ExpROVer - Milestone 1 - Architecture

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Version Control

Version	**Date**	**Authors**	**Changes Log**
V0.1	06/03/2019	António Santos (AS), Beatriz Borges (BB), Gonçalo Marques (GM), João Monteiro (JM), Sérgio Gasalho (SG), Tiago Almeida (TA)	First draft of the Introduction, Positioning and Problem Overview.
V0.2	11/03/2019	BB	Addition of Product Overview section.
V0.8	12/03/2019	AS, BB, GM, JM, SG, TA	Addition of Architecture section. Revision and update of the Product Overview section.
V1	16/03/2019	BB	Integration of project mentors' feedback.

Vision

1. Introduction

Remotely Operated Vehicles (ROVs) are underwater vehicles used across several sea- and ocean-related industries, for fish management, research purposes, dangerous maintenance operations and several other tasks.

The VideoRay Pro 4 (VRP4) is the world's most popular small underwater ROV. It incorporates the latest design and technology, making it stand out on the market as the most advanced, capable, and versatile small ROV.

Figure 1. VideoRay Pro 4.
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With a maximum depth of 300m, the VRP4 is controlled through an umbilical cord which directly connects it to a computer, which is used by the ROV to send data to the computer and to receive commands from it.

The VRP4 is controlled through the VideoRay Cockpit software, developed by VideoRay, executable only on Windows - and unfortunately known to be liable to problems and bugs.

Finally, this software requires training, being complex and demanding high levels of prolonged concentration from its users to ensure the proper maneuvering of the VRP4.

2. Positioning

In this section, the main problems and the project's locality are described.

2.1. Problem Statement

The problem of	operating a ROV or improving its functionality range
affects	all business and research institutions which require underwater monitoring or operations
the impact of which is	high labor costs, accidents' susceptibility and error-proneness during operations
a successful solution would be	the reduction of effort and inconvenience associated with operating a ROV, leading to lower expenses, higher efficiency and the enabling of new functionalities' creation.

2.2. Product Position Statement

For	owners of the VRP4
Who	want to control the VRP4 with either less specialized or more productive workers and have higher effectiveness in its operation
The ExpROVer	is a software solution
That	promotes a reduced workload and lower training requirements, offering several helper functionality and high accessibility to the ROV's systems.

Unlike	VideoRay’s Cockpit software
Our product	will run on Linux, as well as Android, and will have several additional semi-autonomous features, such as object recognition and smart maneuvering.

3. Architecture

3.1. Overview

The ExpROVer system sports a layered architecture with 4 levels:

1. The sensory and actuation layer, composed by the VRP4 and its integrated sensors and actuators
2. The data pre-processing layer, composed of the server machine directly connected to the VRP4 through its umbilical cord, integrates the information received and sent to the ROV with the ROS
3. The data analytics layer, composed of the server machine and possibly other data-processing units, which analyzes the video information and runs an object detection algorithms, as well as the logic responsible for semi-autonomous maneuvers
4. The control layer, running the Android or web ExpROVer application, interacts with users over the end devices

