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# A hybrid AR-EMD-SVR model for the short-term forecast of nonlinear and non-stationary ship motion

**Keywords:** Nonlinear and non-stationary ship motion
Short-term prediction
Empirical mode decomposition (EMD)
Support vector regression (SVR) model
Autoregressive (AR) model

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# Short-term forecast of ship motion

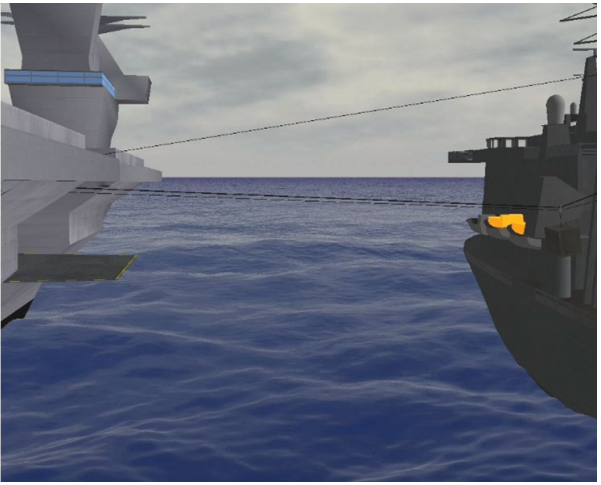


Fig.1 Cargo transfer[1]

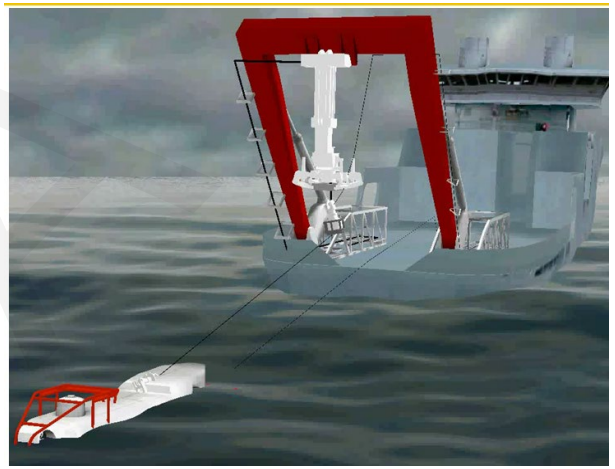


Fig.2 Launch and recovery of submarine[1]

Applications

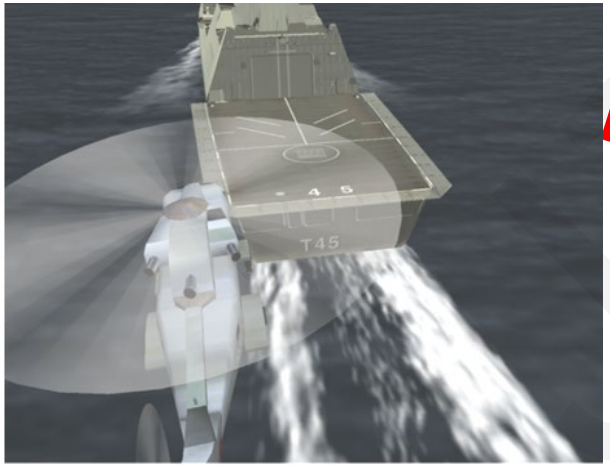
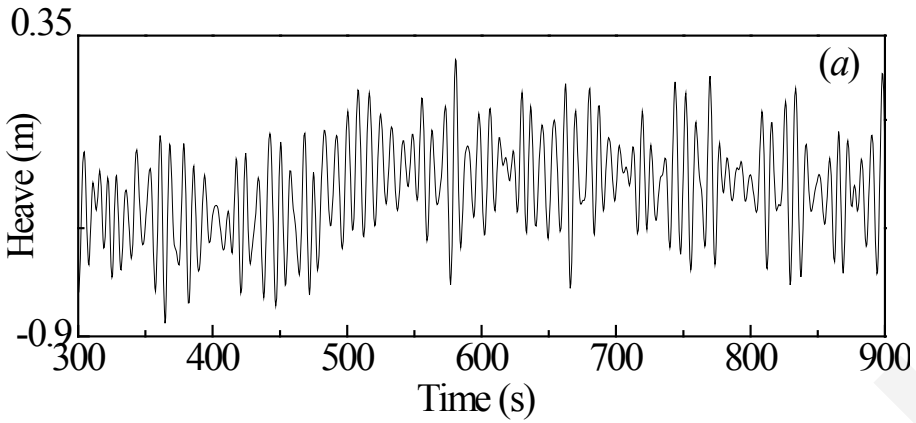


Fig.3 Launch and recovery of ship-borne helicopter[1]

Fig.4 Launch and recovery of Rigid Hulled Inflatable Boats[1]

[1] G. Henry, I. Cox, P. rossland, J. Duncan.Virtual Ships: NATO Standards Development and Implementation[C]. United Kingdom. 2009: 1-16.

