Towards the Implementation of Ship Recognition and Identification System in Costal and River Information Services

Natalia Wawrzyniak & Tomasz Hyla

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Your Presenter:

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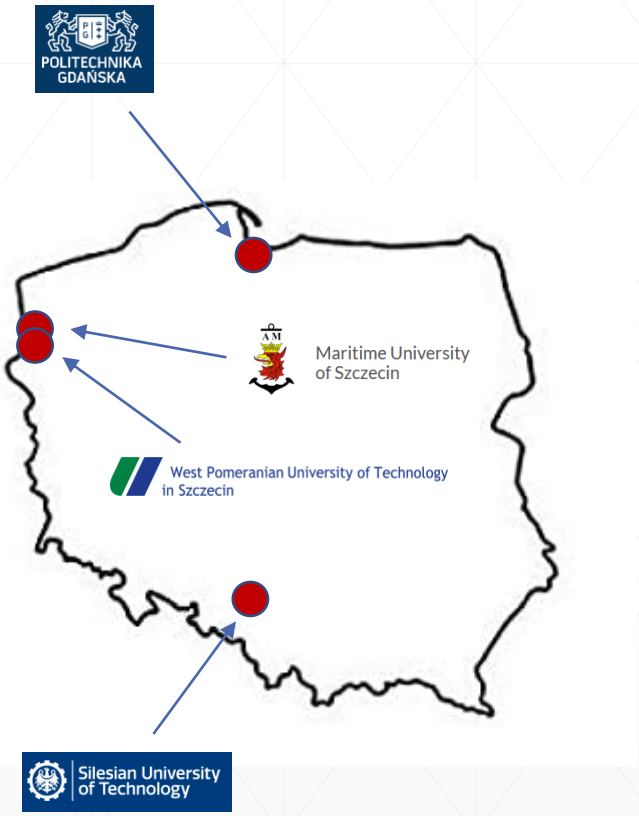
- Lider in SHREC project, Marine Technology Ltd., Poland
- Associate Professor, Maritime University of Szczecin, Poland

Research interest:

- Applied computer science in inland navigation
- Remote sensing, image processing
- Spatial data processing, GIS solutions
- Underwater imaging, hydrography

SHREC Project

- Project financed by National Centre for Research and Development (NCBR) of Poland from program LIDER
- LIDER is a program for young scientists focused on building and leading interdisciplinary teams of researchers focused on delivering innovative solutions
- Our teams consists of 9 young reserchers from 4 Universities in Poland
  - Maritime University of Szczecin
  - West Pomeranian University of Technology
  - Gdańsk University of Technology
  - Silesian University of Technology
- Hosted by Marine technology Ltd



