AQUABOTS DEVELOPMENTS

Background information about the developments at the Aquabots lab

The concept

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ABSTRACT

The Rotterdam University of Applied Engineering, has been cooperating with companies such as PK Marine and RH Marine on the subject of autonomous aquatic vehicles since 2010.

This document gives an impression about the ideas behind this cooperation.

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CONTENTS

FIGURES

1 INTRODUCTION

The Rotterdam University of Applied Engineering, has been cooperating with companies such as PK Marine, Sens2Sea, Innoship e.a. on the subject of autonomous aquatic vehicles since 2010. The aim of this cooperation has been

- To provide to students attractive high-exposure tasks during their study,
- To raise the level of participating students by providing the experience of high-level experts from industry,
- To develop services made possible by special purpose, autonomous, aquatic vehicles and,
- To develop the design tools necessary to support the above aims.

This document provides a functional breakdown of any vessel or ship, whether small or very large, as a guide to introduce the ideas of the Aquabots team that guides these developments.

2 FUNCTIONAL BREAKDOWN OF AQUABOTS

An autonomous aquatic vehicle (in the following referred to as Aquabot) is a complex system comprising many small subsystems that, together, provide some service in the maritime domain. Therefore, the development of such a system requires the completion of many projects, some aimed at the building blocks, others at sensors, at test facilities and more. Because of the complexity of all the many necessary development steps, the Aquabot design team has subdivided the design process in a variety of design themes, each theme describing a various number of small projects that are small enough to be given to students. The interfaces of their project results are the focus of the design team. This way, the design team is able to reduce the complexity of each of the student projects and enable students to get a useful project result within the time frame allotted to them.

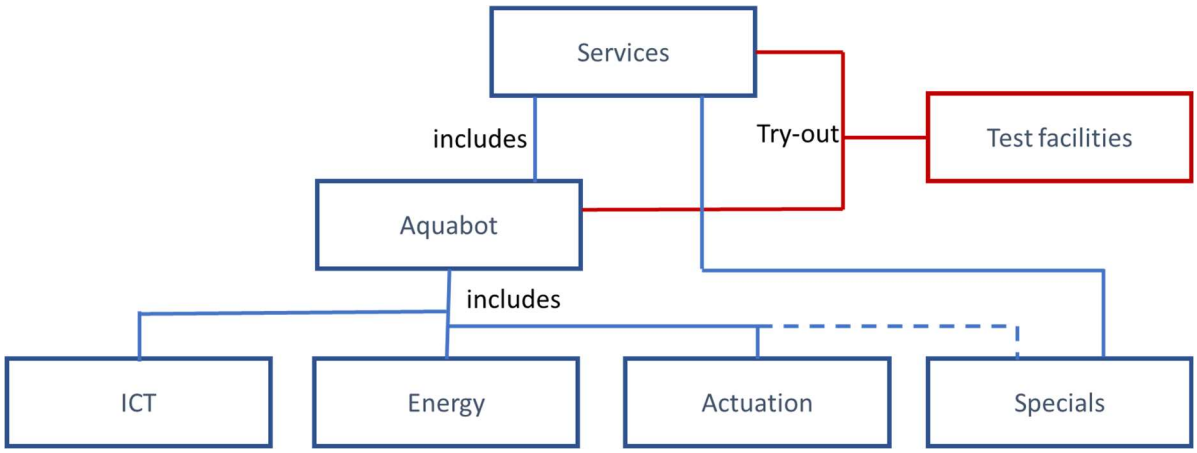

Figure 1 Aquabot themes

The main themes are

- Aquabot ICT architecture and components
- Aquabot energy architecture and components
- Aquabot actuation components
- Tailored aquatic services (usually including specialized components)
- Aquabot test facilities

2.1 AQUABOT ICT ARCHITECTURE AND COMPONENTS

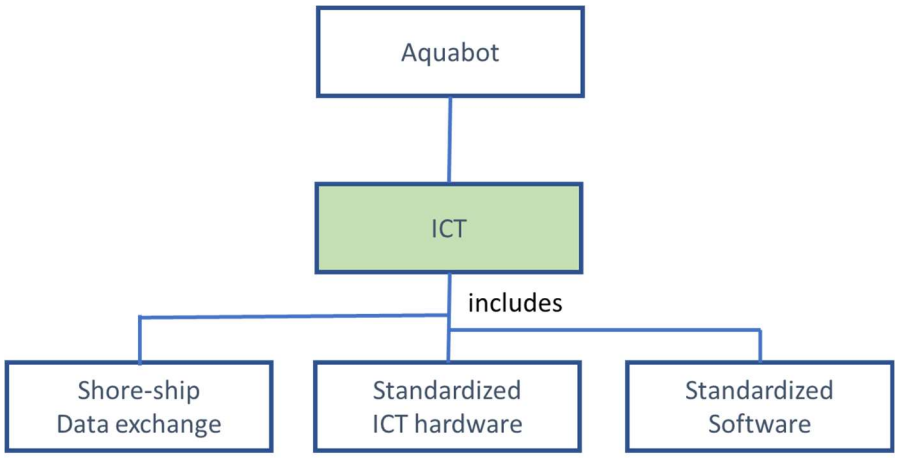

Figure 2 ICT architecture and components

The following tasks are of this category

- The development of a shore-ship data exchange architecture.

