BALLAST WISE Ballast Water Investigation System

Report to the:

The Danish Maritime Fund

Ballast Water Control System

Supported by the Danish Maritime Fund, project number 2013-064

DHI Fishlab adk Environmental Investigations UNIT ONE LIFE SCIENCE & VISION TECHNOLOGY BIORAS Den Danske Maritime Fond

Indhold

Introduction

The project "Ballast Water Control System" 2013-064 is implemented by the companies Bioras ApS, DHI group Unit-One and Fishlab in the period 1/7/2013-31/3/2015 with support from the Danish Maritime Fund.

The aim of the project is to develop an automatic system for quantification of organisms larger than 50 µm in ballast water samples, using image analytical techniques. The sensor should be able to detect organisms as described in recent regulations on ballast water from IMO and US Coast Guard.

The method must be quick and simple to use, so that the test can be performed directly after sampling on the ship. The idea is to develop a new kind of sensor that is adapted to the analysis of ballast water samples that are rugged and simple to operate. The product is intended for port authorities, manufacturers of water treatment technologies, classification societies, testing authorities, as well as ship operators wanting to carry out self-monitoring.

The project partners have during the project period developed hardware and software for a sensor that can detect living zooplankton organisms in water samples. The system can detect individual organisms by means of an intelligent algorithm that can detect movements of even the smallest particles (animals) against a relatively complex background of stationary particles, bubbles, mm. Prototypes that were constructed and tested in the project period have given a fairly clear picture of how the finished system will be put into production in the near future.

More information about the project can be found at: http://ballastwise.dk

Aim of the project

IMO has developed a ballast water convention in order to prevent the spread of invasive species between the various maritime areas, which are expected to enter into force by 2016. According to the Ballast Water Convention, ballastwater must be cleaned before it is discharged, and there must be no more than 10 live organisms larger than 50 µm/m3 in ballast water discharged to the environment. Today control of ballast water is carried out in particular in connection with the approval of new water treatment technologies. According to the IMO Ballast water guidelines, port authorities have the right at any time to verify that ships manage ballast water in accordance with the rules, and sampling should be a simple and quick process which is carried out during the discharge of ballast water.

The purpose of this project was to develop a new method (Ballast Water Control System) that automatically checks the number of live organisms larger than 50 µm in ballast water. The method must be quick and simple to use, so that the test can be performed directly after sampling onboard of the ship. The market potential is large, since there is no corresponding automatic method for automatic control of the number of living organisms over 50 µm, and more than 35,000 ships must have installed systems for purification of ballast water over the next 10 years. With the large number of new installations, there will also be a need for equipment for rapid control of ballast water quality.

Activities

1. Development of counting Chamber for quantification of zooplankton organisms. Responsible: Per Poulsen, UnitOne. Participants: Nick Blackburn, Bioras

2. Customization of the analysis software: Responsible: Nick Blackburn, Bioras.

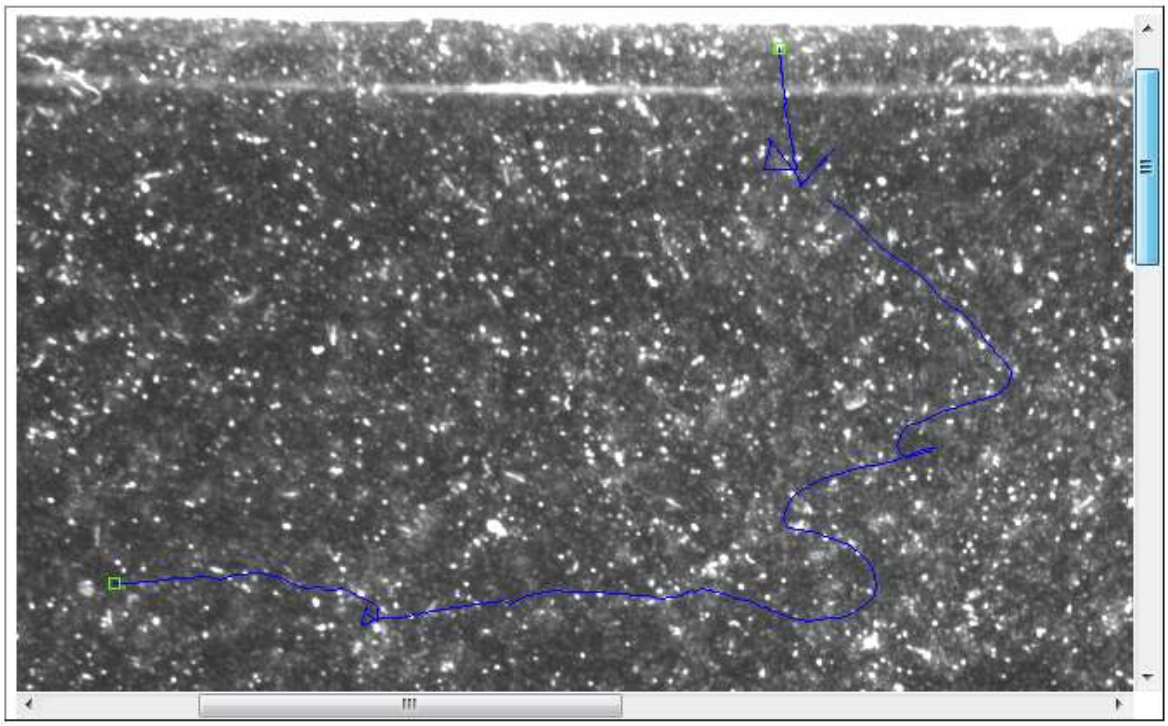
3. Tests with zooplankton behavior: Zooplankton are characterized by their movement, and different zooplankton groups have different behavior patterns. Responsible: Kirsten Engell-Sorensen, Fishlab. Participant: Frank Fotel, DHI

