



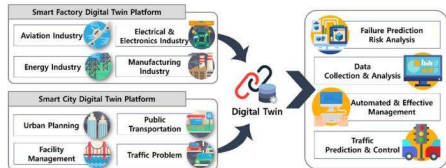
Title:
Digital Twin with Structural Health Monitoring

Supervisor:
Rein Terje Thorstensen and Zhiyu Jiang, UiA

Introduction

The bridge maintenance today relies on workers going out to do inspections manually. With all the infrastructure either being in poor condition or just aging. It's in need of a new method for the maintenance as well as a new system. Digital Twin with Structural Health Monitoring is a technology that can be the new instrument for collecting maintenance and monitoring the bridges condition.

A Digital Twin is a collection of several types of data, like maintenance data for example. The data is put together in a digital model, which is created to a copy of the physical model. With this one can create real scenarios in a virtual environment and get predictions from real world occurrences, or and analyse of the optimal operation condition.



Case-studies

The first case-study was about a bridge in Staffordshire. Were the primary point of the case was to perform an early-age behaviour assessment and do a long-term condition monitoring. The second case-study was about a bridge in Tsing Ma. Were The goal of the study was to monitor the strain of different parts of the bridge with the loads of the railway and highway. The third case-study was about the

Mohammed IV bridge in Morocco, were they wanted to test the laser scanning method to see how good of a DT model it was possible to make. The fourth and last case-study was about Ayvalikemer (Sillyon) bridge. where it was made a basic DT model to find out if the newly renovated bridge would withstand the environment or not.

Method

The method used in this thesis is a literature study in form of a literature search in specific databases to find relevant articles. By doing this the level of knowledge was heighten, to the degree that the research question could be answered. The literature search was made in the database Google scholar.

It was chosen for the accessibility through University of Agder. As well as its vast content of relevant articles.

The articles chosen had to additionally go through an inclusion/exclusion criterion to be stamped as good enough for this thesis, the criteria were:

<u>Inclusion criteria</u>	<u>Exclusion criteria</u>
Norwegian and English written articles	All other bilingual written articles
Articles with digital twin, preferably of a bridge	Articles that don't include a digital twin
Articles that include structural health or structural health monitoring	Articles that don't include structural health or structural health monitoring
Articles must be relevant to the research question	Articles that is not relevant to the research question

Research Question

How can a digital twin with Structural Health Monitoring affect the maintenance of a bridges?

- *In what way will the digital twin with structural health monitoring affect comprehensive maintenance?*
- *How will the digital twin with structural health monitoring affect the life of the bridge?*
- *In which way will this affect the use of material in the bridge?*
- *How will this affect the environmental impact?*

Result/Discussion

The result from this thesis was presented through the four case-studies that was included in this paper. The result from the first case came up with some recommendations and key factors to develop a Digital Twin. Second case came with recommendations sensors that was good for Structural Health Monitoring. The third and fourth study were using laser scanners as an instrument to collect data to use in a Digital Twin. With the use of a numerical model and a Digital twin model as a good instrument for Structural Health Monitoring.

In all 4 case studies, it has been made an attempt to make a digital twin, the level of detail is the same on every model, but the level of the Digital Twin varies.

In the case-studies of Mohammed IV bridge and Ayvalikemer (Sillyon) bridge, it's shown how it

doesn't matter if the bridge is small, big, old or new with the laser scanning method it is easily made a point cloud model which can be made into a Digital Twin model.

In the case- studies of Staffordshire bridge and Tsing Ma bridge, it is showcased how through a DT model it was possible to find out when a train passage occurred. Which makes it possible through long term monitoring to solve traffic problems etc. if this is done in a large-scale scenario like "Virtual Singapore Project", can it help solve urban issues in cities.

By combining a DT model with SHM Digital Twin modelling is an innovative method to optimize the maintenance needs of the bridges, as shown in the case studies.

Conclusion

Too conclude, can a DT with SHM be a useful instrument to eliminate comprehensive maintenance and establish preventive maintenance on bridges all over the world. Which will eliminate the time and cost spent on manually inspection, in addition to prolong the life of the bridges. It will be easier to keep track of the condition of the bridges, which will improve the standard of them. And like mentioned earlier in the social perspective, you will extend the lifetime of the bridge instead of demolishing it and make a new one.