  As a minimum, this architecture should enable the command & control of aquabots from a remote control position on land as well as the collection of maintenance data, test data and camera footage. Some aquabot solutions may accept a close-range wifi solution, others require a solution that allow a much larger distance between aquabot and control centre.

- The development of standardized IT components

  Standardized IT components, specially designed to meet the requirements of aquabot development, will help students to focus on developing aquabot functionality, rather than on the means to design the hardware and software to enable that functionality. The first projects of this task has led to IT components that support plug&play functionality developed by students.

- The development of a standardized data exchange method

  Together with standardized IT components, a standardized data exchange method allows students to develop the set of “smart” functional components that together form the ICT of an aquabot.

2.2 AQUABOT ENERGY ARCHITECTURE AND COMPONENTS

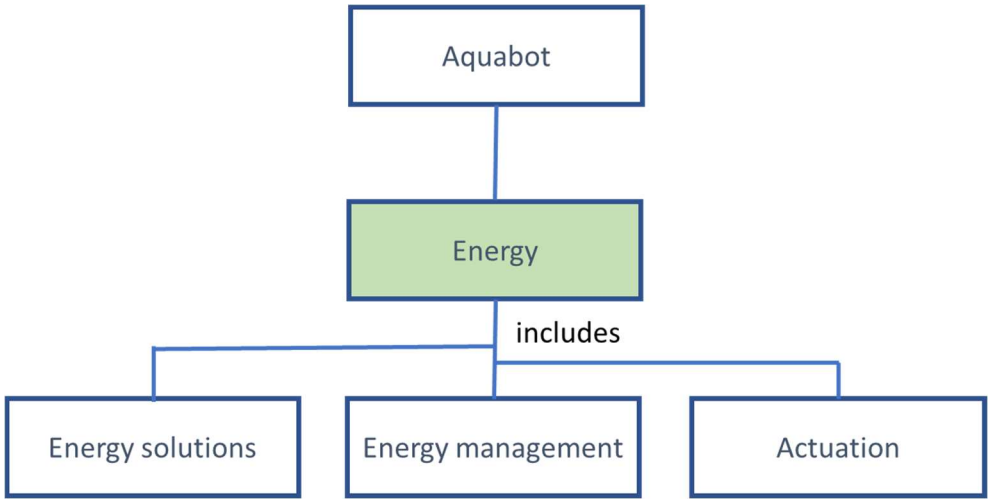

Figure 3 Energy architecture and components

The following tasks are of this category

- The development of energy solutions

  Application of batteries may be acceptable for short-range aquabot service solutions, but fuel cells are better suited for long range operations, possibly augmented by back-up batteries. Other options are sails and solar cells. Research is necessary to decide what to select for which aquabot designs given the services it is expected to conduct. A common aspect of each solution is, that it has to be a plug & play solution that makes optimal use of the aquabot ICT components.

- Energy management

  In all cases, an management & control system is necessary is able to weigh range and speed during the operation of an aquabot. It too should be a plug & play solution realized with the standardized aquabot hardware and software components. In addition, it is important that it should be able to support research in how best to weigh range and speed requirements of an aquabot solution.

- Aquabot actuation components

  Smart actuation components provide the thrust that realizes a desired longitudinal or lateral speed, a desired rotation motion or a desired stabilization force. Some aquabot designs may be driven by propellers, but wheels and sails may be an attractive alternative solution.

2.3 TAILORED AQUATIC SERVICES

An aquabot design heavily depends on its application. At sea, size matters as a small design may be too sensitive to the prevailing sea state. On the other hand, in small inland waters, a small design may be preferable. Whereas a relatively large hull enables a large payload, a small hull may be used in confined spaces like a water duct.

