PROBABILITY DISTRIBUTION OF MEAN CRUISINE SPEED OF TRANSIT VESSELS IN THE STRAIT OF ISTANBUL FROM STATION RECORDS

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INTRODUCTION

The Strait of Istanbul is right across a city with about 14 million inhabitants. It is approximately 31 km (16.74 nm) long with a width varying from 700 meters to 1500 meters and is characterized by several sharp turns. Approximately 50,000 vessels pass through the Straits per year. Total vessel movement in the Strait of Istanbul is about 1,500. This figure does not include the movement of local ferry transportation, leisure craft and fishing boats. The entrance and exit times of all kinds of ships are recorded at the north or south stations. It is easy to find the average speed of ships passing the Strait with the information which ship enters the Strait on what time and exits on what time. This means that the passage time of the ship is known. Finding the average speed of ships is straightforward. However, if only the entrance and exit times are given without any relation between them (without knowing which entrance time belongs to which exit time), finding the average speed of ships passing the strait becomes a stochastic analysis problem. In this respect, the aim of this project is to develop a method to find the PDF of ships' speeds, or at least the average speed of ships, if possible. In fact, the problem is a general problem which is not only related to the ships passing the Straits, and the solution, if it can be found, has a wide application area.

METHODOLOGY

The proposed solution to this problem lies in frequency domain rather than time domain. All ships have different average speeds. Assume that the average speeds are randomly distributed around the general average speed $\overline{V_{\sum}}$. The time shift between entrance and exit times is not constant but a random number. Assume that $\delta(t)$ represents this random, non-constant time shift. Then, the relation between entrance and exit times can be given as $Y(\omega) = X(\omega) \bullet e^{-i\omega\delta}$ and the system transfer function is $H(\omega,\delta) = e^{-i\omega\delta}$. Then the PDF of $H(\omega,\delta)$ with respect to the time shift value δ can be given as $E\left[H(\omega,\delta)\right] = \Psi(\omega) = \int_{-\infty}^{+\infty} e^{-i\omega\delta} \bullet \Theta(\delta) d\delta$. Since the right side of the equality is in fact the Fourier transform of $\Theta(\delta)$, the solution to the problem can be found when $\Psi(\omega)$ is determined. At the last step, a variable transformation should be applied to obtain the PDF of average speeds: $f(V) \bullet \left|V^2\right| = \Theta(\delta)\Big|_{\delta=\frac{L}{V}} \bullet L$.

RESULTS

After developing the formulation, the application is done on Matlab. Unfortunately, the proposed method fails to give the correct results. When the solution is tested on random data, it is seen that the proposed model fails to give correct results for nearly all cases.

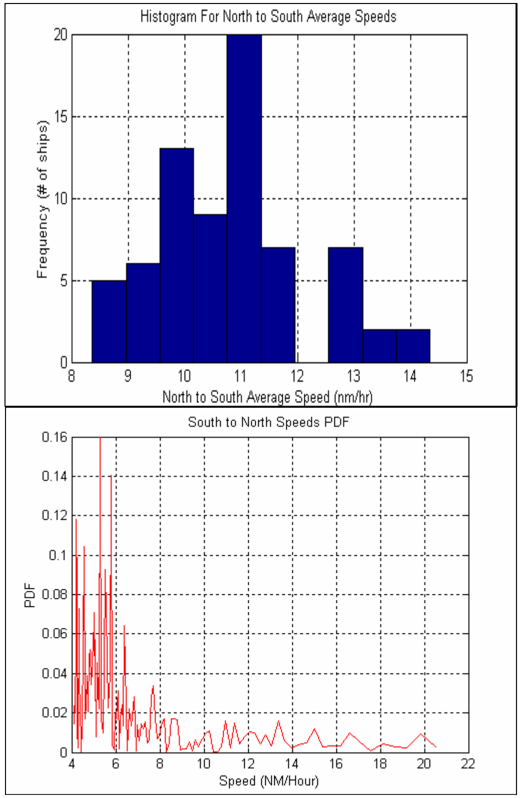

Figure 1 – Real data and the found result

CONCLUSION

The failure of the solution is worked on, and the following results are obtained:

- If the exact expression of $\Psi(\omega)$ can be found, instead of trial and errors, the desired results may be obtained.
- Although for a given case the entrance and exit times are the same, the average speeds and the PDF of speeds may be different. (The given data for both cases is the same). So, the problem is not one-to-one and may not have a solution in the desired format.