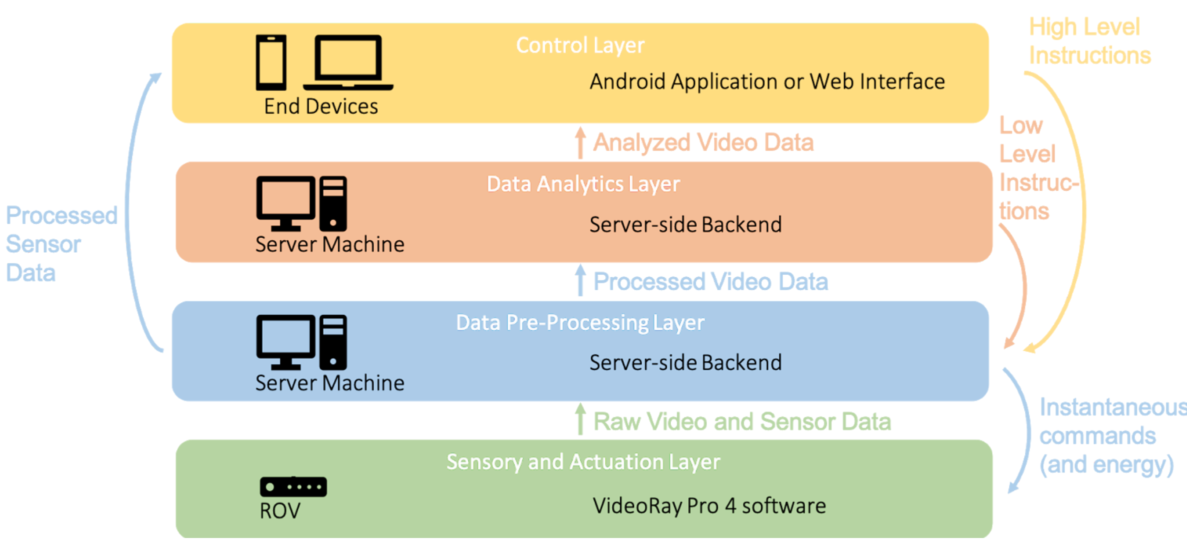

Figure 2. ExpROVer system's layered architecture.

The VRP4 supports a wide array of sensors and other peripherals that either are or can be integrated with the ROV. These peripherals enable additional functionality, such as distance and size estimation, enabled through a fan beam laser and two parallel lasers, respectively. The attached sensors (as the laser peripherals, manipulator arms) are connected to the ROV through the VRP4's unique port, that supports RS-485.

The ROV must be connected through an umbilical cord that powers the system and allows the user to both send commands to control the ROV and receive the sensory inputs which allow them to monitor its status.

This raw video and sensor data are processed and analyzed by the server machine, and the results are relayed to the active end devices. These devices are responsible for issuing high level instructions which the server machine will then break down into the actual ROS messages that the VRP4 will execute.

Another of the system's functioning and modules is depicted in Figure 9:

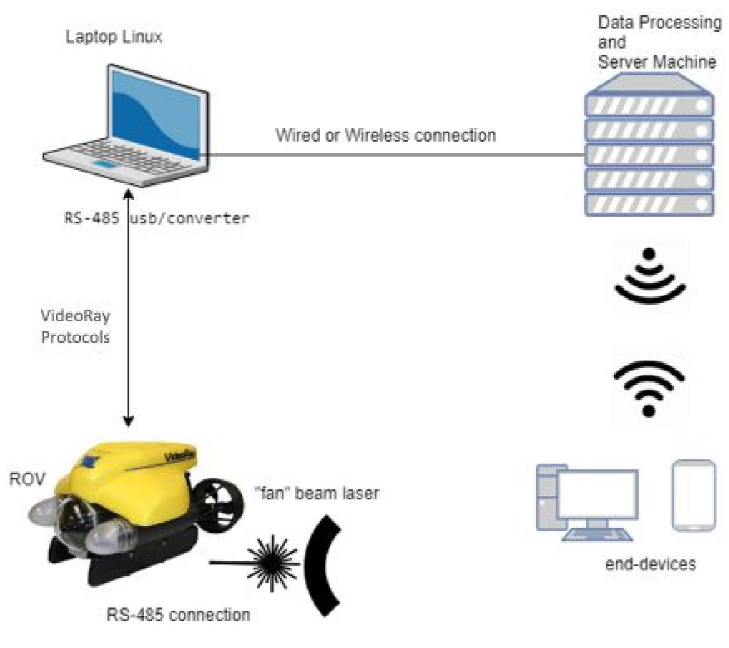

Figure 3. System interconnection diagram.

3.2. Available sensors and actuators on the VRP4

The VPR4 integrates several sensors:

- A camera,
- A pressure sensor, which indicates its current depth,
- A 3 axes compass, which indicates its heading,
- 3 axes accelerometers, which indicate its attitude,
- A water temperature sensor, which indicates the temperature of the water surrounding the VRP4,
- An internal temperature sensor, which indicates its internal temperature,
- And an internal humidity sensor, which indicates the relative humidity of the air inside the ROV.

It also presents a myriad of actuators, amongst which the most relevant are the following:

- Camera controllers, affecting configurations such as focus and tilt,
- Port, starboard and vertical thrusters' velocity and acceleration controllers,
- And its lights' intensity controller.

4. References

Several documents were consulted during the elaboration of this report:

1. Pro 4 Operator's Manual, VideoRay, March 2019, available at http://download.videoray.com/documentation/pro_4/html/index.html
2. Human-Automation Systems Lab general workspace, Georgia Tech ROS Group, March 2019, available at https://github.com/gt-ros-pkg/humans