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Remote sensing and augmented reality in maritime safety

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INTRODUCTION & AIM

Augmented reality (AR) is used more often in many maritime applications. In this paper, AR model is considered for improvement traffic monitoring in ports. It is useful for port authorities.

The model's input is camera installed in the port. It provides a video stream over IP connection to the facility where the processing computer is placed. Ship's detection is performed by YOLO (You only look once) artificial neural network. Developed YOLO detector detects small and large vessels. Hence, ships with automatic identification system (AIS) and non-AIS maritime traffic is detected. This creates realistic real world scenario for Mediterranean port traffic portfolio, which includes passengers' ships, fishing ships, touristic ships, yachts, and other small-type of sailing objects.

By using known frame rate and bounding box center coordinates, a velocity is estimated from consecutive frames. Based on the estimated velocities of the current detected sailing objects, trajectory is projected. Trajectory prediction is updated with new frames.

The model's output is the collision risk. In order to be useful for port authorities, the goal is to visualize collision risks in AR environment. AR is installed on smart phone and employee of port authority can check for possible problems easily without need for powerful computers and desk.

METHOD

Trajectories are estimated based on the central point of the detected vessel on the video stream from the surveillance camera. The intersection of the diagonals of the boundary box gives the central point of the vessel, the position of the central point remains remembered for each frame in the last 5 seconds. Position also depends on external influences. Hence, a linear regression is performed to get the direction of the vessel's movement between the memorized positions.
The collision risk assessment is made based on the distance between the vessels and the direction and speed of the vessel's movement. If the continued movement of the vessel according to the estimated trajectories and speeds will result in the intersection of the motion vector, it is suggested to change the course or speed of the vessel in order to eliminate the potential danger of collision.