4. Validation and testing of the method: Automatic analysis of number of live zooplankton compared with manual counts with cultures and water samples from the DHI ballast water Centre. Responsible: Frank Fotel, DHI. Participants: Kirsten Engell-Sørensen, Fishlab; Pia Haecky, Bioras

Adaptation of motion analysis

BallastWISE is a Visual analysis tool that can track moving organisms. During the project period the algorithm was improved, and a number of adjustments were made to ballast water analysis function.

The image below shows an example of an organism track (blue line) in a sample with a large quantity of particulate material.

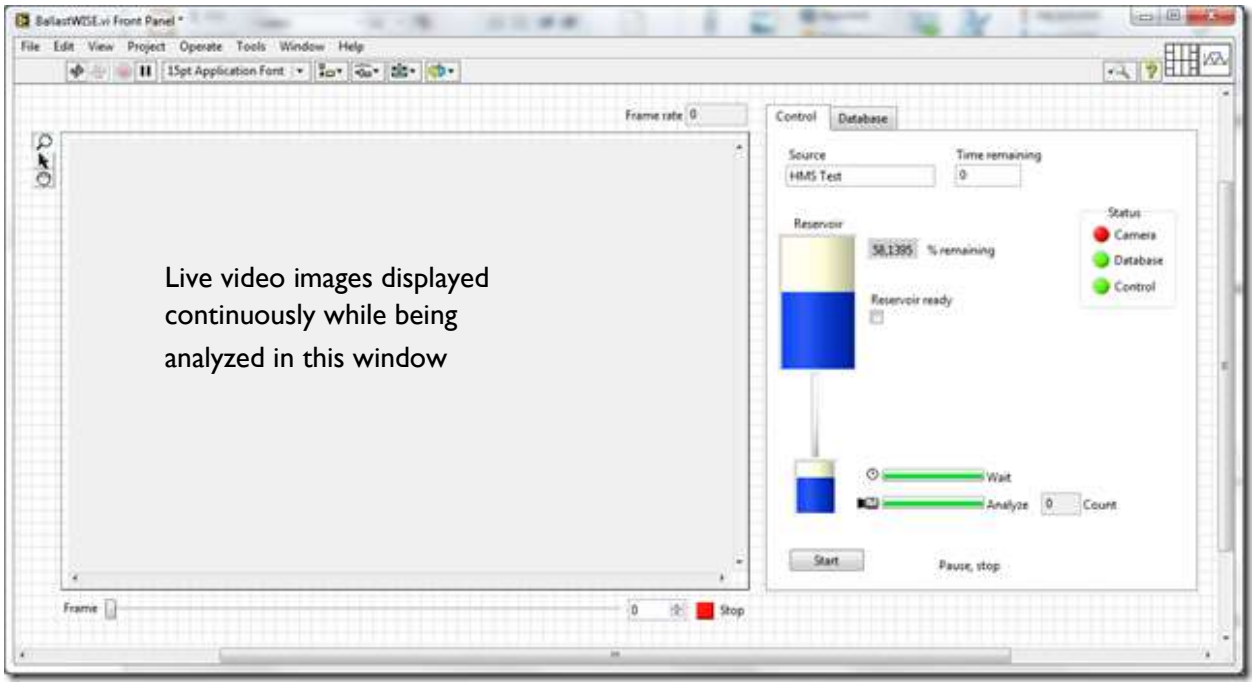


Software

The user interphase shows a live video image of the water sample.

