

ABSTRACT

Siril Yella: Pattern Recognition for Automating Condition Monitoring of Wooden Railway Sleepers

The thesis aims to investigate the current state of railway sleeper inspection and proposes automatic testing procedures based on pattern recognition for future inspections concerning the condition of the sleeper. Wooden railway sleeper inspections in Sweden are currently done by hand. That is to say, a human inspector in charge of the maintenance activities visually examines each structure in turn for the presence of cracks on the sleeper. Where necessary some deeper inspection may be carried out on site, for example using an axe to hit and judge the condition of the sleeper by listening to the sound produced. Though the manual procedure uses non-destructive testing methods (visual and sound analysis), decision making is largely based on intuition; moreover the process is rather slow, expensive and also requires skilled and trained staff. Maintaining an even quality standard is another serious issue.

In order to be able to fulfil the aims of the thesis, emphasis on the likely factors concerning sleeper condition was a key issue. Studies based on emulation of the human inspection process have been considered a promising route of enquiry. The emulation process is achieved by selecting and evaluating two non-destructive testing methods. The first method (impact acoustic analysis) aims to build an automatic procedure to replace the usage of an axe for distinguishing sounds; which can be described qualitatively as a crisp sound in case of a good sleeper and a dull thud on their bad counterparts. The second method (vision analysis) is to develop an appropriate machine vision algorithm to replicate the visual examination. Data were collected for each of the above methods and appropriate features were extracted. Frequency based features and crack based features have been extracted in the case of impact acoustics and machine vision methods respectively. Pattern recognition has been mainly researched for further classification work concerning the condition (good or bad) of the sleeper. Research conducted on the usage of the inspection methods such as impact acoustic and machine vision analysis show that the methods can form the basis of an automatic sleeper condition monitoring procedure. Further, two more non-destructive testing methods namely electrical resistivity analysis and ultrasound analysis have also been tested. Usage of such methods did not yield success in the current case, but they have contributed in adding knowledge to the domain in cases of relevant problems.

Initially, work has pursued data from only one inspection method at a time. Given that data from a single method (or sensor) seems not to be adequate to make a reliable judgement; data fusion was investigated with an aim of achieving more reliable and robust results. Data fusion has been investigated at three different levels namely sensor-level fusion, feature-level fusion and classifier-level fusion. Results achieved by fusion in the current thesis demonstrate an overall efficiency of around 90% when compared to a human operator. This can be regarded as a good result, given that even humans disagree on certain judgements; and destructive testing can be seen as the only way to resolve such disagreements.