Fig. 2. Corrugation.

In this research, the Double-Wayland algorithm was applied to the following engineering fields in order to detect anomalous signals:

1) Mechanical Engineering: Time series data of accelerations were measured for common vehicles, and we examined whether this algorithm could detect defects (corrugation) in railway tracks.

2) Financial Engineering: Time series data of price earning ratio (PER) were derived from the stock average, and we examined whether this algorithm could detect heavy falls or steep rises in prices.

2. Method

Delay coordinates $\{ \vec{x}_t \}$ can reconstruct a continuous trajectory without crossings in an embedding space that has a high dimension. The Wayland algorithm (Appendix) supposes that the difference vectors $\mathbf{v}_t = \vec{x}_{t+\tau} - \vec{x}_t$ in this space are approximated to temporal variations of the trajectories (Fig. 1) and estimates the translation error in an m-dimensional embedding space ($m = 1, 2, ..., 10$). This translation error is a statistical index that measures the complexity of the dynamics generating the time series. In addition, the randomness can be evaluated by the Double-Wayland algorithm (Appendix) by a comparison of the transition errors in the temporal differences of the time series with the results of the Wayland algorithm in each embedding space. Several applications of the Double-Wayland algorithm are presented in order to demonstrate its usefulness in this research.

1) There are several types of defects, such as irregularity of the cross level, alignment and levelling defects, improper distance between two rails, twist and corrugation (Fig. 2). Railway accidents might occur due to these defects, which can be identified either by conducting visual checks or by using expensive detectors in track inspection cars (see