



***FM Broadcasting Monitoring Method
Based on Time Series Analysis***

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Introduction

Architecture of the System

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Conclusions

1

With the successful application of artificial intelligence in various fields, How to integrate artificial intelligence into modern radio monitoring system has become a research hotspot.

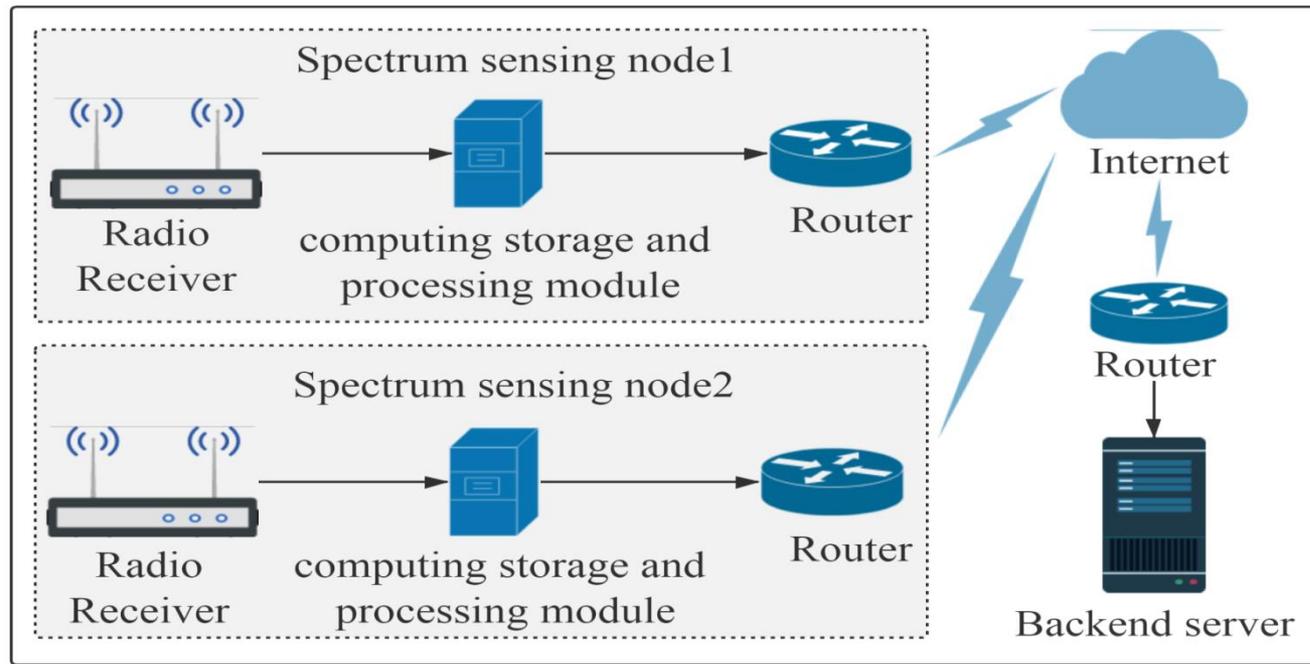
2

In this paper, the architecture of an intelligent FM broadcasting monitoring system which mainly consists of spectrum sensing nodes and a back-end server is proposed.

3

The algorithm consists three steps: the occupied channel is searched, spectrum prediction based on ARIMA and spectrum classification using fully connected neural network.

