Automatic arrival time picking as accurate as picking by a seismologist

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1. Introduction Many authors developed the methods of automatic P and S wave arrival time picking from 1970's. Most of them are based on mathematical methods using AIC. However, reliable picking data are not obtained because of a large time changes in the amplitude and frequency of noise. We developed high quality automatic arrival time picking system, which can measure arrival times as accurate as nearly the same level with human being. The method firstly picks several candidates of arrival times and selects a correct arrival time by using various algorithms and parameters for the judgment.

2. Method of P wave picking

1) Determine 10 candidates of P wave arrival times near the approximate time by changing threshold levels of amplitude with interval of 20%.

2) Calculate time differences, average amplitudes, predominant frequencies, later part of average amplitudes, and displacement amplitudes for time sections between arrival times of candidate.

3) Select correct arrival times among candidates by using observed parameters in 2) and several parameters for the judgment. We determine parameters for the judgment with considering how a human being reads onset times.

4) Check the inclusion of a large amplitude noise just before onset. If there is, search for correct onset time. We also check the inclusion of P or S wave arrivals from other far events.

5) Check if it reads P wave arrival but not S wave. There are records triggered by S wave and no P wave onset.

3. Method of S wave picking

1) S wave picking is made by the component of the rotation vector defined by the following equation.

R(t)=S(t)xU(t)/abs(U8(t-dt)) Ez (1)

Where, S(t)xU(t) and Ez are S wave vector at time t,unit S wave vector of running average at t-dt, and unit vector of Z component. R(t) becomes same with SH wave just after S wave arrival. Sign of (1)does not change so long as S wave particle motion continues an elliptic motion, which makes the predominant frequency of R(t)long.

2) S wave picking is made with the same method of P wave picking except 1)

4. Result Offline seismic observation was continued since 1995 at western Nagano Prefecture. Sampling frequency is 10KHz. We applied the picking method to this data. It is found that our new system can pick P wave arrival times with accuracy of 1-2 msec for nearly 99 % of events.