# Non-stationarity in ship motions



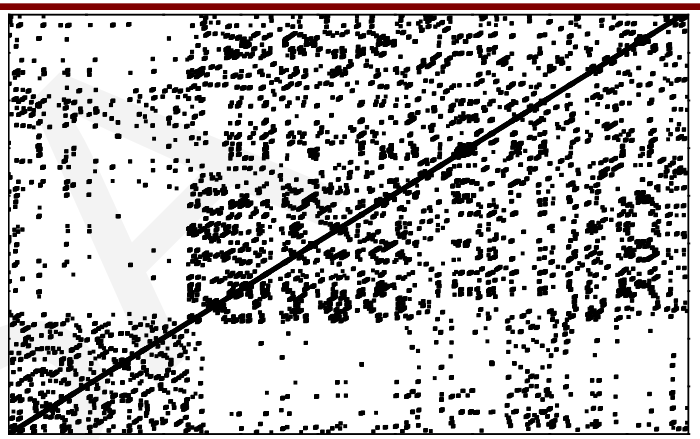



Fig.6 Recurrence plot of heave motion

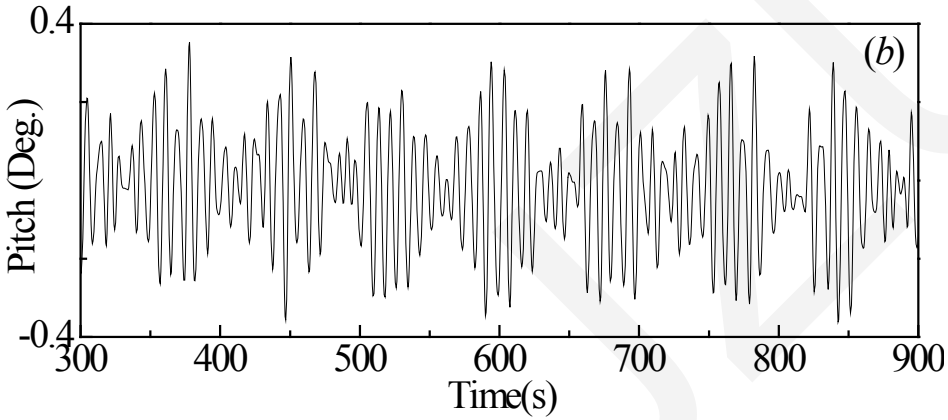



Fig.5 Heave and pitch time history of a large container ship from model testing

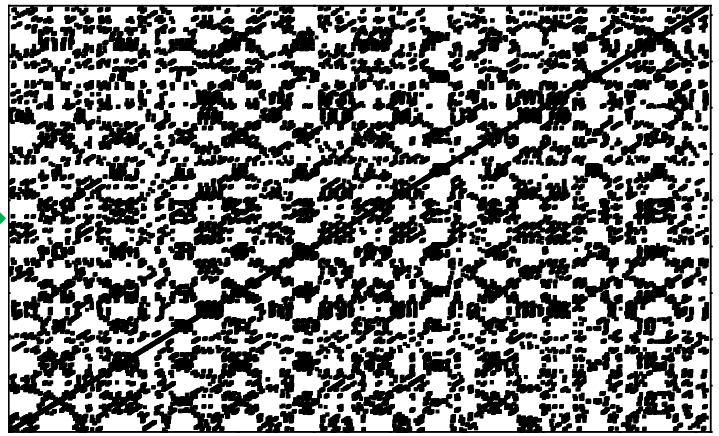


Fig.7 Recurrence plot of pitch motion