Architecture of the System

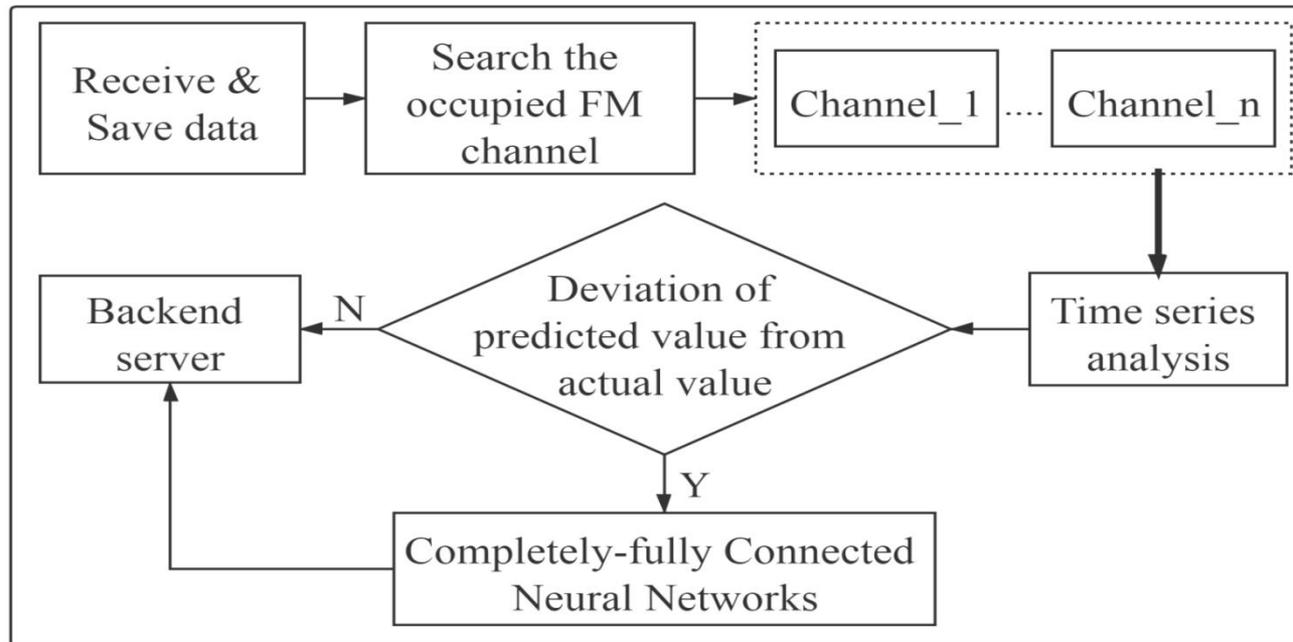


Radio receiver is used to collect the FM broadcast spectrum within the monitoring range.

Industrial computer is the brain of spectrum sensor node, which is used to perform monitoring tasks.

Router is used to establish VPN connection with server.

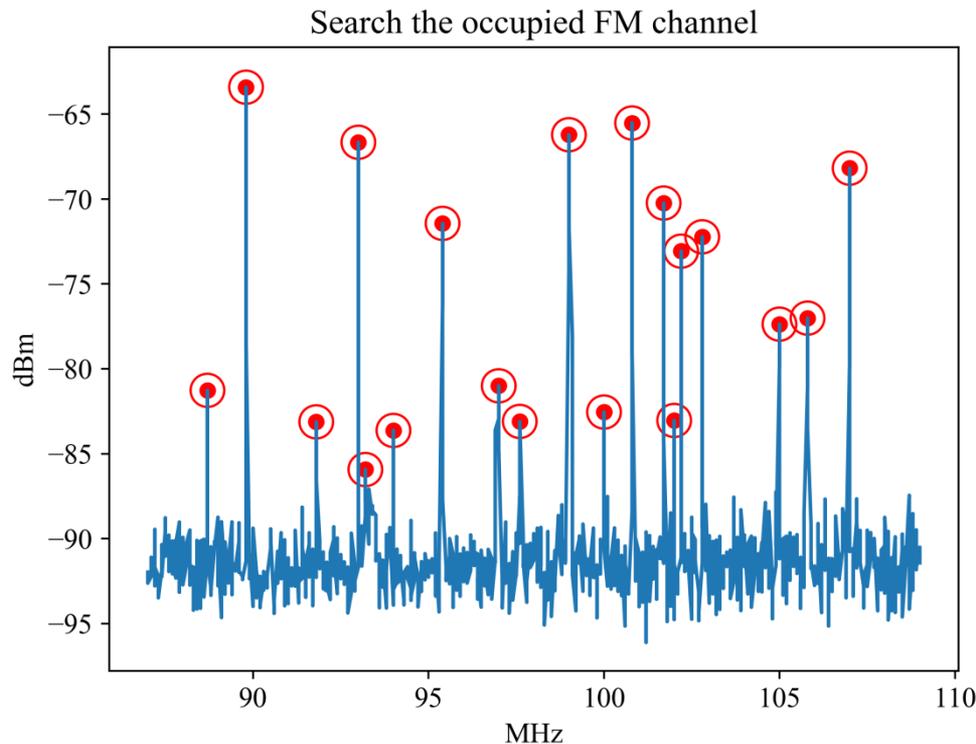
Experiment Results



The program flow of **spectrum sensor node** is as follows:

1. Collect FM broadcast spectrum and search the occupied FM channel.
2. Predict the time series of the occupied FM channel.
3. If the prediction deviates from the actual situation, the spectrum classification is started.