The analysis process is shown:

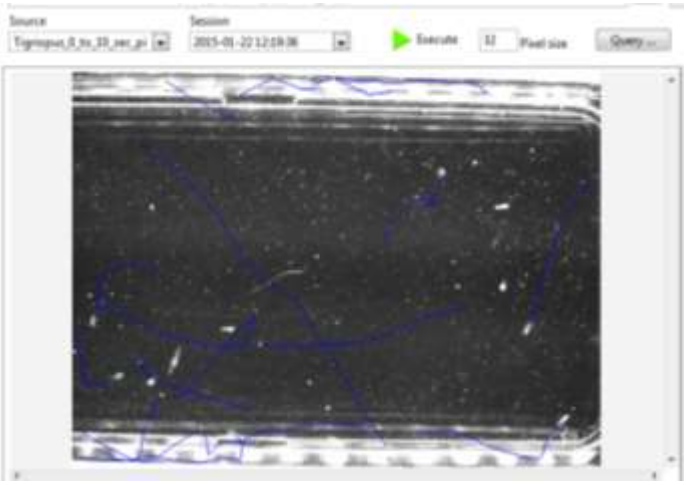
- Filling the measuring chamber
- Emptying the reservoir
- Counting the number of live organisms >50 µm
- Fault diagnostics
- The database will provide an opportunity to look back at past performance

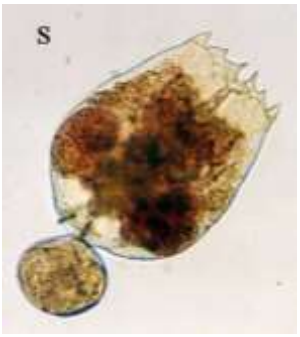
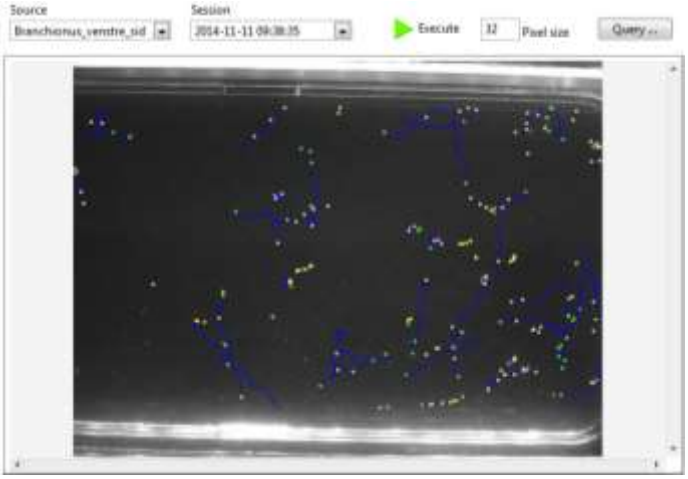
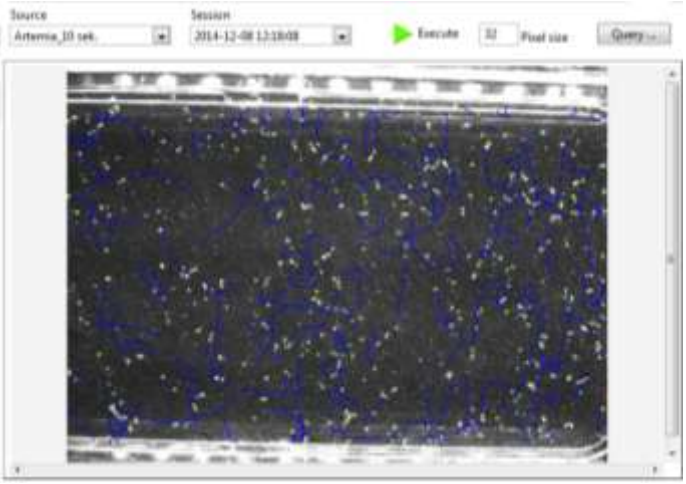
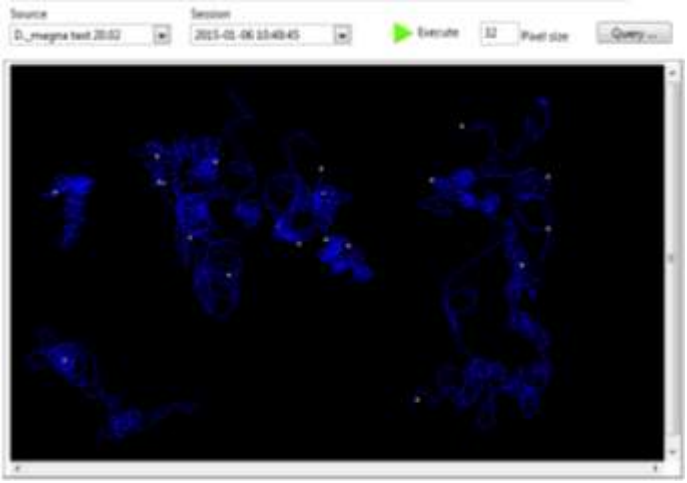