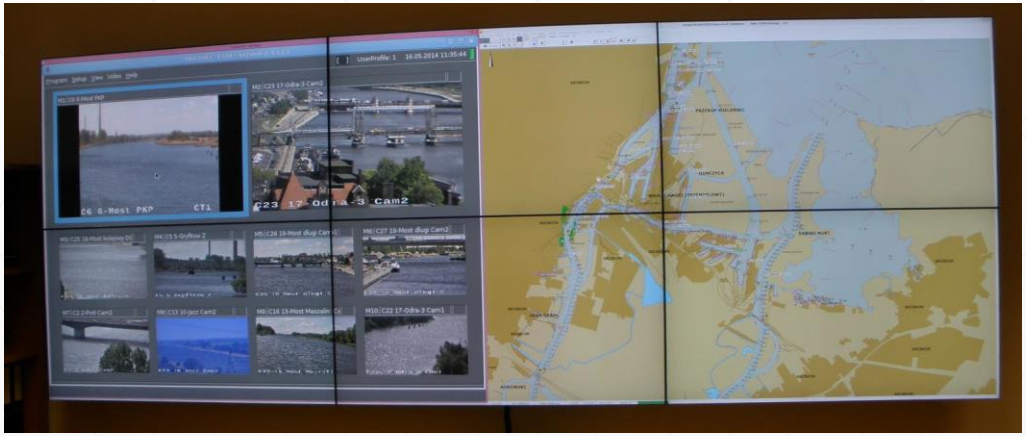
That’s us

Outline

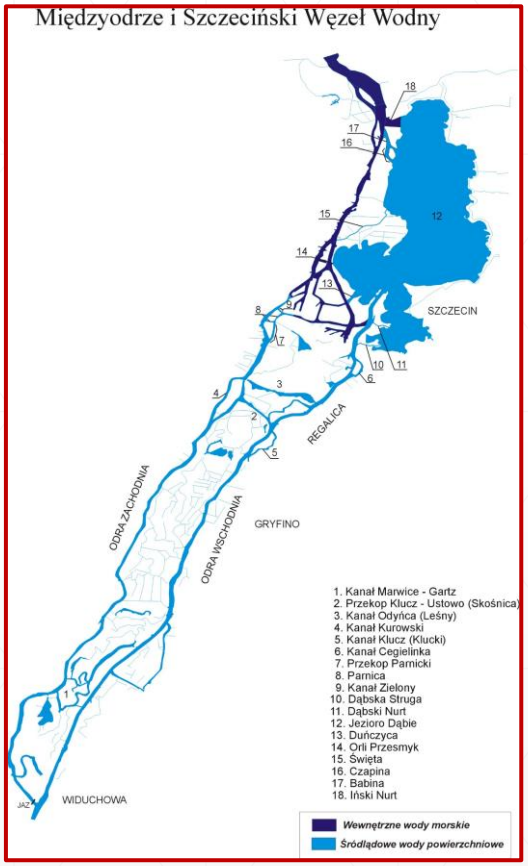
- Motivation and project objectives
- SHREC as a part of River Information Services
- General SHREC system overview
- Conclusion

Motivation

- Ships traffic monitoring is a key issue in limited areas: waterways nods, ports, busy rivers – main reason: safety of navigation
- Such areas are usually covered by some form of vessel traffic information systems: either VTS or RIS
- Video monitoring is used as an addition to other systems (AIS/Radar) and needs an operator to monitor ships traffic



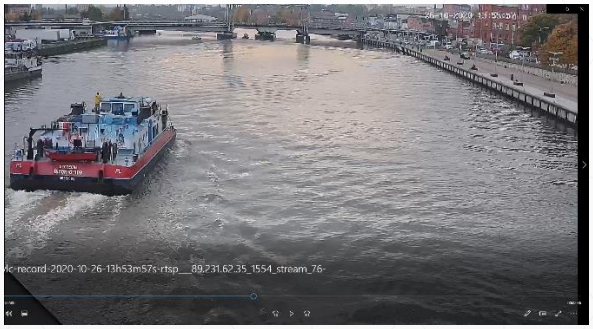
We are here… where marine and inland waters meet