Search the occupied FM channel

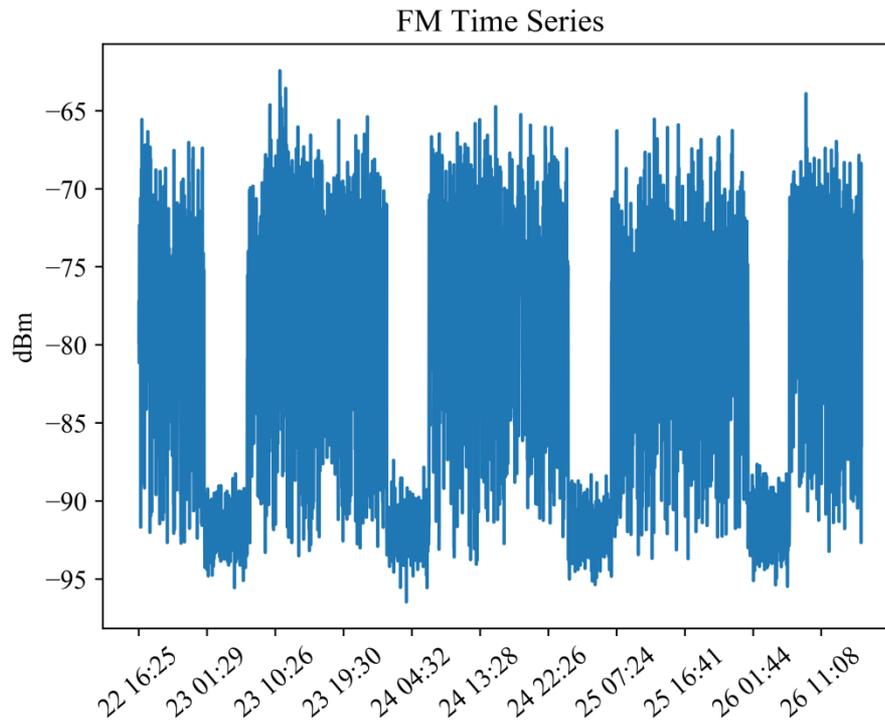


The FM frequency band is divided into 210 channels of which the bandwidth is 120kHz.

The average energy of each channel is calculated and compared with the floor noise using:

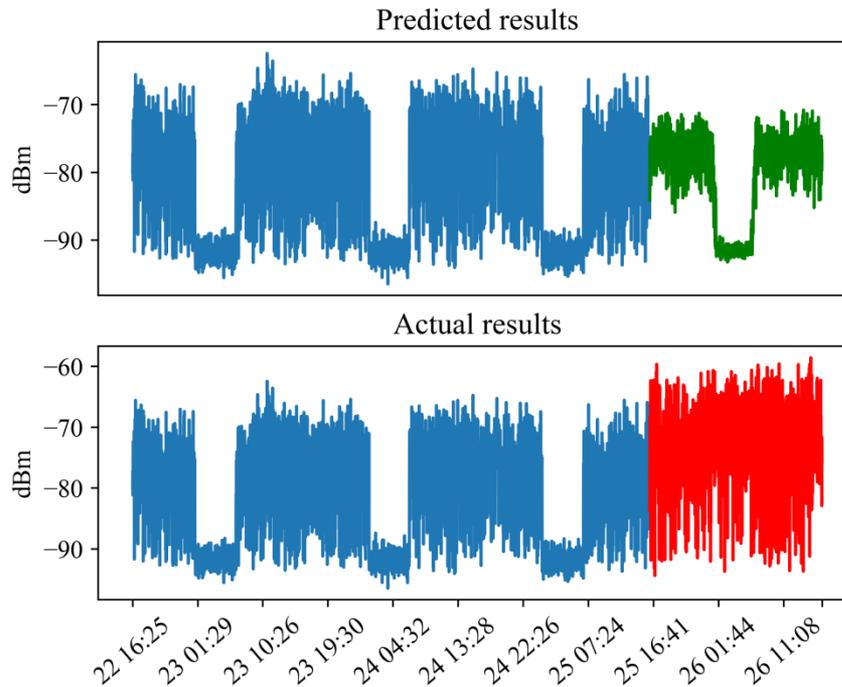
$$\frac{1}{N} \sum_{i=1}^N P_i > P_0$$

Time series display



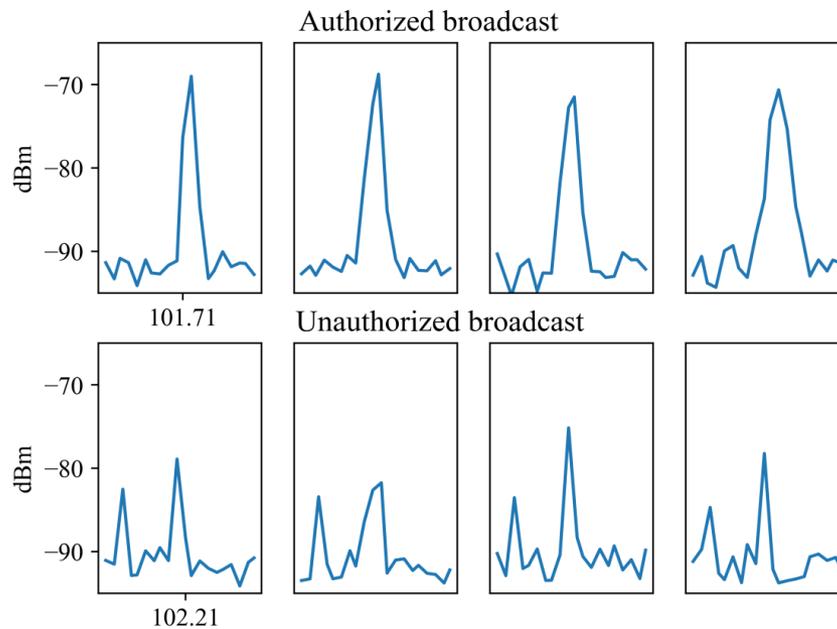
We collected the spectrum data of FM broadcasting band from 22 Dec, 2019 to 26 Dec, 2019, at HuaiZhou Building of Donglu Campus, Yunnan University, China. Taking the FM channel of 107.1MHz as an example. It is clear that this is a periodic time series. FM broadcast continues to play in the daytime and is closed in the early morning.

Comparison between actual value and predicted value



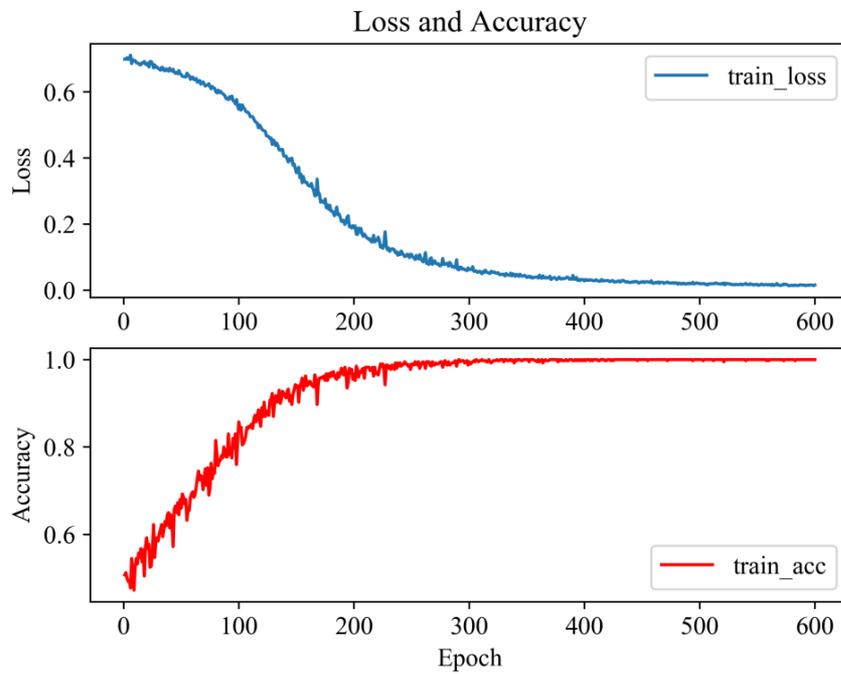
Predict the data of the fourth day through ARIMA model. The figure shows a comparison of the predicted data (the green line) and actual data (red line) of the fourth day. The predicted spectrum reveals that the frequency band is free at 1am on January 26, while the actual spectrum shows that the frequency band is occupied.