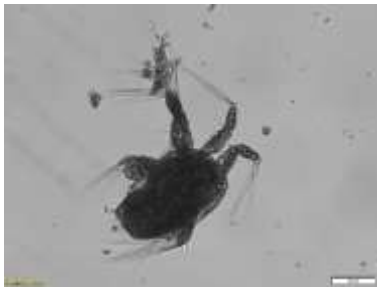
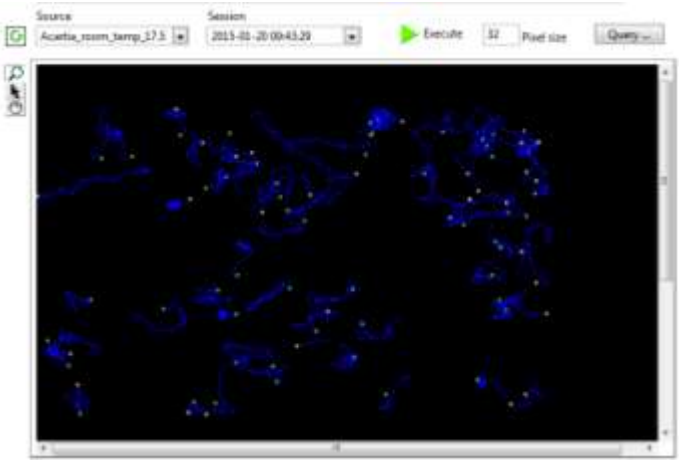
Tests with zooplankton behavior

Tests were made with the following organisms: Daphnia, harpacticoid copepods, rotifers, calanoid copepods, Artemia, Ciliater, natural samples.

In the table below examples of organisms and their movements are shown. The tracks are generated with the BallastWISE system. The blue lines are tracks from individual organisms.