Objectives

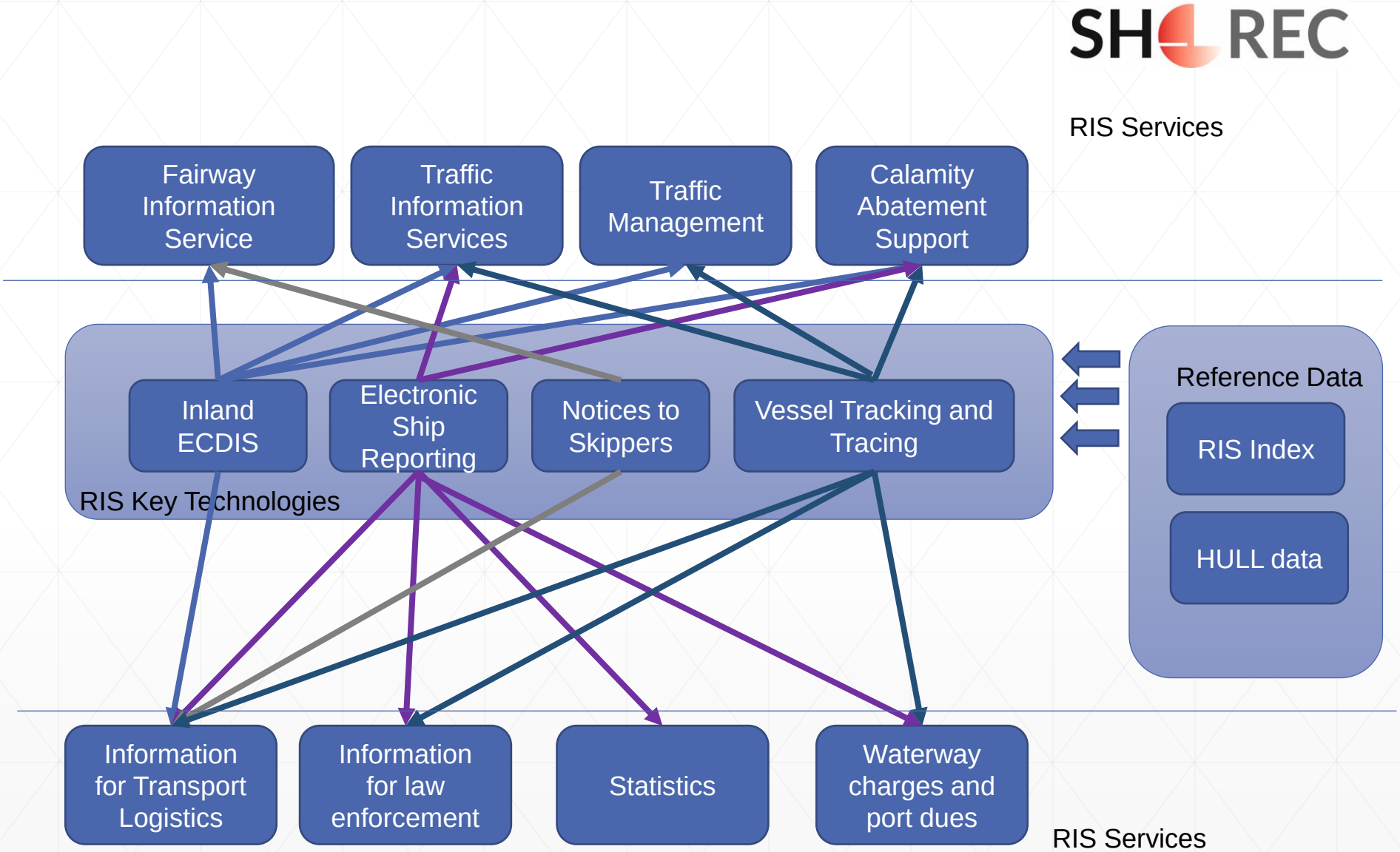
- Vessel traffic information services have problems to detect and identify smaller craft on their waters
- Marine, international ships under SOLAS convention have to use AIS transponders , but its a passive way of identification and ships for a variety of reasons can turn off their transponders or send false messages
- VTS and RIS systems, besides AIS (when possible) and radars (for detection and tracking), use video monitoring as a way to visually identify units.
- Contrary to data in other VTS/RIS subsystems, information on ships identification is not processed in any way, nor passed to other receivers in the system.

