

APPLICATION OF NEURAL NETWORK MODELS FOR FORECASTING OF CRACK INDEX AND PAVEMENT CONDITION RATING

PROBLEM STATEMENT

The evaluation of these conditions is a critical component in pavement management systems (PMS). Typical pavement surface conditions include pavement roughness, pavement rutting, pavement surface distress, pavement cracks, and pavement skid resistance. The Florida Department of Transportation (FDOT) has been using pavement condition rating (PCR) to summarize pavement surface conditions for pavement management purposes. To effectively operate pavement management systems at the project and network levels, pavement conditions or PCR should be adequately forecast so that the proper decisions regarding maintenance and rehabilitation can be made.

The University of South Florida has conducted research towards the development of a neural network model for forecasting the pavement crack index. The research has indicated that the neural network may be a better model for forecasting the pavement crack index than are other traditional forecasting models. However, to fully apply these research results, further efforts are needed to refine the developed crack model and to develop more neural network models (for forecasting the PCR) and the corresponding software needed to implement the developed neural network models in the FDOT PMS.

OBJECTIVES

The purpose of this project was to develop (1) a model framework for PCR forecasting and (2) software to implement these neural network models in FDOT PMS.

The objectives of this project included the following:

- Application of the methodology developed in the previous research to the PCR.
- Development of model structure for PCR.
- Integration of the methodology to SAS or other suitable programming language for compatibility with existing PMS and databases.
- Extension of forecasts to 5 years to allow for budget projection considerations.
- Provision of procedures for retraining and calibrating models.

FINDINGS AND CONCLUSIONS

This research study involved developing artificial neural network (ANN) models for PCR forecasting. By undergoing training with historical pavement condition data, the trained ANN models can extract underlying information contained within the historical database and then make reasonable forecasts of pavement conditions in the future. This premise has been verified by an actual comparison of model forecasts and year 2001 pavement evaluations.

As suggested by this research, the original FDOT pavement condition survey database is not suitable to be used directly for the ANN model development. Accordingly, a data preprocessing procedure was necessary to modify the database, a process that included adding missing data, using moving averages of data in the database, and transforming the database into formats that can be directly used for ANN modeling purposes. A module coded in SAS was developed in order to accomplish these tasks automatically.

To implement the ANN models in FDOT's PMS, a software package was developed by using a popular programming language, Visual Basic. Commercial professional software, BrainMaker, was used in this research for the ANN model training. The use of external software is not inconvenient, because neural network training can be accomplished by using any network training software, and separate text files are used to store the trained network weight matrices. In practice, FDOT needs to update the network weight matrix at regular intervals by retraining the ANN models using newly available data. In order to update the weight matrix, FDOT only needs to update the text file of the weight matrix.

In light of the limitations of the existing models, neural networks offer an attractive alternative. Pavement performance based on historical database is likely to play a key role in PMS. We hope that the neural networks will prove useful as a means of modeling pavement performance and building useful mathematical models for pavement management.

BENEFITS

The proposed research project will develop new procedures and models for forecasting the pavement crack index and the PCR. The new procedures and models will be implemented in the project so that FDOT engineers can use them for real applications. With such new tools, FDOT pavement engineers can obtain a better forecast of pavement conditions, and so make better decisions for pavement maintenance activities and budget allocation considerations. Slight improvements in forecasting accuracy imply a significant saving in expenditure on pavement maintenance and rehabilitation. The new procedures to be developed will also benefit materials and maintenance offices. With the use of the new procedures, materials and maintenance engineers will be able to forecast pavement performance for their research purposes.

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