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DETECTION OF SHIP PATHS ON DOCKING AND QUAY OCCUPATION ANALYSIS BASED ON A VIDEO-IMAGERY SYSTEM AS SUPPORT TO PORT MANAGEMENT

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introduction and motivation

Which is the aim of this work?

The aim of this work has been to **develop a video – monitoring system of port activities** according with Molina et al. (2007). This system provides time, space and location parameters. With them, quay use statistics and the locations of the dock with high level of ship traffic are obtained in an automated way .

Why do we develop this system? Because...

1. The system is as a tool that can help to improve port economic and operative management. In particular:

Dock occupation level is basic information to:
Determine the dock's occupation density by the ships and then, to obtain *dock's occupation probability.*
Risk calculation according to Puertos del Estado (2001), which establishes the probability as the basis for the design, maintenance and exploitation of port facilities.

Quay occupation percentage and its evolution is a fundamental parameter on:
Quay management in order so satisfy mooring demand
Determination of the *capacity trend* of a terminal
Improve investments previsions
Minimize ship's waiting time to optimize terminal performance
In the design stage, to *select the kind of ships* that must operate in the terminal

2. Port Authorities must apply fares to ships and terminal operators based on these parameters

3. Nowadays there is not an automated and/or objective protocol to determine these parameters

Is there a need of additional investment in the infrastructure to support this system?

With this technique there is not need of additional infrastructure investments because it profits of already existent communication infrastructure dedicated to:

Access control Security surveillance

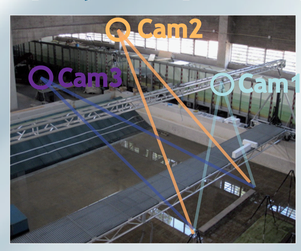
methodology

The following work-flow summarizes the methodology steps (Gómez et al. (2011)):

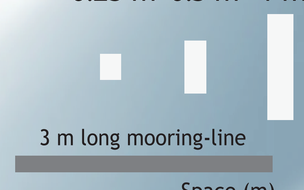
Acquisition system configuration	**Environmental light** **Camera parameters:** intrinsic, extrinsic **Recordings length, resolution, fps**	[1]
Video - recordings setup	**Continuous - discrete recordings** **Single - several areas of observation**	[2]
Distortion correction	**Lens distortions:** spherical, comma, astigmatism, field curvature, distortion	[3]
Image restitution	**Transformation** from oblique views to **ortho-normal wiews** where **measurements** can be taken	[4]
Video-processing algorithm application	Time stack, segmentation, optical flow, ROI, background - foreground subtraction	[5]
Basic parameter subtraction	**Time, space, location & others:** depending on the monitored activity	[6]
Information	**Occupation percentage & ship's paths registration**	[7]

laboratory experiments I: quay occupation percentage evolution

1



3 Ship sizes:
0.25 m 0.5 m 1 m



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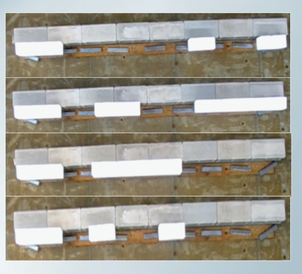
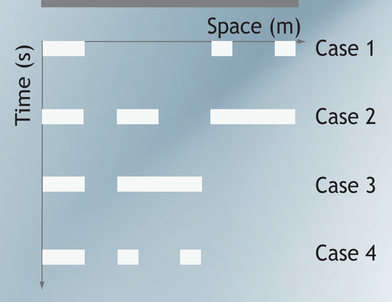
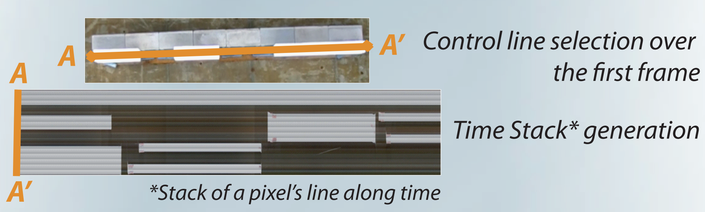




3 & 4 No needed because observation is zenital and close to the object (Cam 1)