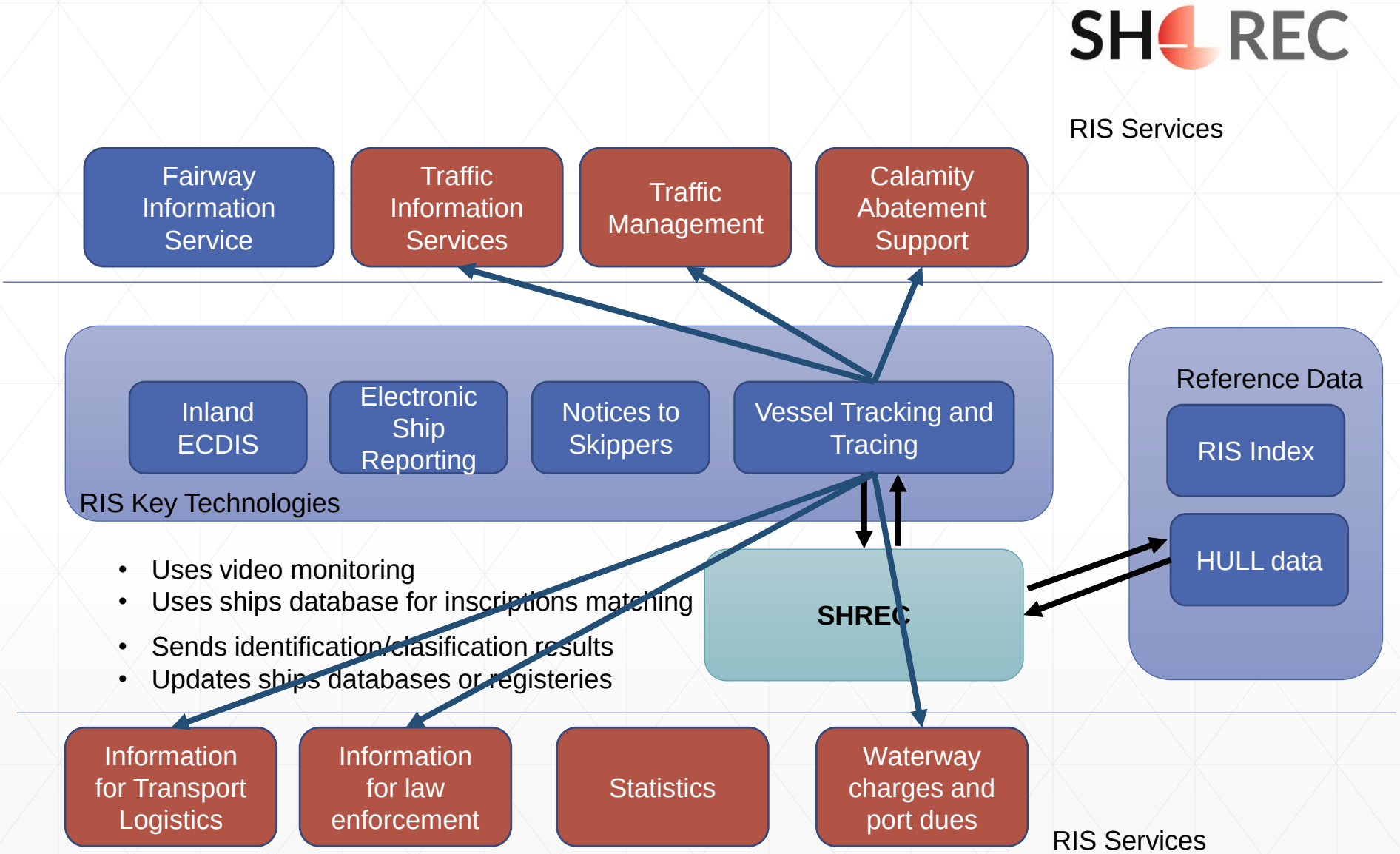
SHREC



Our approach:

- uses video monitoring of any traffic monitoring systems (RIS/VTS)
- detects, clasifies and identifies ships
- uses AI and analytical techniques of image/video processing
- Modular architecture
- Designed mostly for smaler craft, not regulated under SOLAS convention
- transmit information about the ship to other system services and their recipients


RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notices to Skippers
Vessel Tracking and Tracing
RIS Key Technologies
Reference Data
RIS Index
HULL data
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services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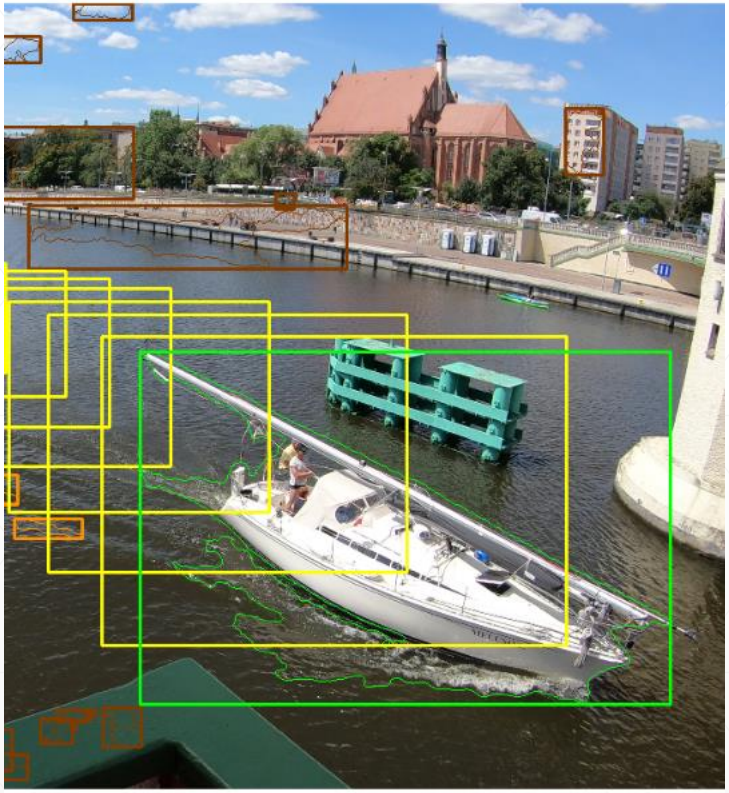
SHREC
• Uses video monitoring
• Uses ships database for inscriptions matching
• Sends identification/clasification results
• Updates ships databases or registeries
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services

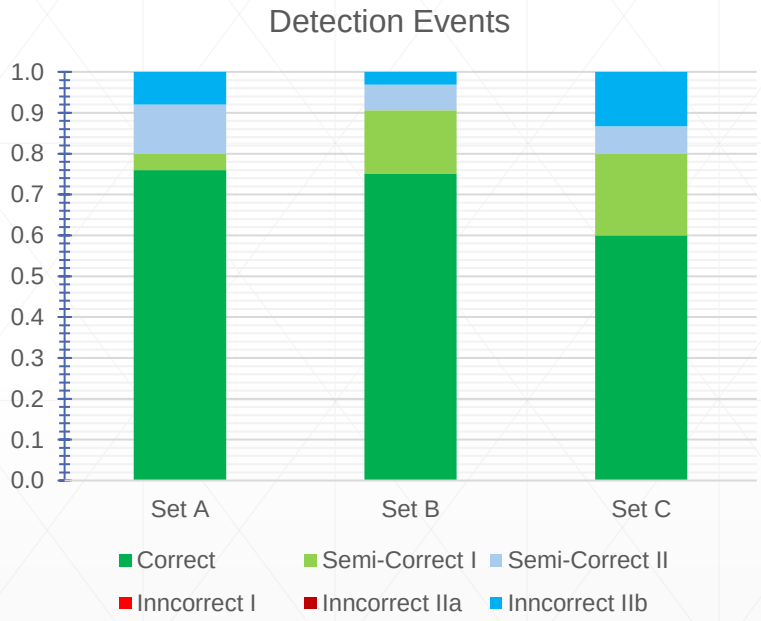
Detecting and tracking

- The method is designed to detect all kinds of moving vessels and to work efficiently, so it can be used to process data from multiple cameras (20 or more)
- For each camera view there is a determined detection zone that eliminates areas of the scene where either ships cannot appear (e.g., on land) or they are too far for the detection process to make sense.
- The background subtraction algorithm (GSOC) is used for each frame from a video stream to obtain foreground objects, find their contours, and to obtain bounding boxes for each detected ship



