Lean Innovative Connected Vessels “LINCOLN” Project

Petros Karvelis, Chrysostomos Stylios and John Garofalakis

Computer Technology Institute & Press “Diophantus”, Patras, Greece,
karvelis@westgate.gr, stylios@cti.gr; garofala@cti.gr

Abstract
LINCOLN is a 36 months innovation action project funded by European Union (EU) Horizon 2020 under Blue Growth programme: “High value-added specialized vessel concepts enabling more efficient servicing of emerging coastal and offshore activities”. Lincoln objective is to develop three new added value vessels with innovative on board equipment, using lean design methodology and IoT solutions, able to be used in diverse maritime coastal activities and sectors in an efficient and sustainable way. Computer and Technology Institute & Press "Diophantus" has developed the PortWeather application, an IoT application, gathering information and providing useful information on weather monitoring and forecasting for safe sea transportation especially rescue operations.

Keywords: marine weather, monitoring & forecasting, IoT solutions

1 Introduction

The main objectives of the LINCOLN project are to a) improve vessel design and manufacturing through the LEAN Product, fostering EU Small and medium-sized enterprises (SMEs) maritime competitiveness, b) to develop and deliver Internet of Thing IoT based solutions for the maritime professional market, enhancing EU SME technological capabilities and c) to adopt lifecycle environmental and economic assessment to provide sustainable vessels solutions. CTI has developed the PortWeather solution that operates as an autonomous system to provide weather forecast at a specified geographical position and it is integrated into the LINCOLN platform. Portweather application forecasts the speed of the wind, hours ahead, based on previously recorded values and other measured parameters. It utilizes a small memory footprint Machine Learning (ML) algorithm, which runs in a low power, low CPU frequency and low memory microcontroller. It provides warnings reports and the forecasting weather values to the Lincoln Web platform. The method has been successfully tested in real data.

2 LINCOLN Project description

LINCOLN is a complex project where innovative vessels are designed according to lean design tools (KbeML – Knowledge Based Engineering Modelling Language) and

methodologies (SBCE – Set Based Concurrent Engineering), taking care of sustainability of the whole process, from environmental (LCA - Life Cycle Assessment) and financial (LCC - Life Cycle Cost) point of view and adopting digital solutions, through an integrated IoT (Internet of Things) platform, able to provide knowledge and future services to the maritime sector actors. In detail, the IoT platform consists of a physical part made of dedicated black boxes the Universal Marine Gateway (UMG) black box for vessel prototypes and the Marine Gateway (MG) for commercial versions, hosting sensors and connected to other vessels systems, like the on-board weather station. The data gathered by the sensors are collected and processed in the Lincoln IoT hardware and finally analyzed through specific machine learning algorithms. The generated information is published through a web interface to different users' categories, like designers, shipbuilders, suppliers and maintenance companies and so on. Moreover, the platform includes a semi-automated virtual towing tank, based on High Performance Computing (HPC), where the designers can simulate the hull behavior in different conditions, fastening the design choices.

2.1 The Partnership

The consortium is formed by 16 partners from six European Union countries and is led by the Politecnico di Milano. More specifically, the partners of the project are:

1. Politechnico di Minalo, Italy, [Coordinator] www.polimi.it
2. Asociacion Centro Technologico Navaly Del Mar, Spain www.ctninnova.com
3. HUBSTRACT SRL , Italy www.hubstract.it
4. Technopro Hispania SRL, Spain www.tecnoprosl.com
5. BIBA - Bremer Institut fuer Produktion und Logistik GMBH, Germany www.biba.uni-bremen.de
6. HOLONIX SRL-Spin off del Politechnico di Minalo, Italy www.holonix.it
7. STIFTELSEN SINTEF, Norway www.sintef.no
8. CINECA Consorzio Interuniversitario, Italy www.cineca.it
9. HYDROLIFT AS, Norway www.hydrolift.com
10. SOUPER TOYS SKAFI EPE, Greece www.supertoys.gr
11. INVENTAS KRISTIANSAND AS, Norway www.inventas.no
12. TOI SRL, Italy www.zerynth.com
13. CTI Diophantus, Greece www.cti.gr , www.westgate.gr
14. Balance Technology Consulting GMBH, Germany www.bal.eu
15. ARESA MARINE SL, Spain www.aresaboats.com
16. Center of Technology Research and Innovation LTD, Cyprus www.cetri.net