Oragnisme	**Billede**	**Spor**
Tigriopus		

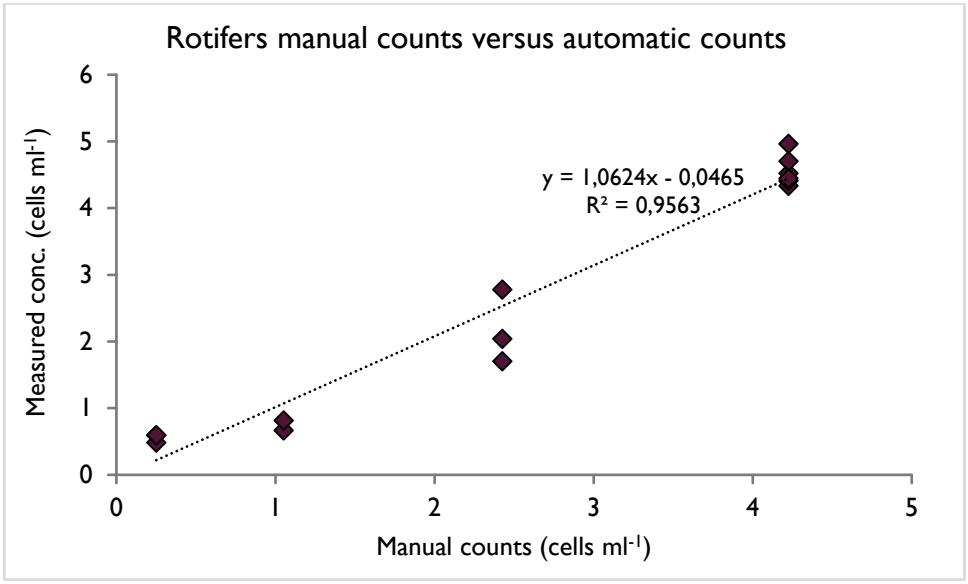
Brachionus		
Artemia		
Daphnia magna		

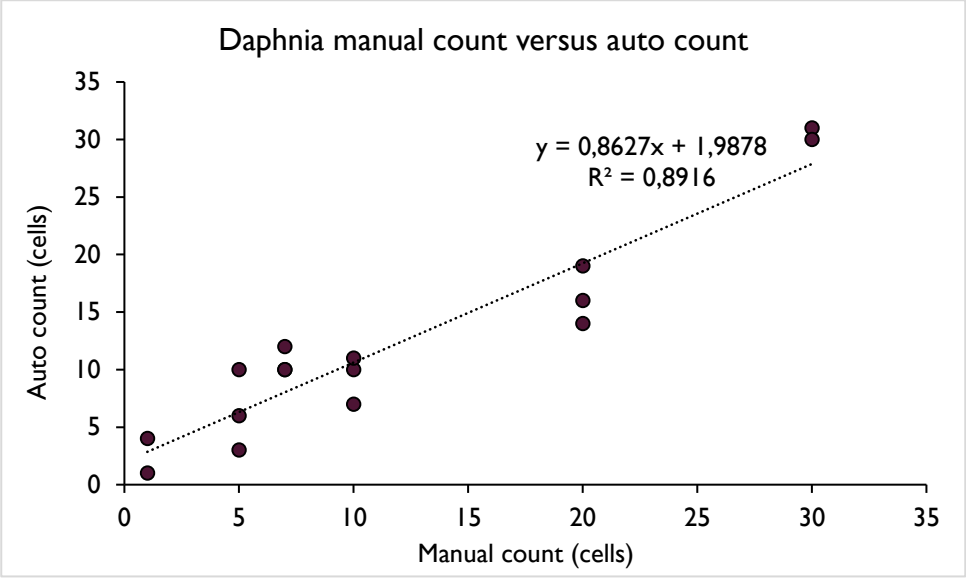
Acartia nauplia		

Validation and testing of the method

Comparison of manual and automatic counts

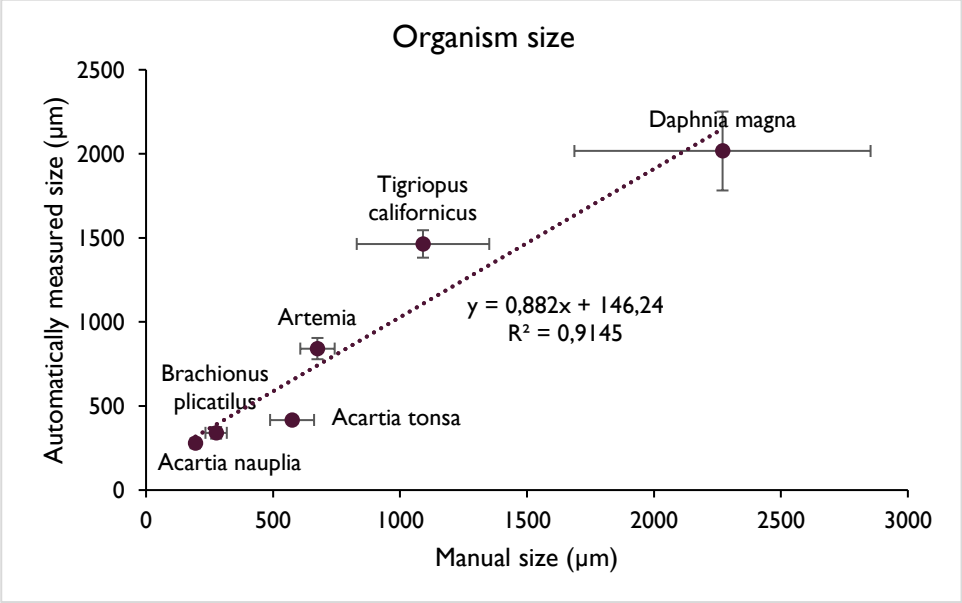
There was good agreement between manual and automatic counts for Brachionus and Daphnia, as shown in the diagrams below.





Organism sizes by manual and automatic measurement

A comparison of manual and automatic measured sizes on organisms in the experimental period is shown in the graph below. The sizes of the individual organism groups varied, especially for the largest organisms, there were considerable variations.



Conclusion and next steps

We have defined the main parameters in connection with this system for the detection and measurement of movement organisms from 50 µm and above in an observation Chamber. The specification of the Chamber was a greater technical challenge than expected. On the other hand, it turned out to be technically possible to reduce disturbances to a minimum with choice of shape and the right materials. This enables higher precision for detection of individual organisms by means of an intelligent algorithm that can detect movements of even the smallest particles (animals) against a relatively complex background of stationary particles, bubbles, etc. The prototypes that were constructed and tested have given a fairly clear picture of how the finished system will be put into production in the near future.