Detection and tracking

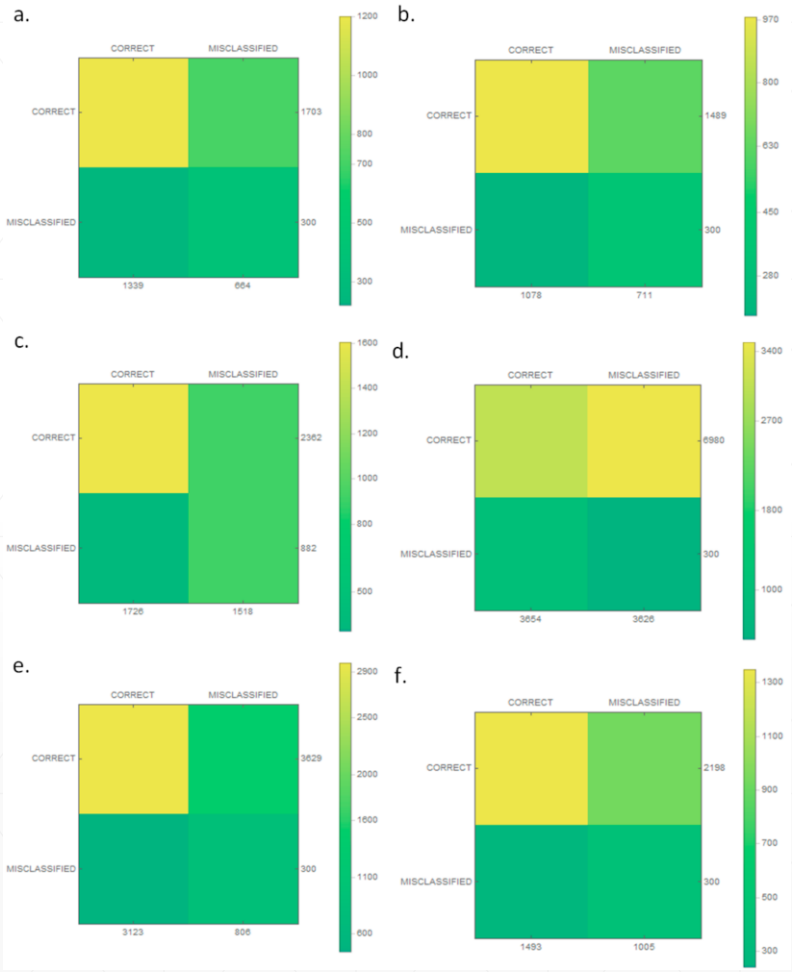
- Works in variable lightning conditions and with slight changes of the background.
- Identifies the same ship across the frames and can filter out artifacts based on a 5-frame window
- Movement direction is detected based on camera location.
- Method returned around 90% of correct detection events for test sets of good quality scenes and around 80% for test sets of streams of bad quality



N. Wawrzyniak, T. Hyla, and A. Popik, A. “Vessel Detection and Tracking Method Based on Video Surveillance”. Sensors 2019, 19, 5230, pp 1-14

