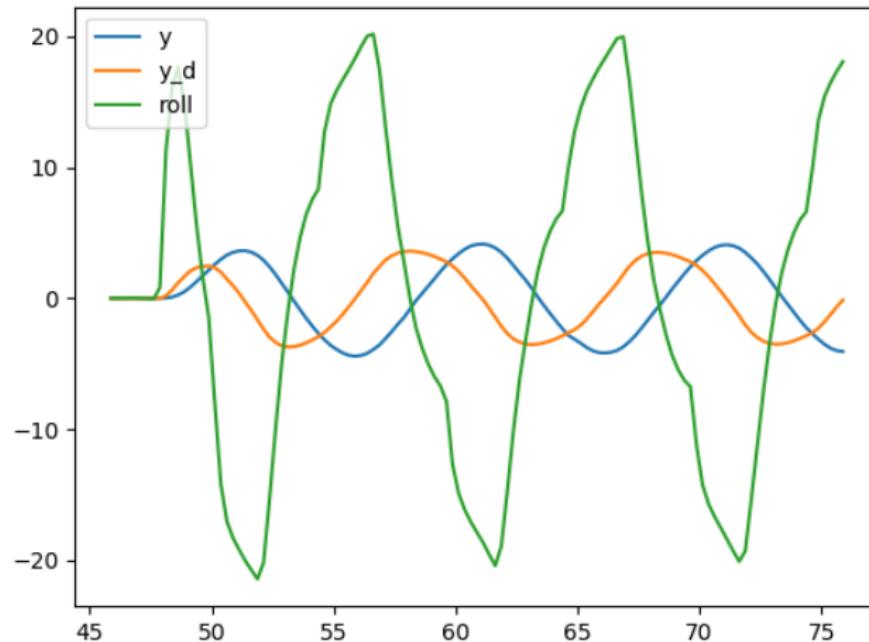
- ▶ Paparazzi and V-REP use different coordinate systems
- ▶ V-REP coordinates conform to ENU, Paparazzi uses various systems
- ▶ → multiple interdependent sources of errors, difficult to debug



Connection stability

- ▶ Connection failure should not crash the entire simulation
- ▶ Correctly track connected and unconnected copters
- ▶ "Ghost Copters" lead to crashes

Evaluation: Simple flight plan



Statistics: Eight-shaped flight plan

checkpoint	std_x	std_y	var_x	var_y
A	0.09	0.08	0.008	0.006
B	0.03	0.07	0.0008	0.004
C	0.07	0.03	0.05	0.001
D	0.04	0.08	0.001	0.007
E	0.08	0.08	0.007	0.006
F	0.06	0.1	0.004	0.012



Demo



Thanks for your attention

- ▶ Special thanks: Christoph for always helpful advice and bug-hunting expertise

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