Broadcast spectrum classification



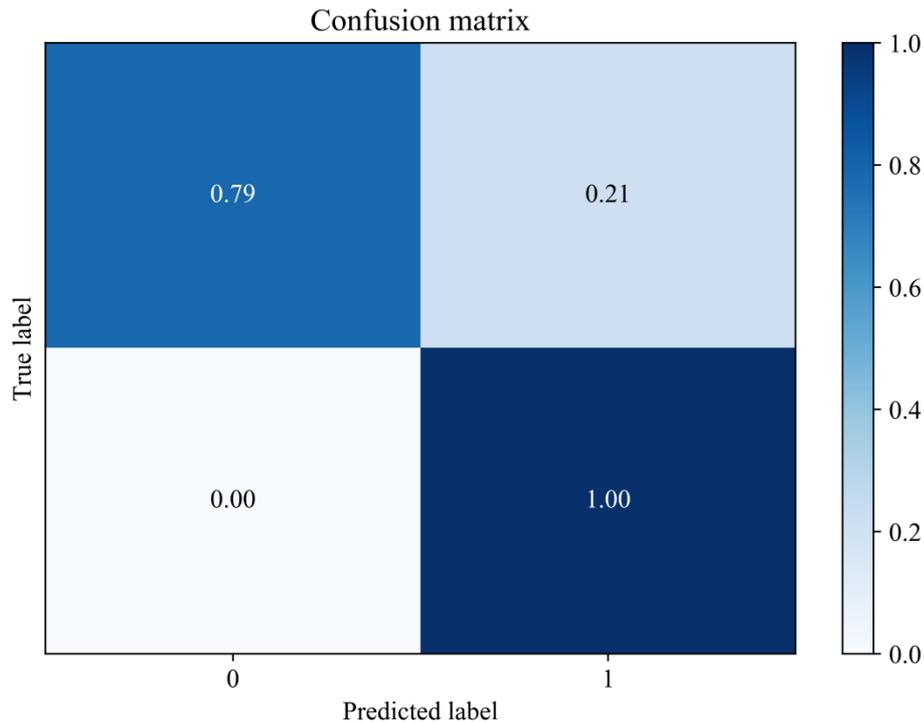
The peak value of the authorized broadcast channel is about -70dBm, the shape of which is high and straight; the peak value of the unauthorized broadcast channel is about -80dBm, the shape of which is short and often accompanied by side lobes.

Loss and accuracy



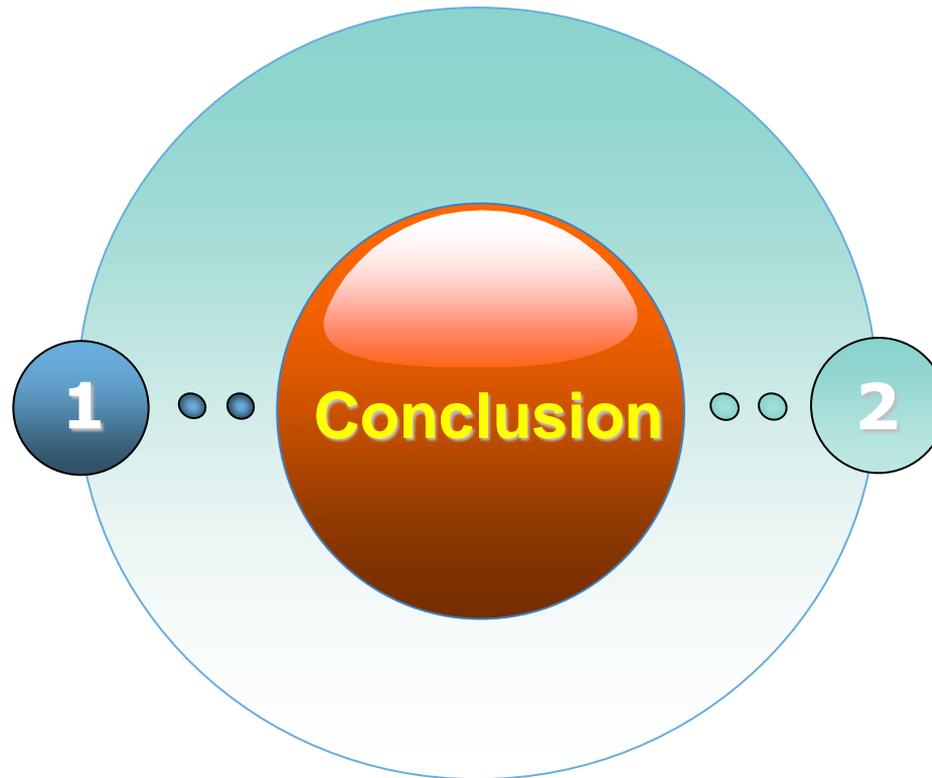
The training set of the neural network contains 1000 groups of broadcast spectrum data, and takes the spectrum peak of each channel as the characteristic training. The loss function converges to 0 at 600 epochs, and the accuracy is close to 1.

