17. Real-Time Earthquake Detection System using CNN + LSTM

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Introduction

Earthquake detection is difficult due to noisy environments and variable waveform patterns.
This project applies a CNN + LSTM model to identify seismic events in real time.
The system analyzes multi-channel signals to reliably distinguish earthquakes from noise.

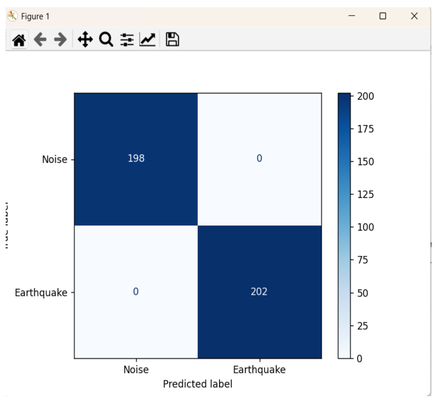
System Architecture

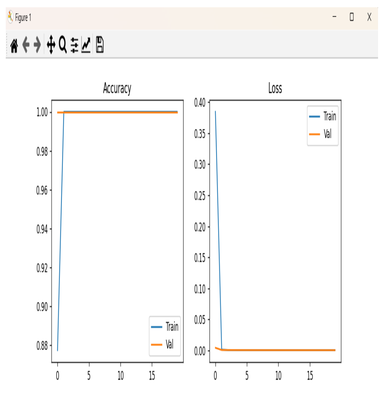
Pipeline:
Data Generation → Preprocessing → CNN → LSTM → Real-Time Virtual Sensor→ Dashboard.

PRE-Processing & Dataset Engineering

- Synthetic seismic dataset.
(Gaussian-modulated waves)
- 2 classes: Earthquake vs Noise.
- 2000 training, 400 testing signals.
- 100×3 sensor channels.
- Noise: Gaussian white noise.
- Standardization applied.

Visualization Plots





Results

- Accuracy: 96.8%
- Precision: 95.4%
- Recall: 97.2%
- F1-Score: 96.3%

Confusion Matrix:

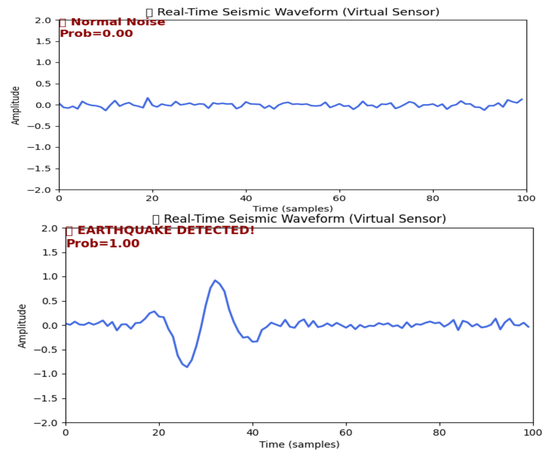
- High recall for EQ class.
- Clear separation from noise.

Actual \ Predicted	Noise	Earthquake
Noise	TN=198	FP=0
Earthquake	FN=0	TP=202

Real-Time Virtual Sensor

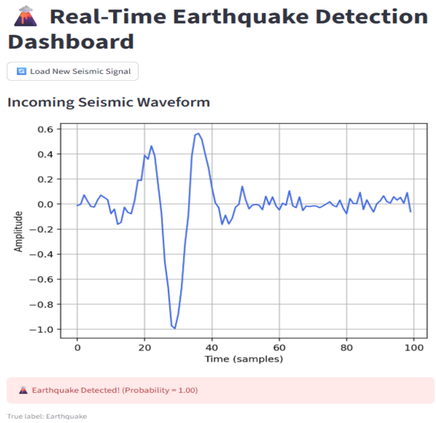
- Simulated IoT seismic sensor.
- Near-zero latency (3–8 MS).
- Stream lit dashboard outputs class probability timeline.

Output: Earthquakes detection appears by 1.
Noise by 0 baseline.



Conclusion

- CNN+LSTM performs highly for seismic pattern recognition.
- Real-time detection ready for deployment.
- Useful for smart-city monitoring & early-warning systems.
- Dashboard allows interactive visualization.



Future Development

- Integration with IoT seismic sensors for continuous Monitoring.
- Advanced ML architectures for improved early-warning Response.
- Deployment on edge devices for low-latency field inference.
- Global-scale dataset integration for more realistic Performance.
- Mobile application for remote monitoring.

References

1. Hochreiter & Schmidhuber – LSTM (1997)
2. Goodfellow et al. – Deep Learning
3. USGS Seismic Data
4. Synthetic waveform modeling literature

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