# The proposed AR-EMD-SVR model

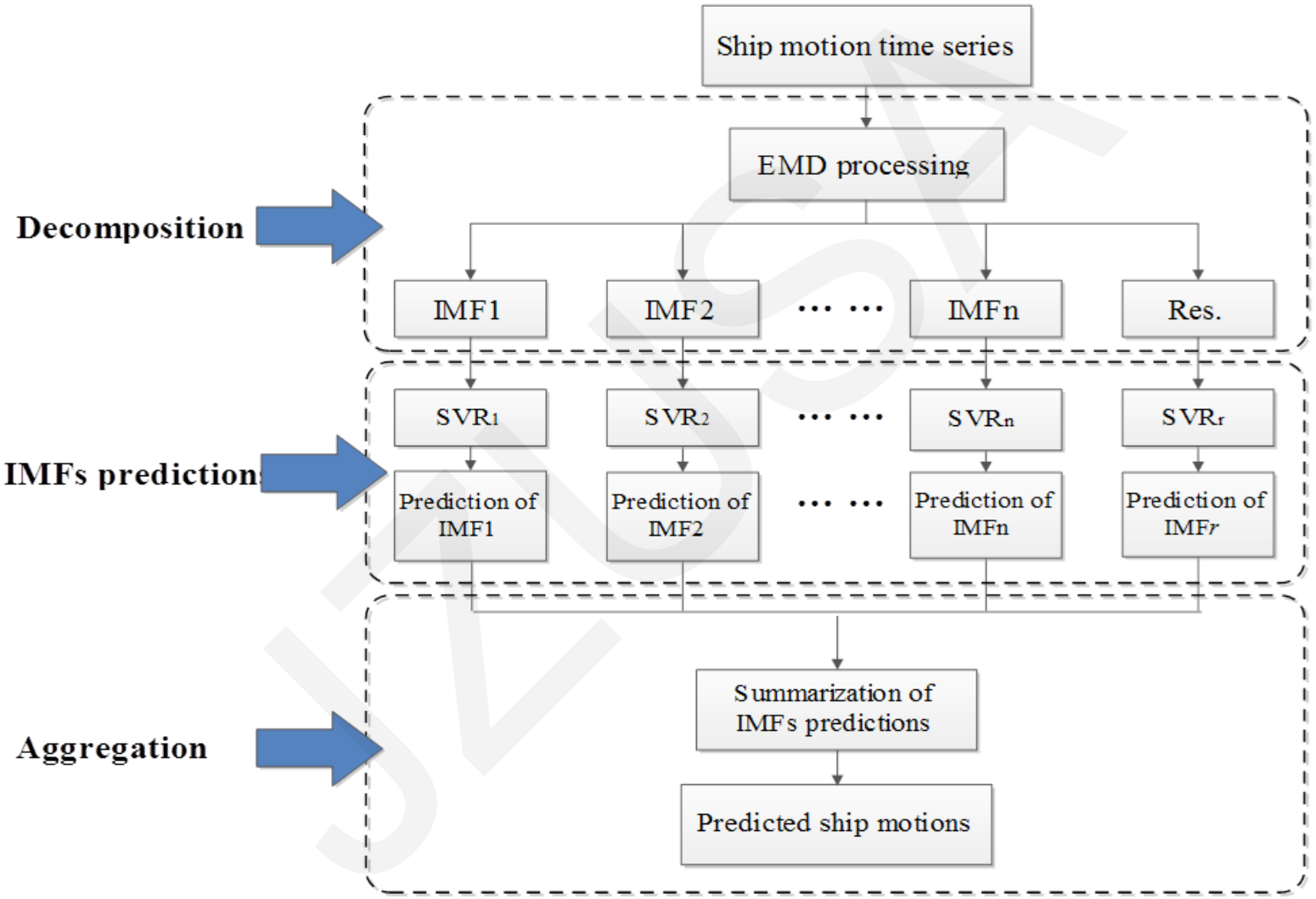



**Fig.8 Flowchart of the hybrid AR-EMD-SVR prediction model**

# Results

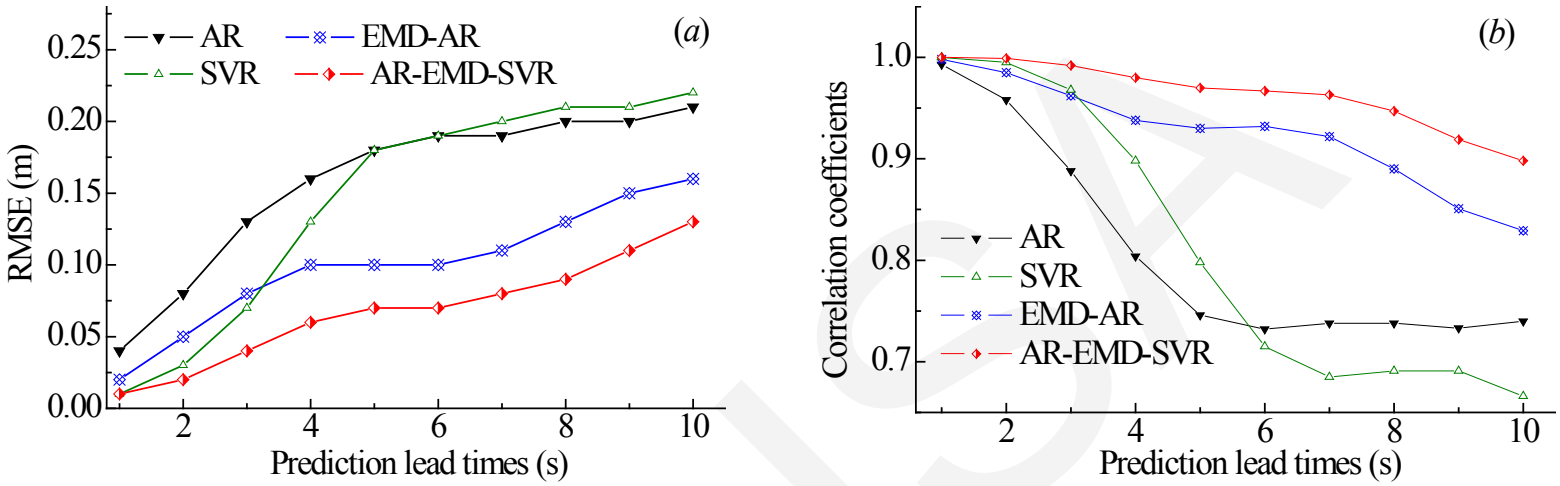



**Fig.9 Accuracy comparison of heave prediction**

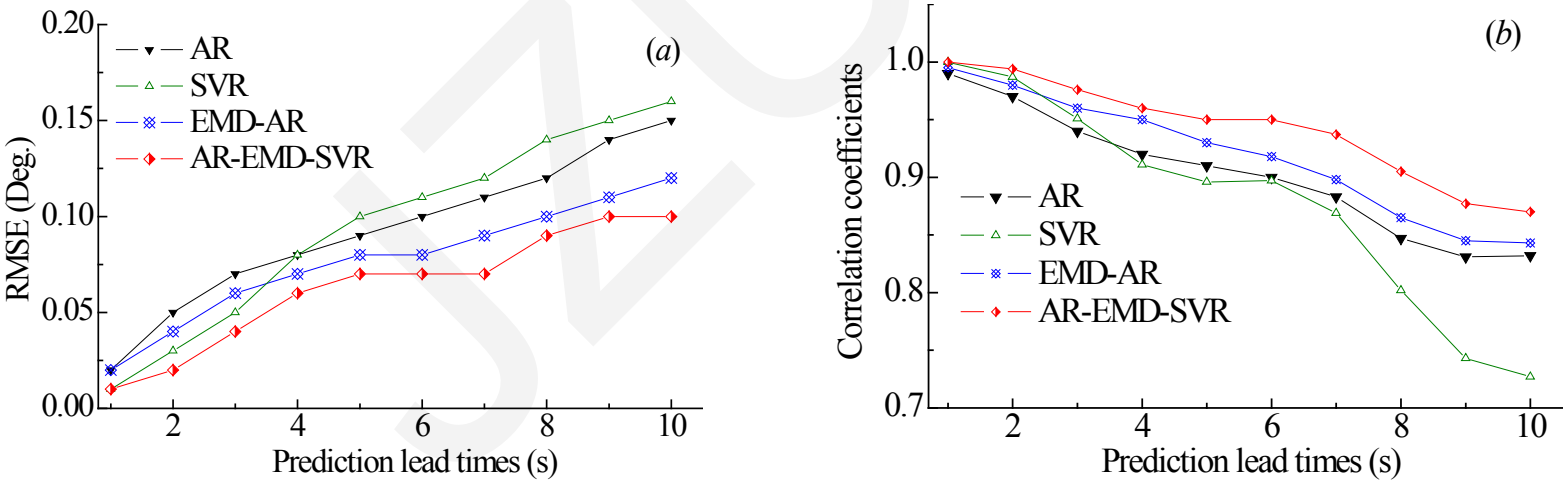



**Fig.10 Accuracy comparison of pitch prediction**

# Conclusions

- The AR-EMD technique is able to handle the non-stationarity in ship motions whereas the conventional AR and SVR models suffer difficulty.

- Comparative analysis of AR, SVR, EMD-AR and AR- EMD-SVR models highlights the superiority of the proposed method providing forecasts.