Introduction

The term *playability* denotes the ability of a non-ideal optical disc system to play back a disc without noticeable errors at the user side. *Disc defects* like scratches, dirt spots, and fingerprints can endanger playability since they severely distort the internal servo signals. Based on these signals a disc defect *classification* is developed and a possible method for defect *detection* is investigated. The results of this research form a basis for playability improvements with respect to disc defects.

Methods

Investigations show that the MIRN signal is the most suitable servo signal for defect classification and detection. This signal shows a direct relation with the changes in laser light reflection, induced by disc defects.

A set of measured MIRN signals, affected by different disc defects, is mapped into a property space. The corresponding property vectors consist of the mean value, peak value, duration, and the number of samples in a limited set of amplitude bands for those signals. Through the Euclidean distance the dissimilarity between the various property vectors is expressed. Agglomerative, hierarchical clusters are formed by sequentially combining sets of entities that have the lowest dissimilarity.

![Figure 1: Hierarchical linkage of disc defect clusters.](image)

A detection method, based on the likelihood ratio principle, results in an optimal defect detector with respect to detection time and reliability. It determines which of the following hypotheses (normal situation or defect present respectively) is true:

\[
H_0 : y(t_s + k) = y_n(t_s + k) \\
H_1 : y(t_s + k) = y_n(t_s + k) + y_c(k)
\]

with \(k = 1, 2, \ldots, N\). The resulting on-line detector is a simple threshold comparison for the output of the following FIR-filter:

\[
\sum_{k=0}^{N-1} Y_c(N - k) (z^{-k} \cdot Y(z)) > H_1 < H_0 \ TH
\]

The detector observes whether a constant, non-zero defect signal \(y_c(k)\) is present in the noisy, zero-mean signal \(y_n(t_s + k)\) that represents the normal MIRN behavior. \(N\) is the number of observed samples.

Results

Defect classes are obtained by fitting polynomials through all time series in each cluster. Identification of new defects is possible by calculating the distance of its property vector to those of the class models. Simulations with the maximum likelihood detector show that detection times can be improved by \(0 - 30 \mu s\) with equal reliability.

Discussion

Improved defect classes can be obtained by using more time series and when the reference models are generated with a more accurate fitting algorithm. Maximum likelihood detection is sensitive for signal offset variations. Accurate offset cancellation of the MIRN signals is therefore required.

References