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Application of SVR and GRNN Models in Estimating Scour Depth at River Confluences under Live-Bed Conditions

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1. Introduction

River confluences have a complex flow and sedimentation pattern due to the three dimensional flow structure. Hence, researchers have become interested in evaluating these complex patterns in recent years.

A review of the literature on the subject under study here showed that there is a lack among the previous studies of work done for estimating the maximum scour depth at river confluences under live bed conditions using support vector regression (SVR) and Generalized Regression Neural Networks (GRNN). On the other hand, these artificial intelligent models show a very good efficiency for estimating the river engineering parameters in the literature. Therefore, the main goal of the current study is to evaluate the application of two well-known models named SVR and GRNN for estimating the scour depth at river confluence under live bed conditions, and compare the results of the models with each other.

2. Materials and methods

In the present study, the experimental data from Balouchi (2012) [30] are used for training and validating the artificial intelligent models. Besides, dimensional analysis is done by using the Buckingham theorem in order to find the important dimensionless parameters of this study. Finally, by doing some simplifications, one can reach the following dimensionless parameters:

$$\frac{D_s}{B_3} = f_2\left(\frac{Q_2}{Q_3}, \frac{Q_b}{Q_3}, F_g\right) \qquad (1)$$

In which, Q_2 is the flow discharge of the lateral channel, Q_3 is the flow discharge of the main channel (downstream of confluence), g is the gravity, B_3 is the width of the main channel, Q_b is the sediment load from the lateral channel, D_s is the maximum scour depth and F_g is the densimetric Froude number of the downstream channel. It should be noted that the three dimensionless parameters on the right side of Eq. 1 are the inputs and the one on the left side is the output of the SVR and GRNN artificial intelligent models in this study.

3. Results

In order to reach the goals of this study, 3 kinds of SVR model and a GRNN model are developed. Figure 1 shows the results of artificial intelligent models used in this study named: train-test SVR (this model used train-test method for training stage), K-Fold SVR, leave-one-out SVR and GRNN, versus the observed maximum scour depth ratio for the total number of data. It is obvious from Figure 1 that the train-test SVR model shows better results when compared with other models.

In addition, Table 1 shows the results of accuracy assessment of models based on five well-known statistical error indices (R^2, MAE, MARE, RMSE and NSE). In order to compare the results better, these five statistical error indices were computed for the total data, train and validation data sets (It should be noted that the K-Fold SVR and leave-one-out SVR models do not have the train and validation stages).

According to Table 1, the values of R^2, MAE, MARE, RMSE and NSE for the total data of train-test SVR model are 95.66, 0.0124, 4.26, 0.0168 and 0.993, respectively. These values show that the train-test SVR model is more accurate among the models used in this study. The values of R^2 for other models (GRNN, K-Fold SVR and leave-one-out SVR) are approximately similar to each other (88.77, 88.9 and 88.62, respectively). Besides, the values of MAE for both K-Fold SVR and leave-one-out SVR are near to each other (0.0208 and 0.02, respectively). However, this statistical index (MAE) with the value of 0.03 shows a weak efficiency for GRNN compared with the other models. Moreover, there is the same trend as MAE of GRNN, K-Fold SVR and leave-one-out SVR models for MARE (9.6, 6.79 and 6.62, respectively), and RMSE (0.0382, 0.0266 and 0.0265, respectively).

The values of the NSE index for GRNN, K-Fold SVR and leave-one-out SVR models are 0.758, 0.8828 and 0.9776, respectively. It can be concluded from the values of all statistical indices used in this study that after the train-test SVR model, the leave-one-out SVR, K-Fold SVR and GRNN models are respectively more accurate to estimate the maximum scour depth at river confluence under live bed conditions.

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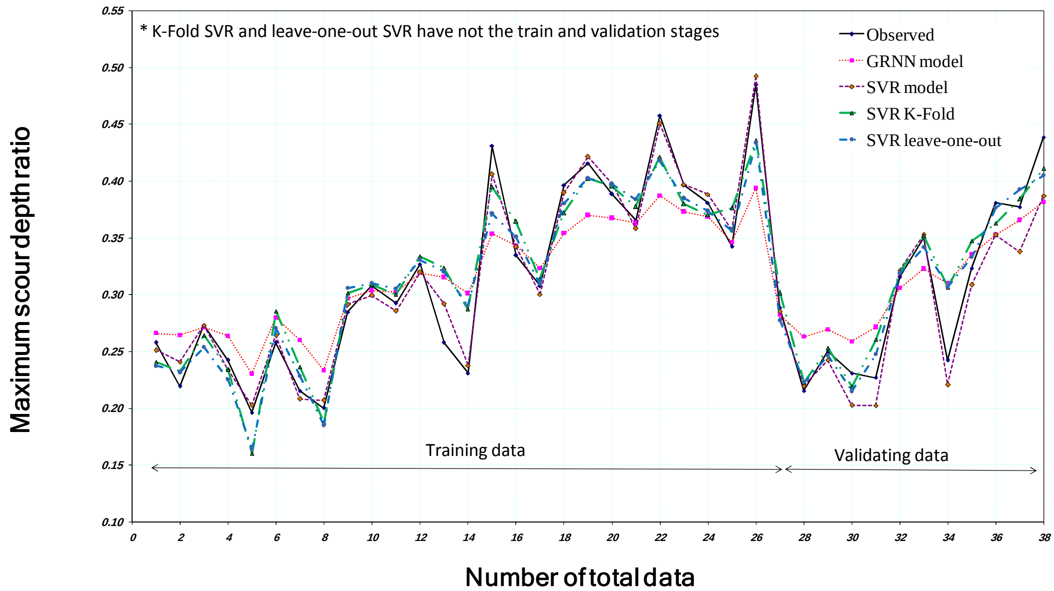

Fig. 1 Comparison of efficiency of SVR and GRNN models

Table 1. Accuracy assessment of artificial intelligent models using statistical error indices

Model		Statistical error indices				
		R^2(%)	**MAE (m)**	**MARE (%)**	**RMSE (m)**	**NSE**
GRNN	Training data	88.83	0.0293	9.24	0.0387	0.7644
	Validating data	88.95	0.032	10.5	0.0370	0.7389
	Total data	88.77	0.03	9.6	0.0382	0.758
SVR (train-test)	Training data	98	0.009	3	0.0114	0.9976
	Validating data	94.41	0.0207	7.37	0.0255	0.8757
	Total data	95.66	0.0124	4.26	0.0168	0.993
SVR (K-Fold)	Total data	88.9	0.0208	6.79	0.0266	0.8828
SVR (leave-one-out)	Total data	88.62	0.02	6.62	0.0265	0.9776

4- Conclusion

Based on the results obtained from the developed SVR and GRNN artificial intelligent models, the following conclusions are drawn:

- In this study, the K-Fold SVR model is more accurate while k=9 (MARE=6.79). It should be noted that k represent the number of folds in the SVR model.
- Although all models show approximately good results, the accuracy assessment shows that the train-test SVR can be introduced as the best model of this study. Moreover, after train-test SVR model, the leave-one-out SVR, K-Fold SVR and GRNN models are respectively more accurate to estimate the maximum scour depth under river confluence under live bed conditions.