Case study – e-Navigation trials on APPS project

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I. Introduction of APPS Project
Eureka R&D project

- From Jan 2015 to Dec 2017
- 15 partners from Netherlands, Turkey, Spain, Republic of Korea
- 2 end users (Port of Rotterdam, Republic of Turkey Ministry of Transport, Maritime Affairs and Communication)

APPs (Advancing Plug & Play Smart Surveillance) Project

- Sensor integration
- Behavior analysis
- MSI service & visualization

- Multiple sensor processing
- Data security & sharing platform
- Real-time data interface

- Plug & Play architecture
- UAV platform
- Standardized data model

- 3D visualization
- Operator Aids

- Netherlands
- Turkey
- Korea
- Spain
Purpose

- Enable the development of plug & play solutions
- Enhance sensors-processing and intelligent decision-making capabilities and intelligent operator-aids of such systems to achieve smart surveillance
- Developing acoustic and physico-chemical sensors, LTA(Lighter Than Air) and stationary wing UAV(Unmanned Aerial vehicle)
II. e-Navigation trials on APPS (from Jan to Dec 2015)

Case #1. How to collect sensor data on board
Case #2. Detection and tracking of small or non-cooperative vessels
Case #3. How to improve software quality
Case #1. How to collect sensor data on board
Case #1. How to collect sensor data on board

**Data collection from sensors on board**

- **Background**
  - There is various accident risk in maritime, such as collision, grounding, sinking, fire/explosion and engine damage.
  - There are several devices and sensors that are installed on vessels in compliance with international regulations.
  - Sensor data on board is key parameters for behavior analysis to predict maritime accident and to detect abnormal behavior.

<table>
<thead>
<tr>
<th>Sensor data on board</th>
<th>Services</th>
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<td>AIS</td>
<td>Vessel monitoring</td>
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<td>UHF</td>
<td>Collision prediction</td>
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<td>Gyro</td>
<td>Recommend safety route</td>
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<td>Wind</td>
<td>Small vessel monitoring</td>
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<tr>
<td>6 axis</td>
<td>Marine weather</td>
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<tr>
<td>Fire</td>
<td>Detection of sinking, grounding</td>
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<tr>
<td>Engine</td>
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<tr>
<td>Sonar</td>
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Case #1. How to collect sensor data on board

Requirements for Sensor interface device

- To interface with legacy sensors on board
  - Need to apply international standard (IEC61162-1,2,3,450, SensorML...)

- Algorithm to select optimal maritime communication autonomously
  - Considering type, priority, transmission interval of collected data and cost and data rate of available network

- Data exchange between ship and shore side system
  - Using proper interface with open API (IoT platform, Maritime Cloud...)
Case #1. How to collect sensor data on board

System configuration

Ship side

On board system

Sensor interface device

AIS, UHF...

Ethernet/ Wi-Fi

3G, LTE, Satellite...

IoT platform, Maritime Cloud...

On board plotter

Mobile Application

Plug & Play platform

Behavior analysis server

Rules & Knowledge server

AMIS service system

Situational awareness system

AIS /UHF

Sensor integration server

Web Server

Web server

Data server

Mobile Application

Command & Control system

Mobile Application

Plug & Play Layer

3G, LTE, Satellite...

UAV systems

Interfacing system

Ship side                Shore side

Wind sensor

Fire sensor

Engine sensor

Sonar sensor

Gyro sensor

Echo sounder

6 axis sensor

nonstandard sensor

...
Case #1. How to collect sensor data on board

Prototype of sensor Interface device

- We implemented the prototype of hardware to interface with some of the sensors on board.
- This year, we are going to implement the plug & play function and other remaining algorithm based on this prototype.
Case #2. Detection and tracking of small or non-cooperative vessels
Case #2. Detection and tracking of small or non-cooperative vessels

**Background**

- Detection relies on radar & AIS signals (which non-cooperative vessels do not send).
- Existing surveillance systems based on radar only are not always able to recognize not reported threats and issues, such as non-cooperative vessels, carrying illegal immigrants.
- We are going to use multiple sensors to detect and classify the vessels.
  - IR(Infrared Ray) cameras, PTZ(Pan Tilt Zoom) cameras
  - Acoustic sensors
- **Unmanned Aerial Vehicles (UAV)**
  - Lighter-Than-Air
  - Fixed-wing UAV
Case #2. Detection and tracking of small or non-cooperative vessels

1st demonstration in port of Rotterdam

- The 1st demonstration in port of Rotterdam (17th Dec, 2015)
- Purpose of demonstration
  - To detect vessels using visual sensors
  - To integrate by DDS(Data Distribution Service) system
  - To portray detected targets and analyze for collision prediction based on ENC
- Installed cameras
  - 2x fixed thermal cameras
  - 1x Pan-Tilt-Zoom (PTZ) cameras
  - Extensions for 5x additional cameras

![Cameras and map of port of Rotterdam]
Case #2. Detection and tracking of small or non-cooperative vessels

1st demonstration in port of Rotterdam

- Data integration using DDS (Data Distribution Service)
- Data of detected target: ID, position, SOG, COG, size of ship...

![Diagram showing the demonstration process in port of Rotterdam.](image-url)
Case #2. Detection and tracking of small or non-cooperative vessels

1st demonstration in port of Rotterdam

- Integrated detected target using DDS
- Displayed target based on ENC (red symbol: detected by sensor)
- Collision prediction demonstrated using AIS and detected target data
Case #3. How to improve software quality
Case #3. How to improve software quality

How to improve software quality

- **Background**

  - The guideline on “Software Quality Assurance and Human-Centered Design for e-Navigation” was adopted by IMO.

  - In order to assure the software quality, it is necessary to follow a defined procedure throughout the entire software development period.

  - The utilization of tools to support this can become one of important factors to improve productivity of software development and to keep the software quality consistently.
Case #3. How to improve software quality

Adopted CI (Continuous Integration) tool

- Adopted CI (Continuous Integration) tool to keep software quality consistently
- Automated the process which compiles – tests – verifies – deploys source codes
- Four steps to apply CI tool

Adapting software development process → Tailoring templates and documents → Adopting CI tools → Applying to a sub-system of APPS
Case #3. How to improve software quality

**Improvement of**

- Managing the status of progress **visually**
- **Communicating** between stakeholders **using templates and documents**
- **Tracing the history** of change of every requirement
- **Reducing cost and time** to integrate and build source codes
- Understanding the necessity of quality management
III. Conclusion
Conclusion

- Introduced e-Navigation experience in EUREKA-supported APPS project
- Conducted 3 case studies focusing on e-Navigation.
- This result can be connected to the existing test-beds with proper interfaces in the future.
Thank you