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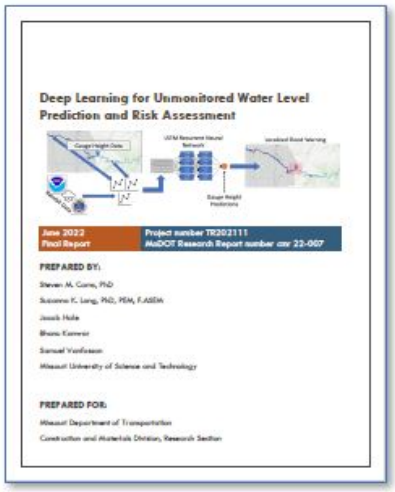
Research Summary

Deep Learning for Unmonitored Water Level Prediction and Risk Assessment


Deep Learning for Unmonitored Water Level Prediction and Risk Assessment

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Recurrent flash floods pose serious threats to the safety of residents of Missouri. Flash floods also damage infrastructure elements such as roads which disrupt both the supply chain and transportation networks of the affected areas. The government authorities have already installed gauges to monitor the river water levels and forecast flash floods in many regions of Missouri. However, certain areas in the state are devoid of gauges that can assist in predicting flash flooding activities at unmonitored locations. Due to the threats posed by flash floods, it is important to develop methodologies that can accurately predict such events at unmonitored locations in Missouri. Implementation of such a methodology will assist the key stakeholders in developing robust flash flood management plans for the safety of the public.

In this research, Long Short-Term Memory (LSTM)-based deep learning models are developed that can predict river water levels at virtual gauges located between the actively monitored upstream and downstream gauges in an unmonitored location. The model outputs can be used to predict flash floods for the area surrounding the modeled virtual gauge. The LSTM-based deep learning models are implemented in conjunction with both clustering and ensemble learning techniques. These techniques assist in getting more accurate localized prediction results as compared to a standalone LSTM model.

The time series-based multivariate input dataset consists of variables such as the gauge heights for the upstream and downstream gauges and daily catchment rainfall. The dataset is developed from the publicly available data gathered from agencies such as the National Weather Service (NWS) and the United States Geological Survey (USGS). The deep learning models efficiently capture the interdependencies between the dataset's input feature values. Also, the inclusion of diverse real-time data variables in the input dataset improves the model's ability to generate more accurate predictions for an unmonitored location in a given region.

Multiple gauges from selected catchments are divided into four different clusters to train an ensemble of 30 LSTM models. The four clusters with gauges are 'Close-Close' (CC), 'Close-Far' (CF), 'Far-Close' (FC), and 'Far-Far' (FF), respectively. The ensemble LSTM models are implemented for the clusters and the learning outcome is eventually used to make predictions at the virtual gauge.

The ensemble models provide more accurate results as compared to a single LSTM deep learning model. The models showcase high correlation coefficient results between the predicted and actual gauge height values. Also, the ensemble models predict correlations while predicting gauge height values that lie 4 hours ahead into the future.

> *"The ensemble LSTM deep learning models accurately predict gauge height values 4 hours into the future."*

Instead of installing actual gauges at unmonitored locations, the authorities can use the outputs from the developed models to monitor variations in the river water levels and determine the possibility of flash flooding activity in an area. By following this approach, timely and highly localized warnings can be issued well in advance of flash flood events.

Figure 1: Focused Flash Flood Warnings for Unmonitored Locations

Project Information

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