- APROVIS3D -

Analog PROcessing of bioinspired VIsion Sensors for 3D reconstruction

Document Reference:		
Title: **D1.2.1 Initial Version of Specification of Demonstrator**		
Contractor: **ULille**		
Prepared by: **Pierre Boulet**		
Document Type: **Deliverable**		
Version: **1.2**		Pages: **1**
Classification: **External document**		

Document Track

Version	Date	Remarks and Authors
1.0	25/01/2021	First Draft (P. Boulet – ULille)
1.1	26/01/2021	Minor changes and editions (J. Martinet – UCA)
1.2	09/05/2021	Follow-uo of discussions of 28/04/2021 and clean-up (P. Boulet – ULille)

Authors

	Role / Function	Name	Organisation
Prepared by	T1.1	P. Boulet	ULille
Checked by	Quality	J. Martinet	UCA
Released by	WP1 Leader	P. Boulet	ULille
Approved by	Project Coordinator	J. Martinet	UCA

TABLE OF CONTENTS

FIGURES

TABLES

1. Introduction

This deliverable lists the initial version of the specifications of the demonstrator aerial vehicle and on-boarded sensors and computing devices.

This document translates the requirements expressed in D-1.1 into specifications.

2. Documentation

2.1. Applicable and Referenced Documents

#	Id	Description	Identifier (Ed Rev)	Date
AD1	FPP	Full Project Proposal	1.0	15.01.2019
D.1-1	D.1-1	Definition of Scenarios, Use Cases and Requirements	1.3	09.05.2021

2.2. Glossary and Terminology

Acronym	Definition
WP	Work Package

3. Contents

3.1. Specifications of the event sensor

- Resolution: 128x128 to 256x256
- Latency: 1-10 microseconds
- Field of view: it depends on the used lens and the sensor size. For the current lens (8mm) and retinas that we have in the lab. I have computed a FOV of about 50º.
- Data throughput: 20 Mega events/second
- Communication link: the sensor output is a parallel 4-phase handshaking connector, although a microcontroller can be added to the PCB to do USB connection to the computer.
- Weight pcb+sensor: 24 gr
  - Cage: 32 gr
  - Lens: 38 gr
- Power Consumption: 1-10mW
- Sensor Area: 5x5 mm2
- Pcb size: 3.5 x 8 cm2
- Cage size: 4cm x 8.2cm x 2.8cm
- Battery weight <1kg

3.2. Specifications for integration

- Neuromorpic processor: SpiNNaker is the main target. Some partners also plan a comparison with Intel Loihi, but it will depend on the access to the physical hardware.
- Including the USB interface for the DVS Camera
- Digital Processors (microcontroller); An Arm-cortex-M based processor or the ETH Academic parallel processor RISC-V based
  - Power consumption: below 200mW
- Serial interface communication (USB o QUAD-SPI) for communication Neuromorphic processor - Digital processor
- Serial interface communication (USB o QUAD-SPI) for communication Digital-processor - Drone Processors
- Drone Processors: this can be any kind of existing hardware (ranging from microcontroller to GPUs) as the communication will allow to keep the control on the drone processors and it is not part of the project.

3.3. Specifications for demonstration

Aerial Vehicle Specifications:

The vehicle used for the demonstration will have the following specs:

- Octarotor: max payload 6kg~ 12 min of flight, 4.5 kg ~18 min of flight, no extra payload ~ 35min of flight.
- Navigation Sensors: Standard Navigation Package (IMU, GPS, barometer, altimeter, etc.), ArduPilot, ROS compatible (via mavros).
- RGBD Sensor: StereoLabs ZED2
  - Output Resolution Side by Side 2x (2208x1242) @15fps.
  - 2x (1920x1080) @30fps.

  - 2x (1280x720) @60fps.
  - Field of View Max. 110°(H) x 70°(V) x 120°(D).
  - 2x (672x376) @100fps.
  - Depth Range: 0.3 – 20m.
  - ROS compatible.
  - Mounting of the sensor in different angles (w.r.t vehicle) will be possible.
- Embedded Processing Unit: NVIDIA Jetson AGX Xavier Developer Kit
  - Real-time data acquisition from navigation and RGBD sensors (ROS).
  - Real-time control commands from visual servoing algorithms running on-board (ROS).

The following must be defined by the relevant partners:

- Neuromorphic hardware dimensions, weight and communication link: 12cmx12cm, 200g, ethernet cable + power via usb.
- Additional DSLR camera for coastline video acquisition (e.g. topographic applications): one hyperspectral camera, 500g-1kg + 15cm x 15cm + batteries <1kg

UAV protocols and specifications for coastal surveys

In general, the main parameters for coastal surveys are morphology of the area, environmental conditions, survey planning, wind speed, precipitation probability, temperature, cloud cover, wave height, sun elevation angle (sunglint).

Here are some typical values for these main parameters:

- Wind Speed ideally up to 4m/s
- Payload – event sensor ("conventional" and FPGA or FPAA/spinnaker setup)
- Possibility to add DSLR and hyper-spectral camera (500-1000 gr) operating at 420~1000nm to help to distinguish between land and sea
- Flight altitude will vary ~ 100m for 2-5cm ground resolution
- Camera height and obliqueness are dominant factors in 3D reconstruction performance
- Structure from Motion (SfM) algorithms for the creation of coastal orthophoto maps (that is, a reconstructed orthorectified map, i.e. corrected from terrain distortion), notably by inferring depth by motion parallax cues
- Deep spatial feature extraction with different scales.

Visual Servoing Specifications:

We provide additional specifications below:

- Operational height for coastline data acquisition (e.g. volumetric reconstruction) (UNIWA). Typical height is 80 to 100m for 3D reconstruction – not mandatory. We will use 10 to 20m for first experiments and ajust if necessary.
- Operational height range of stereo sensors: from 1m to about 20m.

Traditional stereopsis typically requires a baseline distance of a few centimetres (~10-30cm), and operates at distances (*z* in the figure below) ranging from ~1m (near distance observation) up to about ~20m, depending on the resolution of the sensor.

For stereopsis based on event sensors, these values will be determined experimentally.

Notes: the UAV vibrations might be an advantage to generate events. If not, the IMU could be used to subtract vibrations (to be investigated).

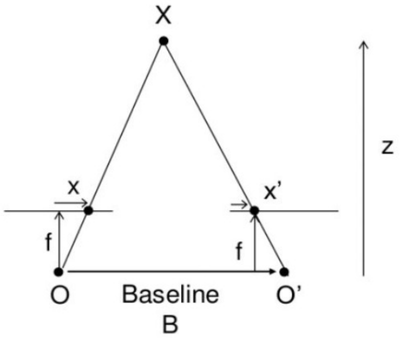

Figure 1: Stereo vision geometry.

- Min-max vehicle velocity for meaningful image data acquisition (in terms of topography), for reliable DVS operation, and for coastline detection algorithm (SNN-based) will be specified only after experimenting on the preliminary dataset.
- Output signal form (DVS+SNN) in the use case of coastline detection: we plan to output the estimated discrete position (and possibly discrete orientation) of the coastline.

We will use one couple of sensors for both use cases, with the same flightplan, and the same altitude. These sensors will be oriented at 45° from the horizontal level to be able to see in front of the UAV and avoid the worst light reflections on the see surface.

Base on these first specifications, we will define a feasible path forward and take into account the first experimental results in D-1.2.2.