5 ***[a] Time stack***

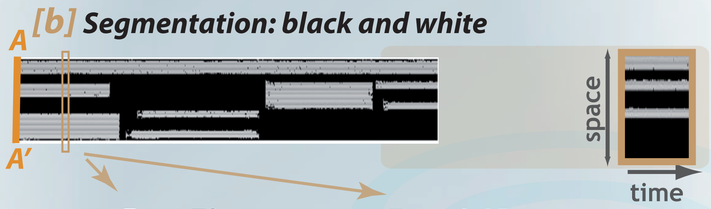


Control line selection over the first frame

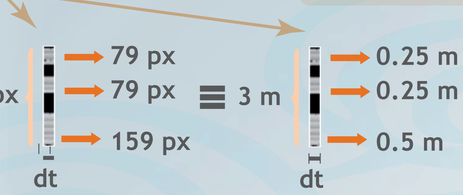
Time Stack generation*

**Stack of a pixel's line along time*

[b] Segmentation: black and white



6



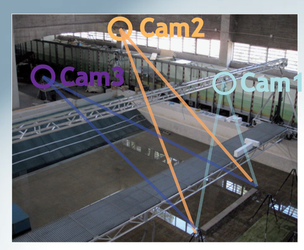
7

$$O[t = t_1] = \frac{\text{Number of white pixels}}{\text{Number of total pixels}} \times 100 = \frac{79+79+159}{476} \times 100 = 66.66\ \%$$

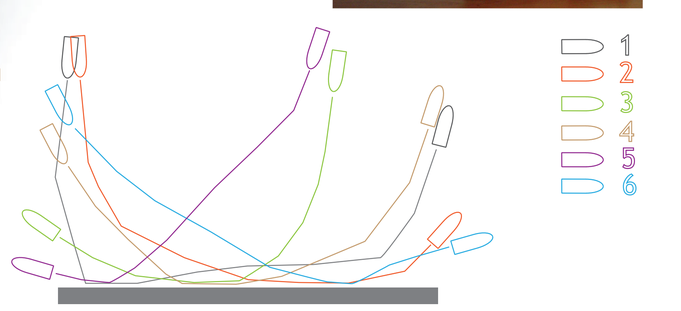
$$O[t = t_1] = \frac{\text{Sumatory of ship's lengths}}{\text{Quay length}} \times 100 = \frac{0.25+0.25+0.5}{3} \times 100 = 66.66\ \%$$

laboratory experiments II: Ship's paths registration

1

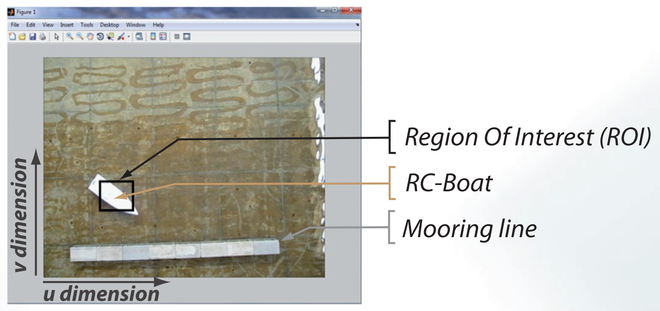


2



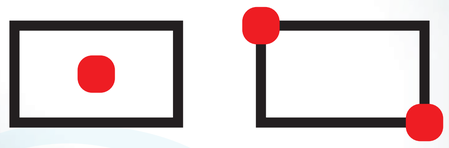
3 & 4 No needed because the chosen observation is zenital view and close to the object (Cam 1)

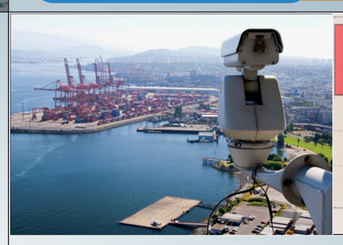
5 ***[a] Segmentation in black and white***
[b] Automatic creation of a ROI around the ship