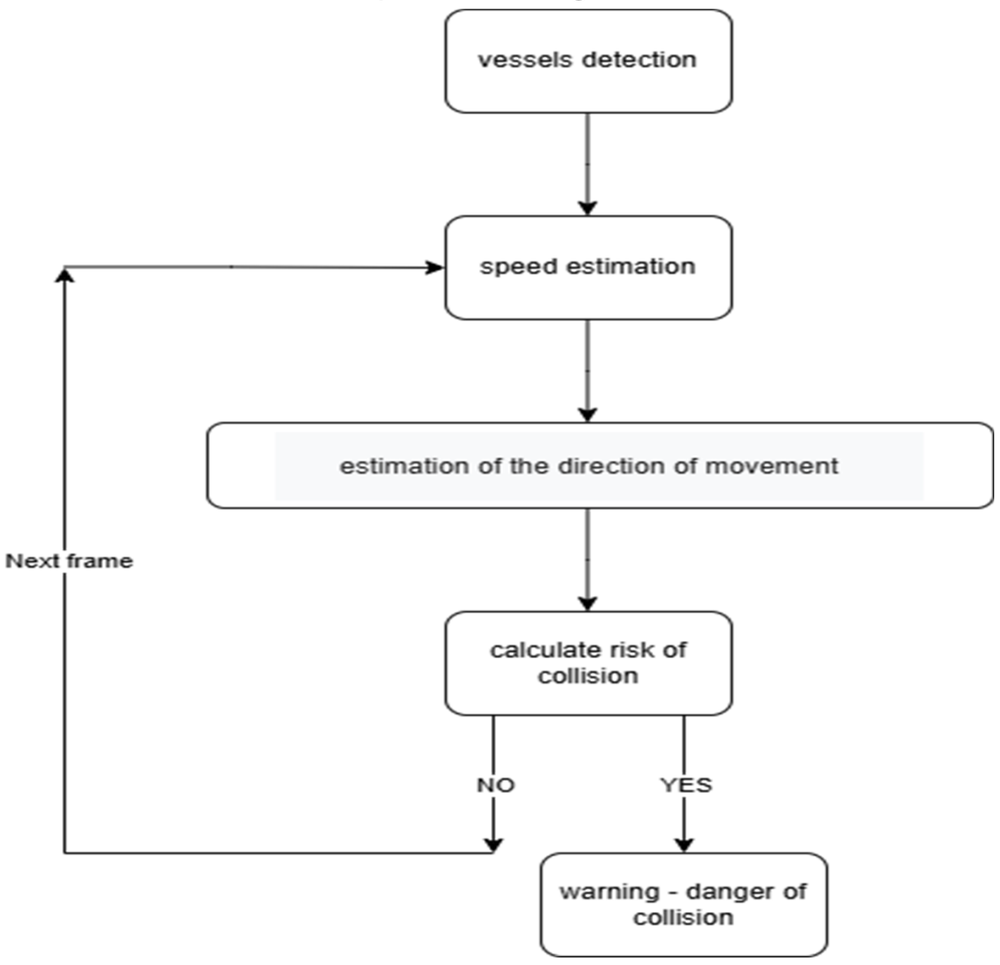

Figure 1. Flow diagram of the process

RESULTS & DISCUSSION

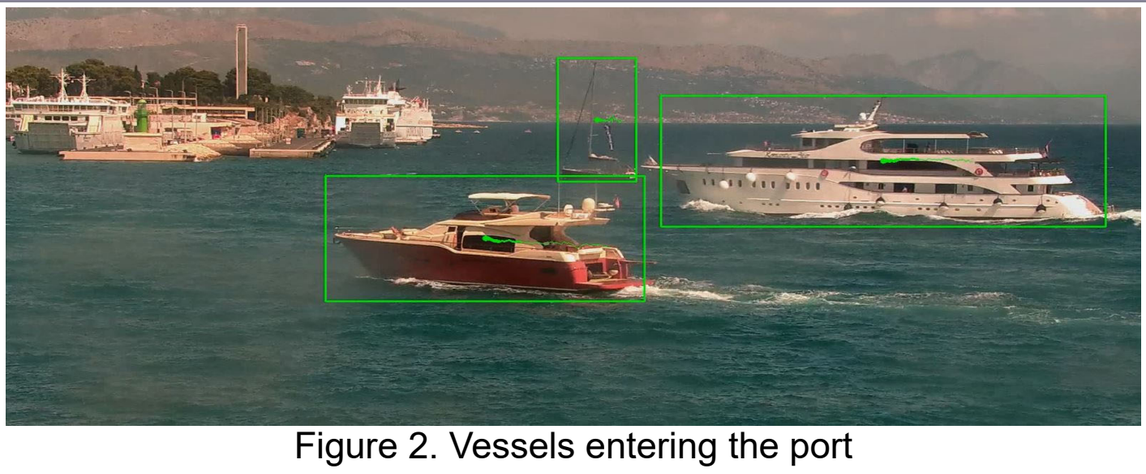

Figure 2. Vessels entering the port

Figure 3. Vessels leaving the port

The length of the observed trails depends on the vessel's speed and its direction of movement relative to the position of the surveillance camera. By applying linear regression to the data points represented in the x-y coordinate system, the direction of the vessel's movement can be effectively determined.

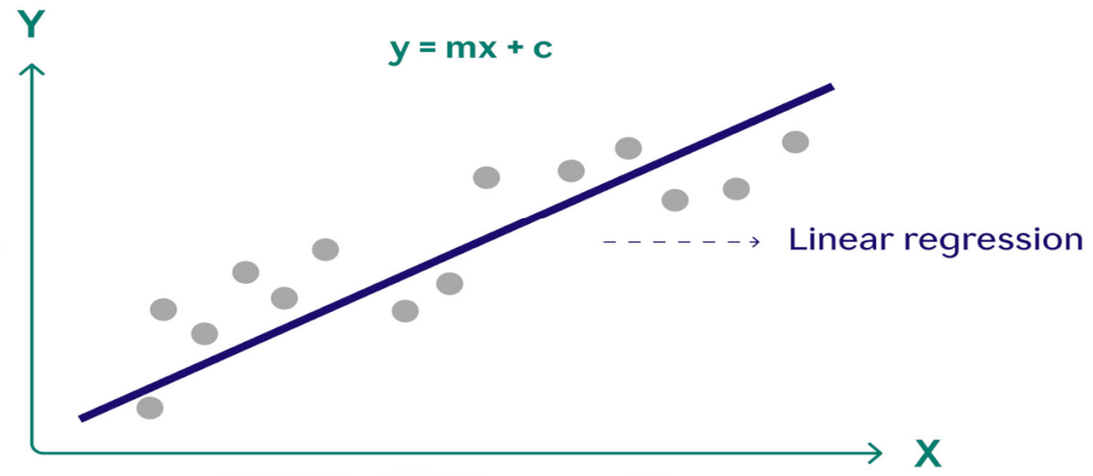

Figure 4. Linear regresion between data points

CONCLUSION

The results demonstrate the effectiveness of our approach in detecting vessels entering or leaving the Port of Split. By applying this method to all identified vessels, we can determine their movement directions and calculate the intersection points of their trajectories within the coordinate system. If an intersection point is in close proximity to a vessel's current position, it could signify a potential collision risk.

FUTURE WORK / REFERENCES

Future work will address technical challenges such as false-negative detections, adverse weather conditions, and occlusions. The ultimate goal is to develop a server application capable of processing all data and communicating in real-time with onboard hardware. This system will provide maneuvering recommendations to the vessel in case a potential collision is detected.

1. Petković, M.; Vujović, I.; Lušić, Z.; Šoda, J. Image Dataset for Neural Network Performance Estimation with Application to Maritime Ports. *Journal of Marine Science and Engineering 2023, Vol. 11, 578* 2023, 578, doi:10.3390/JMSE11030578.
2. Pujara, A.; Bhamare, M. DeepSORT: Real Time & Multi-Object Detection and Tracking with YOLO and TensorFlow. *Proceedings - International Conference on Augmented Intelligence and Sustainable Systems, ICAISS 2022* 2022, 456–460, doi:10.1109/ICAISS55157.2022.10011018.