3 "Portweather" Application

Portweather is a an IoT application, which provides local short-term weather forecast, which is very useful for safe sea transportation, especially during rescue operations contributing to the rescue of people at risk in the sea. The application operates using

continuous measurements from a meteorological station on a pilot vessel. The meteorological station *records automatically all the measurements of its sensors*. A Machine Learning algorithm embedded on hardware provides wind speed forecast and warnings. The Portweather solution operate as an autonomous system, which is integrated in the LINCOLN platform. This way, information on vessel behavior is combined with sea and weather conditions at a specified geographical position.

The weather data are collected and transmitted through the National Marine Electronics Association (NMEA) 2000 protocol to the UMG black box where they are processed and fed to a machine learning algorithm [3], [4] which predicts the wind speed ahead of time. The data are then send to the cloud and the user can view the current weather parameters as well as the forecasted wind speed in the LINCOLN web platform.

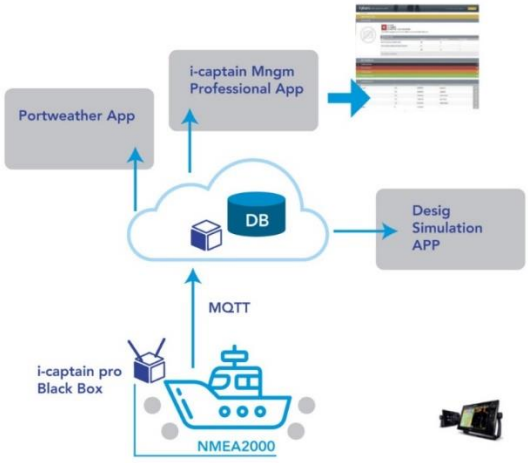

Fig. 1. Visualization of the platform and applications correlations.

PortWeather application forecasts the speed of the wind, minutes/hours ahead, based on previously recorded values and other measured parameters. The data is collected online from an on board weather station and used as input to an advanced Machine Learning Algorithm, which provides Wind Speed prediction for 30 minutes, one and two hours ahead.

Fig. 2 displays the forecasted values for the wind speed as they are visualized in the LINCOLN web platform.

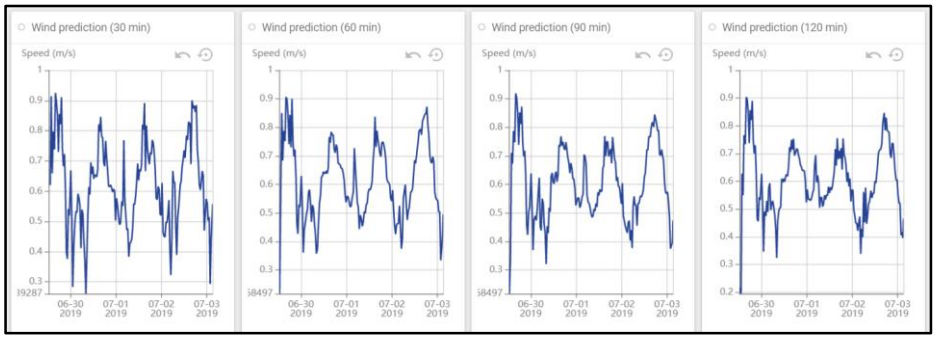

Fig. 2. The LINCOLN web platform displaying the wind speed forecasts for 30, 60, 90 and 120 minutes ahead of time for a boat.

Portweather application is considered essential during rescue operations and/or general sea-transport because it provides on-site weather information and visualization along with alerts and forecasts regarding potential extreme weather conditions. All this information will be provided as final products of an automated classification algorithm, embedded into a decision support system, which will visualize such type of information through graphs and alert notifications.

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