Confusion matrix

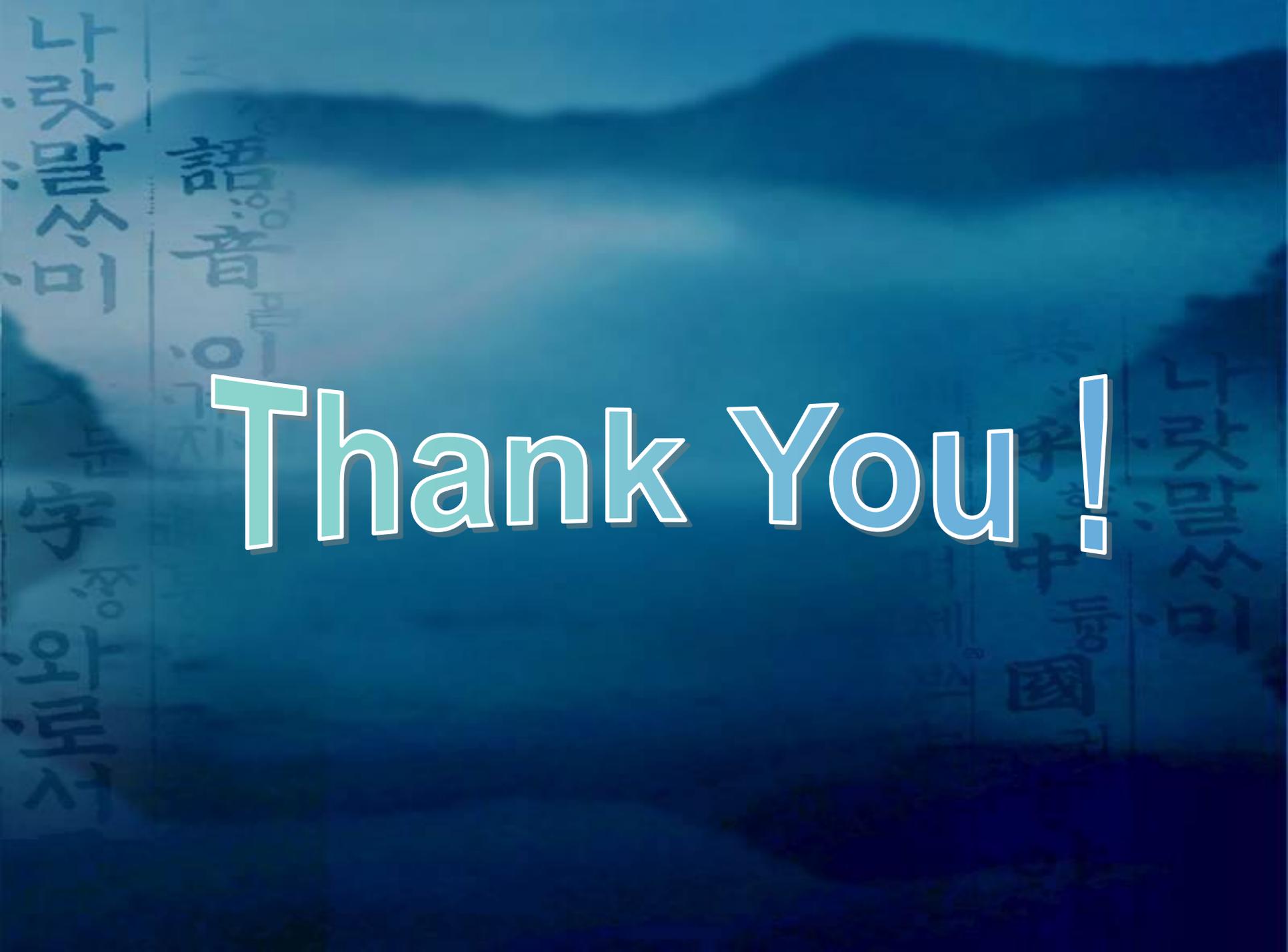


Using confusion matrix to evaluate the classification model, "0" represents normal spectrum, "1" represents abnormal spectrum, the classification accuracy of normal spectrum is 100%, and the classification accuracy of abnormal spectrum is 79%.

In this paper, an architecture of the FM broadcasting monitoring system is proposed.



An algorithm consisted of the occupied channel detection, time series prediction and completely-connected neural network classification is implemented.



Thank You!