LEVERAGING THE POWER OF DEEP LEARNING AND ML TO IMPROVE VESSEL OPERATIONS

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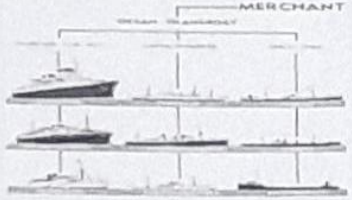
ABSTRACT

Developing an artificial neural network for the marine industry presents significant challenges, including limited computing power, unreliable communication infrastructure, low availability of data and complex vessel systems.

The goal of this problem is to design and develop an effective AI solution using deep neural networks that can optimize vessel performance, reduce operational costs, and improve safety in the context of merchant vessel operations.



OBJECTIVES

- **Peak period** : predicting the peak period of the wave using LSTM model.
- **Weve height** : predicting the future wave behavior using LSTM model.
- **Hydrodynamics** : predicting the residual resistance of the vessel using ANN model.
- **Fuel consumption** : predicting the fuel consumed during the voyage.
- **Co2 emission** : predicting the amount of Co2 emitted per unit distance.
- **Weather forecasting** : predicting the weather of the day using a deep learning model.
- **Speed trim** : predicting the optimum trim for the ship using CNN model.

PEAK PERIOD

The peak wave period (in seconds) is defined as the wave period associated with the most energetic waves at specific point or area.

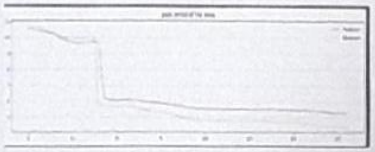
If the peak period is:

- 6 sec -> the energetic waves are due to local winds.
- 14 sec and above -> the energetic waves are due to distance storm.
- 12 sec -> it means most of the waves will be swells which means a smoother ride.

Using the last 3 days data ,our long-short term memory model predict the peak period of the current day.

OUTPUT OF OUR MODEL:

```
0 day input [0.76] 0.77  0.747]
0 day output [[0.7501669]]
1 day input [0.77      0.747     0.75016689]
1 day output [[0.7449573]]
2 day input [0.747     0.75016689 0.74495733]
2 day output [[0.7357854]]
```



RESIDUAL RESISTANCE

Hydrodynamics is the interaction of the vessel with the surrounding fluid.

Residual resistance comprises wave resistance that refers to the energy loss caused by waves created by the vessel and viscous pressure resistance.

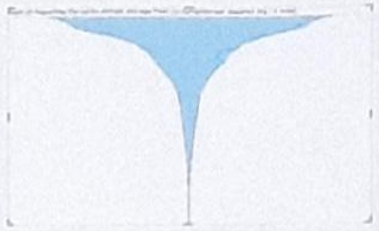
Prediction of residuary resistance of sailing ship at the initial design stage is of a great value for evaluating the ship's performance and for estimating the required propulsive power.

Marine propulsion is the mechanism or system used to generate thrust to move a ship or boat across water.

FUEL CONSUMPTION

Fuel consumption accounts for 50-60% of operational cost.

Predicting the fuel used per unit distance helps us to measure and display the exact amount of fuel oil used.



Co2 EMISSION

There is the non linear-relationship between speed and Co2 emission of the ship.

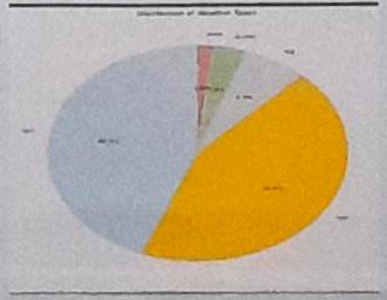
Reducing ship speed by 10% will lead to a 27% reduction of the ship's emissions.

Therefore by predicting the amount of Co2 emitted per unit distance we can optimize the vessel performance.

WEATHER PREDICTION

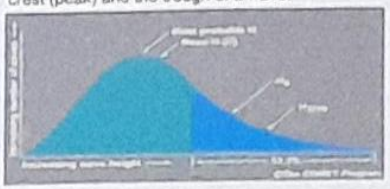
Accurate weather forecasts are very important for sailors.

This information is used to pick a safe anchorage and safety precautions to protect the sailors from a risk.



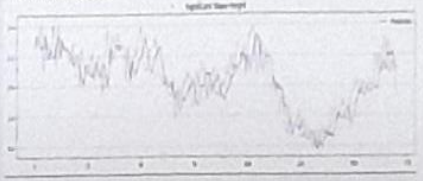
WAVE HEIGHT

Wave height is the vertical distance between the crest (peak) and the trough of a wave.



Hs is the significant wave height. This is the average of the highest one third of waves. *This is* currently what is displayed in the forecast.

Using the last 3 days data ,our long-short term memory model predict the wave height of the current wave



SPEED TRIM

There is a trim which minimizes the ship resistance, the main engine power and the fuel consumption at the same speed.

Speed_trim is the average speed of a vessel from point to point on a chart determined from the distance between two points divided by the time interval between them