Ships classification

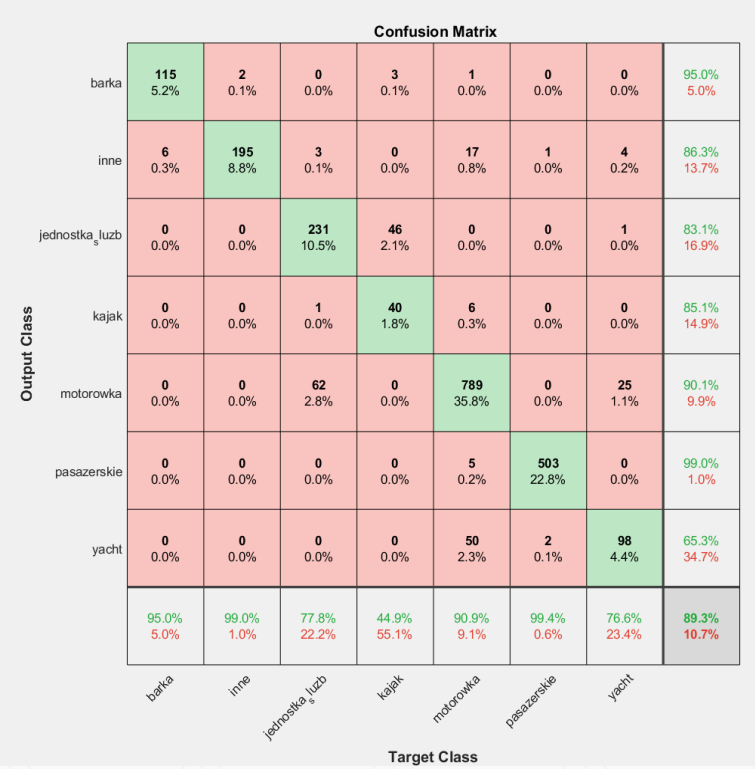
- The module has two classification algorithms implemented
- First : original CNN developed for the project
- Using only own-gathered data (recorded ships images) on 16 different architectures gave maximum ~20% efficiency during training. Training with the additional older database attached was ~41%. Finally, classification accuracy between 60 and 70% was achieved, but for only 5 classes.



M. Wlodarczyk-Sielicka and D. Polap,“Automatic Classification Using Machine Learning for Non-conventional Vessels on Inland Waters”, Sensors, 2019, 19(14), 3051., pp 1-17

Ships classification

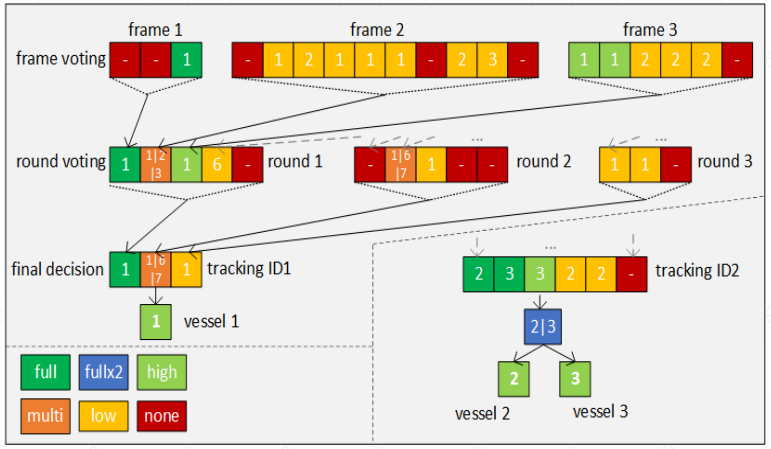
- The second method was implemented using existing GoogleNet solution trained with thousands of images of non-SOLAS ships acquired during last 3 years the area cover by Lower Oder RIS System
- Many configuration was tested – different numer of classess, different training sets, separate CNNs for side and out front vessels views
- It gave a classification accuracy of ~ 84% for 7 classes (barge - together with a pushed kit, motorboat, sailing yacht, kayak, service unit, passenger, and others).



K. Bobkowska and I. Bodus-Olkowska, “Potential and use of the GogleNet Ann for the purposes of Inland Water Ship Classification,” Polish Maritime Research, vol. 4 (108), vol. 27, pp.170-178, 2020,

Identification

- Vessel identification is based on the location and recognition of the hull inscriptions of the detected ship by the detection module
- Our hybrid approach uses three text localization methods (CCA [5], MSER [6], EAST [7]) and Tesseract OCR to recognize inscriptions
- The module uses its own ship registry (that can be fed from ships data bases from external services) and compares the found inscriptions with its records.
- It runs in near real time, in 5-second-rounds.
- The degree of correct identification is determined depending on the degree of text matching.
- Results of conducted tests : 69% full matches, 25% high matches, 3% low matches, 3% multiple matches (matched simultaneously with more than one ship), and 9% of vessels were not identified.