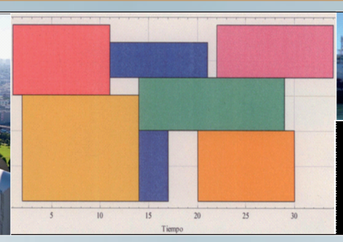


6 & 7 [u, v] positions of

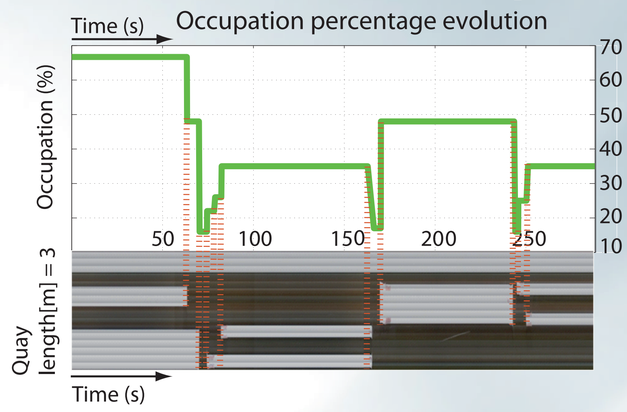
ROI Centroid ROI Opposite corners



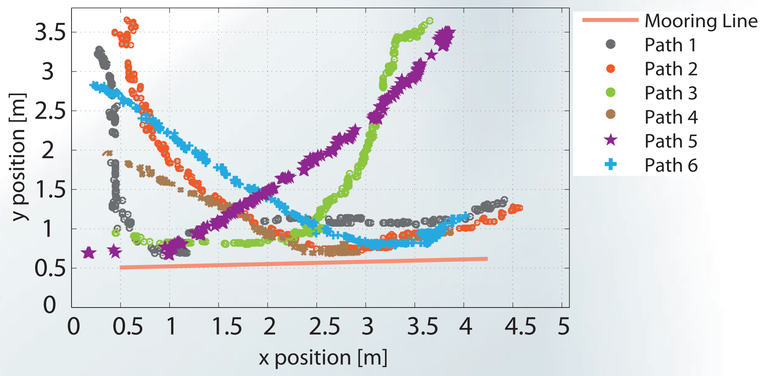




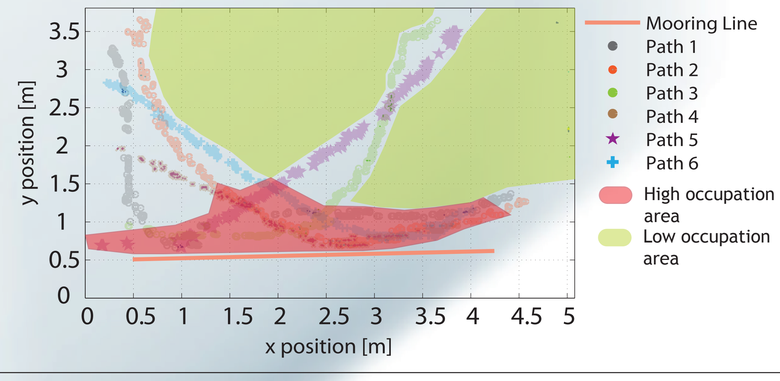
experimental results



Ship paths corresponding to several approximations



Ship paths corresponding to several approximations



conclusions

1. The quay management strategies may be based on the real traffic of the quay and not on year-averaged ratios.
2. The evolution of the occupation percentage of a quay can be obtained through time-stack techniques.
3. It is possible to monitor ships's paths and to obtain the trajectories's envelope through video-processing algorithms.
4. The analysis of trajectories envelope allows determining the areas with high and low traffic. This allows knowing which are the areas where an accident is more likely to occur.
5. Video - monitoring techniques can be used to calibrate actual ship maneuvre tools because they provide them empirical data of ship movements.
6. The video-processing algorithms are being developed continuously. Thus, it is necessary to adapt them to port management and operation field.
7. A combination of motion-detection and time-stack techniques leads to a quantitative measure of port operation parameters. This fact leads to a better management of port areas.

main references

Gómez et al. (2011): Análisis de las operaciones portuarias basado en un sistema de video-monitorización. In proc. XI JPyC. Las Palmas de Gran Canaria (Spain). pp 671-676.

Molina et al. (2007): Gestión integral de puertos y costas mediante técnicas de video-imagen. In proc. IX Jornadas Españolas de Puertos y Costas. San Sebastián (Spain). pp 27-28.

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acknowledgements

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Puertos del Estado