IMPROVING FEATURE EXTRACTION IN THE AUTOMATIC CLASSIFICATION OF SEISMIC EVENTS. APPLICATION TO COLIMA AND ARENAL VOLCANOES

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Abstract

1. INTRODUCTION

Seismic signals have proven to be an important tool for controlling the state of a volcano and the vicinity of a possible eruption. The rate of occurrence of seismicity in an active volcano is high, with the presence of hundreds of events per hour in days or weeks. Since a visual inspection by human operators is an arduous task in terms of time, Artificial Neural Networks [1] [2] or Hidden Markov Models (HMM) [3] [4] have been proposed in order to automatically classify the different types of volcanic events. Feature extraction is one of the critical point in these classification systems since it consist of choosing those features which are most effective for preserving class separability. Mel Frequency Cepstral Coefficients (MFCC) have been previously used as frequency features to classify the different types of volcano-seismic events [3]. In addition to MFCC, novel features representing both time and frequency behaviors of the different volcano-seismic events are proposed in this work. A Gaussian Mixture Model (GMM) based classifier [5] has been implemented in order to assess the effectiveness of the proposed features.

2. DATA ACQUISITION AND AUTOMATIC CLASSIFICATION SYSTEM

The volcanic signals used in this work were recorded from stations situated at Colima (Mexico) and Arenal (Costa Rica) volcanoes. Nine types of event classes were manually labeled by expert technicians: silence, explosions, long-period events, regional earthquakes, volcano-tectonics events, harmonic tremors, spasmodic tremors, collapses and lahars [6]. Unlabeled segments were previously removed from continuous records. The number of events varied from 24 (lahars) to 720 (long period events) and from 44 (regional earthquakes) to 7047 (silence) in Colima and Arenal volcanoes, respectively. Half of the events of each class was used as training events and the other half was used for testing the automatic classifier of volcano-seismic events implemented in this work. This elementary classifier is based in a Gaussian Mixture Model [5]. Each Gaussian was defined using both Mel Frequency Cepstral Coefficients (MFCC) [3] and novel features that assess the impulsiveness of the signal onset,

the bi-log frequency behavior, the chromatic behavior and the presence of harmonics. In order to evaluate the effectiveness of using the proposed features only one Gaussian was assigned to each class.

3. RESULTS AND DISCUSSION

Our results show that the MFCC features allow to classify the events with a mean accuracy of 70.19% and 56.49% in Colima and Arenal volcanoes, respectively. Using all the features presented in this work the mean accuracy can be increased to 76.28% and to 70.01% in Colima and Arenal volcanoes, respectively. Therefore, the accuracy of this elementary GMM-based classifier is improved considering the proposed features. These results suggest that the features presented in this work would improve the recognition performance in continuous seismic-event classification. Testing the proposed features in a continuous Hidden Markov Models -based recognition system [3] [4] is needed.

4. REFERENCES

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