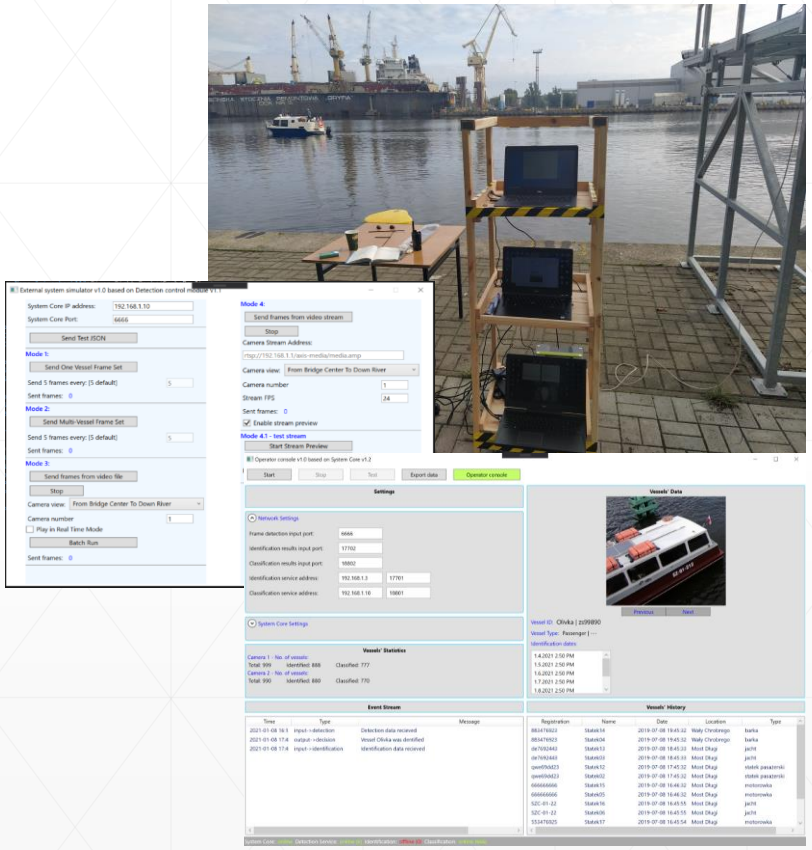
T. Hyla and N.Wawrzyniak, “Identification of Vessels on Inland Waters Using Low-Quality Video Streams”, Proceedings of the 54th Hawaii International Conference on System Sciences, 2021

Identification

- The method works well identifying commercial vessels, as their inscriptions are placed according to the binding rules.
- With the recreational craft situation varies
- When the visible inscription exceeds 10-12 pixels in height, the OCR returns satisfying results.
- Usually, the module analyses 10 to 20 vessels frames per vessel passage in front of the camera,

Summary

- The system is able to recognize and identify all kids of ships using only video surveillances that are part of many already existing vessel monitoring systems
- In a case when the identification is impossible, it classifies passing vessels into one of determined categories
- The system detects vessels in less than a second with the background model updating 3 times per second during that process
- Pre-identification is performed once per five-second round and the final identification outcome is given after the ships pass (after a round where tracking ID of the passing ship is lost).



Summary

- Deployment of proposed solution enables for automatization of operators work in monitoring centres and significantly reduces its cost.
- This system is a smart management system for port and costal traffic services. The approach is in line with current trends for digitization, data sharing, and the development of the information society
- By connecting to other river information technologies (esspecially vessel tracking and tracing service) it can push information on identified vessels to traffic/transport management services, costal and port charges, customs or law enforcement etc.
- Classification module can be used for statistics purposes.
- Currently talks on implementing SHREC solution are ongoing with Szczecin Inland Navigation Office

Thank you for your attention

- Towards the Implementation of Ship Recognition and Identification System in Costal and River Information Services

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