

# Machine Learning Project Proposal

(Automotive management of defects in construction phase)

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## Proposer details

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## Outline

Detecting defects automatically in construction phase using pictures under construction and sending this data to all constructors and sorting them by each construction stage.

## 1. Introduction

### 1.1 Background

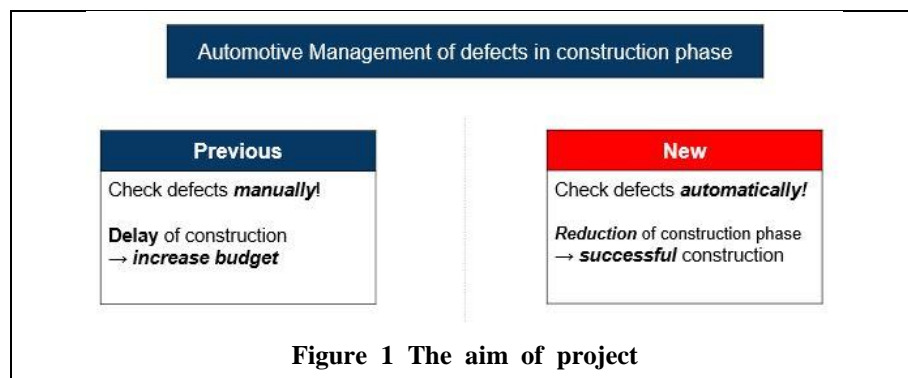
The construction phase is the process of constructing a building or infrastructure. In general, the defect is the work which is not performed in accordance with the requirements of the construction contract. To be specific, construction defect is defined as a defect in a design, the workmanship, and, in the materials or systems used on a project that results in a failure of a component part of a building or structure and causes damage to person or property. Construction defects are one of the most common causes of disputes and litigation in the construction industry. Hence, it is important to detect defects as soon as possible and remedy defects promptly to progress the construction phase. That's the background of the project.

In September 2019, the three students in architectural engineering and computer science and engineering department invented the idea of developing the "*Smart Construction Communication Tool (SCCT)*", which helps to communicate among constructors, contractors, sub-contractors using 4<sup>th</sup> Industrial Revolution technologies in construction phases. We introduced the idea of the "*Automotive Management of defects in construction phase*" in this

idea agenda. Therefore, this project will be an implementation and a part of above idea agenda.

## 1.2 Aim of project

The aim of this project is to *detect a defect automatically when a constructor is taking a picture and send this data to all constructors and sort them by each construction stage*. Therefore, it will reduce the effort of constructor to record the type of a defect manually, which is the current defect detection method. Consequently, it will reduce the construction period and lead to the successful construction phase. [Figure 1] represents the overall aim and purpose of this project.



## 2. Previous study

### 2.1 Machine Learning and Construction

With 4<sup>th</sup> Industrial Revolution flow, many projects which apply the machine learning technologies in a construction field are executed. Especially, many projects were executed in construction safety and construction scheduling fields. This part will cover three representative previous construction projects regard the machine learning.

[1] In June 2012, Ning Dong issued the thesis called "Automated Look-Ahead Schedule Generation and Optimization for the Finishing Phase of Complex Construction Projects". The idea of this thesis is to generate and optimize the continuous look-ahead schedule before the finishing phase in construction phases by observing the state of construction fields.

[2] In Feb 2017, Kim, Yoo and Shin issued the thesis called "Application of Artificial Neural Networks to Prediction of Construction Safety Accidents". The idea of this thesis is to predict the construction safety accidents before the construction phase using "IBM SPSS Statistic 19" and check the application possibility.

[3] In Oct 2017, Gil, Jeon and Lee issued the thesis called "Classification of Images from Construction Sites Using a Deep-learning Algorithm – Preliminary Study". The idea of this thesis is to study and classify the picture by each construction stage using "Google Inception Model" based on "Convolutional Neural Network (CNN)".

## 2.2 Surface Defect Detection

In June 2019, Domen Tabernik, Samo Sela, Jure Skvarc, Danijel skoca issued the thesis called **“Segmentation-Based Deep-Learning Approach for Surface-Defect Detection”**. The idea of this thesis is to apply the deep-learning approaches to a surface-crack detection of an industrial product. [Figure 2] represents the examples of true-positive (green solid border) and false-negative (red dashed border) detections with the segmentation output and the corresponding classification.

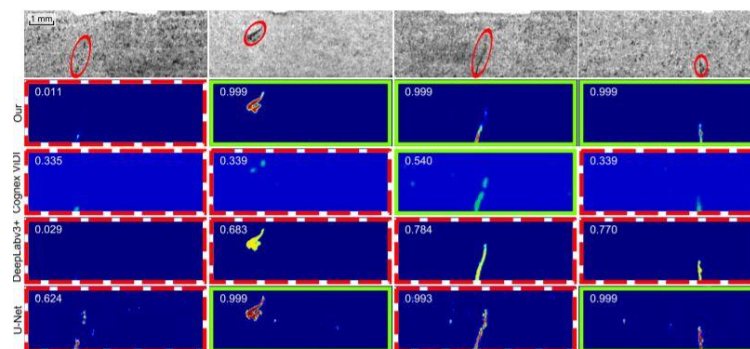


Figure 2 Examples of detections with the segmentation output and the corresponding classification

## 3. Project

### 3.1 Project content

The project consist of two main parts.

- (1) Detect the defect in pictures of the construction phase using deep learning.
- (2) Classify the pictures by each construction stage and improve the effectiveness in construction phase.

In conclusion, with two procedures, the defect will be recorded in the picture and classified by each stage. This will reduce the construction period and enhance the ease of construction phase.

[Figure 3] represents the concept and the idea of this project.