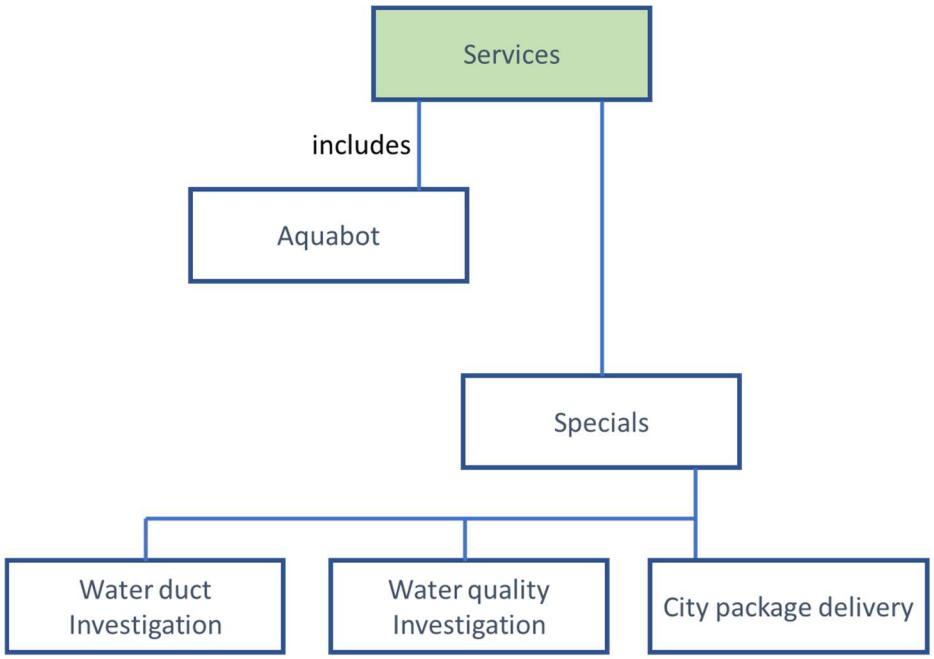

Figure 4 Aquatic services

- Water duct investigation

  Water ducts are applied to connect small inland waters underneath roads, such that a much more expensive and voluminous bridge is not necessary. The service to be developed is a fast, low cost, solution to acquire data about the interior of the water duct, data that is suited for determining whether or not maintenance is required. It requires dedicated sensors able to detect problems in a difficult environment

- Water quality measurement

  One land-based control centre may operate several autonomous aquabots and replaces a manned ship while being able to collect more data and also in confined inland waters that are not accessible to manned boats. Specialised sensors and a simple system to get the ship in the water and retrieve it again are important aspects of the service

- Package delivery along inland waterways

  The accessibility of cities by means of its roads tends to be poor due to often heavy traffic. Some of these cities have a lot of waterways that may be used by a small package delivery aquabot to bring (small) packages to the inner city without contributing to that traffic. Specials include the loading/unloading of packages and methods to prevent unauthorized access.

2.4 AQUABOT TEST FACILITIES

Aquabot solutions need extensive testing, preferably in realistic test conditions. For that purpose, the Aqualab, part of the Innovation Centre on the RDM premises, comprises a basin and a large tube. Both have the ability to create waves, though that of the tube requires a substantial improvement.

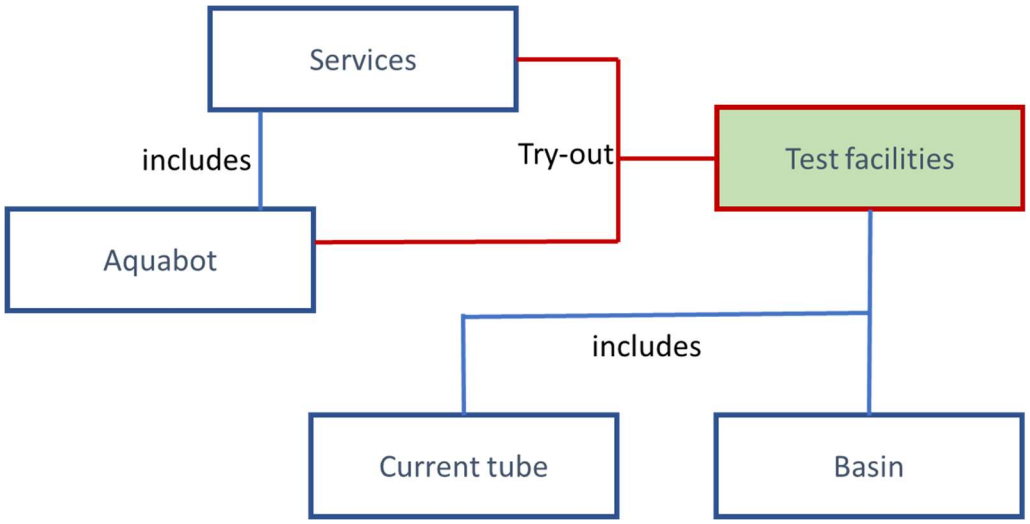

Figure 5 Aquatic services

- Wave control in the current tube

  In theory, it is possible to generate unidirectional waves in the tube system. However, the type of waves cannot be influenced. Research should provide a solution where the operator enters a wave profile while the system to be designed transforms this to a pattern on its actuation system such that the desired pattern will be realized.

3 CONTACTS

The following tabel lists the primary team members (those that define the development path and the main design choices) .

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In addition, there are various lectors and teachers who guide the students that are involved in the various developments. Furthermore, there are companies and authorities that provide support where needed.