### 3.2 Data source

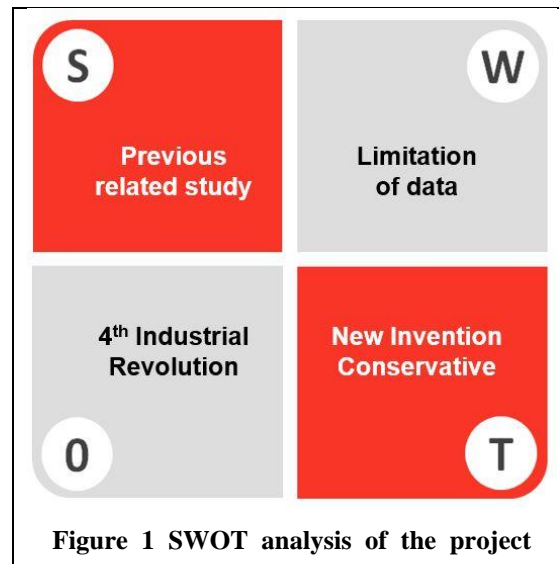
To implement a project, it is essential to acquire various construction phase pictures which have defects or don't have defect. Few web sites provide the construction phase pictures regarding defects.

First, *Seoul Metropolitan Government Construction Allimi (SMGCA)* provides a good quality of pictures. *SMGCA* is the online service which helps citizens to access the construction information in Seoul such as outline, size and documents, which is operated by *Seoul Metropolitan Government*. Every citizens can utilize the pictures of 145 construction phases from 2000 to 2019. The website is attached below.

Second, few construction companies which deal with the defect maintenance provide the pictures of defects. Even if they have worse quality than *SMGCA*, they provide somewhat good quality of pictures.

#### 4. Risk Management

SWOT analysis is one of the most effective ways to manage the risks of the project. [Figure 4] represents the SWOT analysis of this project. The brief descriptions of each sector will follow below the [Figure 4].



##### (1) Strength

The strength of this project is that there are few studies relating this topic. As I mentioned in Chapter 4, Domen Tabernik, Samo Sela, Jure Skvarc, Danijel skoca issued the thesis called “Segmentation-Based Deep-Learning Approach for Surface-Defect Detection”. The idea of this thesis is to develop the surface-defect detection technology using deep-learning. The significant point is to broad this technology to construction site pictures and to define the other types of defects and create the deep-learning model which can detect that defects.

##### (2) Weakness

The weakness of this project is the limitation of data. The number of open data of construction defect pictures is restricted and the quality of data is worse than that in major construction companies. Hence, it is difficult to obtain the high-level results in this project. However, the project is meaningful because this is the starting point of managing the defects automatically. In addition, our team will expand the project with various and good quality of data after partnering with major construction companies.

##### (3) Opportunity

The construction field is one the most conservative fields when it comes to the change because the fault change or design occur the huge disaster (killing thousands of people). However, with the 4<sup>th</sup> Industrial Revolution flow, construction field starts to accept new technologies nowadays.

Hence, there are a lot of possibility to introduce this project and technologies to construction field. In addition, the numerous convergence studies between construction field and machine learning will be conducted in the future.

#### (4) Threat

New Inventions always produce numerous problems when it is applied to the real field. The gap between the project and the application in the construction field will occur because the simulations are not conducted. However, simulating this project to various construction phases in the total stages helps to reduce this gap. In addition, applying this project might be difficult because of the conservative tendency in the construction field.

### 5. Sustainability

Two aspects ensure the sustainability of this project.

First, as I mentioned in *chapter 1*, this project is a part of the project called "*The development of Smart Construction Communication Tool (SCCT)*". Creating *automotive management of defects in construction phases* and applying it properly are the key elements in SCCT. Hence, our team will develop this project continuously even after finishing this project.

Second, further study about this project is vital because the open data is restricted. As mentioned in *Chapter 3*, there are various open construction defects pictures, however, they are still small and have worse quality than the construction pictures in major construction companies. Hence, our team plans to sustain the project with various and good quality of data after partnering with major construction companies.

### 6. Schedule

Weeks	Contents
~5	Define the project subject
6~7	Search the data and write a proposal
8	Gather the data related to the project
9	Understand the thesis and reference codes
10 ~ 12	Create the prototype model(version-1)
13	Contact with professor and analysis of problem
13 ~ 16	Create the final model(version-2)
16	Presentation

## 7. Conclusion

In conclusion, this project will reduce the budget and construction period and improve the effectiveness of construction phase by reducing the manual management with using the automotive management of defects in construction phase.

## 8. Reference

[1] Automated Look-Ahead Schedule Generation and Optimization for the Finishing Phase of Complex Construction Projects, Ning Dong, June 2012, CIFE Technical Report #TR211, STANFORD UNIVERSITY

[2] Application of Artificial Neural Networks to Prediction of Construction Safety Accidents, Kim Yeon-Cheol, Yoo Wi Sung and Shin Yoonseok, Feb 2017, J.KOREAN Soc, Hazard Mitig. Vol 17, No. 1 pp 7 ~ 14

[3] Classification of Images from Construction Sites Using a Deep-learning Algorithm – Preliminary Study, Gil Dae-Young, Jeon Ka-Hyun, Lee Ghang, October 2017, ARCHITECTURAL INSTITUTE OF KOREA

[4] Segmentation-Based Deep-Learning Approach for Surface-Defect Detection, Domen Tabernik, Samo Sela, Jure Skvarc, Danijel skoca, 11 June 2019, arXiv:1903.08536v3 [cs,CV]

[5] *Seoul Metropolitan Government Construction Allimi*

[https://cis.seoul.go.kr/TotalAlimi\\_new/Main.action?cmd=main](https://cis.seoul.go.kr/TotalAlimi_new/Main.action?cmd=main)