Image Processing For Construction Projects

Hyoungkwan Kim

Based on sources such as

Junhao Zou, and Hyoungkwan Kim (2007). "Using Hue, Saturation, and Value Color Space for Hydraulic Excavator Idle Time Analysis" Journal of Computing in Civil Engineering, 21(4), 238—246.

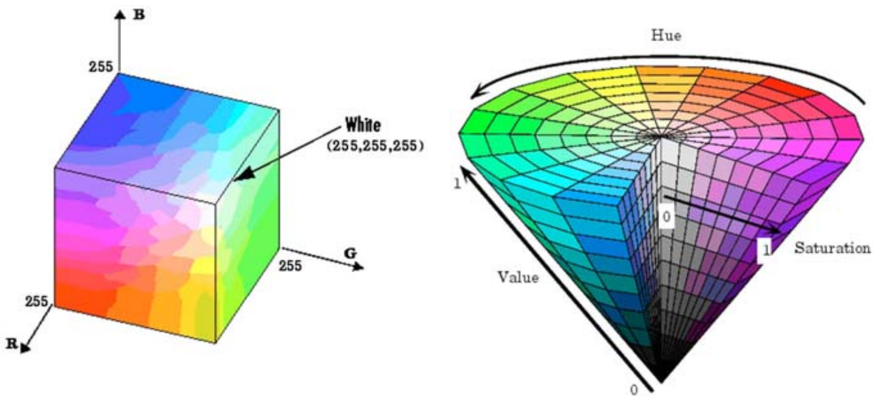
Yuhong Wu, Hyoungkwan Kim, Changyoon Kim, and Seung H. Han (2010). "Object Recognition in Construction Site Image Using 3D CAD-based Filtering" Journal of Computing in Civil Engineering, 24(1), 56—64.

Using Hue, Saturation, and Value Color Space for Hydraulic Excavator Idle Time Analysis (Zou and Kim 2007)

- Accurate analyses of equipment idle time are crucial for the efficient utilization of construction equipment in large construction projects.
- The less idle time the equipment has, the higher productivity it can achieve.
- However, it is not feasible for field personnel to visually observe the operation of construction equipment all day.
- An image processing-based methodology is presented in this paper to automatically quantify the idle time of hydraulic excavators.

Construction Site Images with Equipment

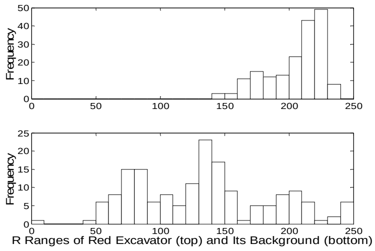
RGB and HSV Color Spaces



(MathWorks 2003)

Sample Image of Excavator in Background of Black Soil and White Snow

Original Image



Red Color Distribution

Grayscale Image

Saturation Image

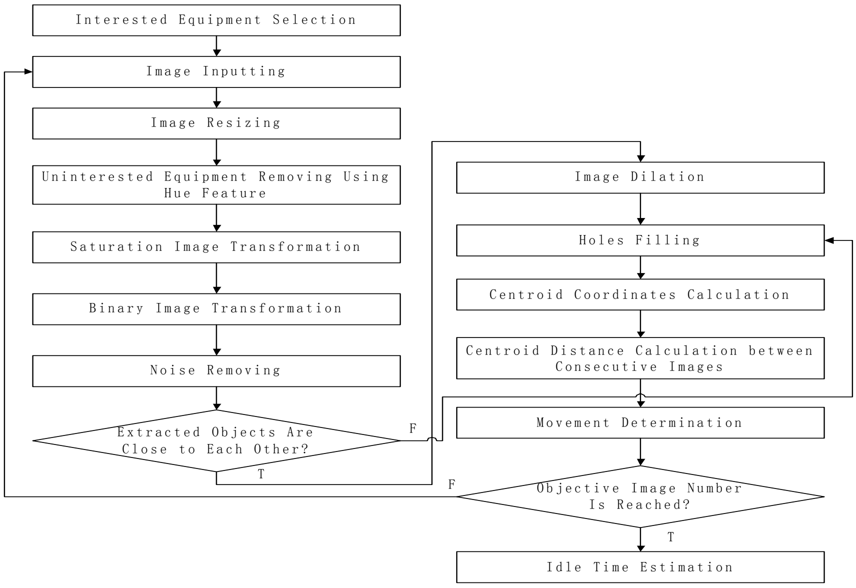
Comparison of Hue- and Saturation-based Extraction

Original Image

By hue

By saturation

System Architecture



Conclusions

- With the help of the proposed methodology, a high degree of accuracy was achieved when a 3 h long image series a total of 1,080 images was processed.
- The results show that the hydraulic excavator works 7,210 s (2 h 10 s) during the 10,800 s (3 h) investigation period, with a working rate of 66.8% and an idle time of 3,590 s (59 min 50 s).
- The real working rate by visual observation of the original images was 67.0%. This gives a discrepancy of only 0.2%.
- Experimental results show that the presented methodology has a promising application potential for effective equipment management in construction projects.

Object Recognition in Construction-Site Images Using 3D CAD-Based Filtering (Wu et al. 2010)

- Construction-site images that are now easily obtained from digital cameras have the potential to automatically provide the project status information.
- For example, once construction objects such as concrete columns are accurately identified and counted, the current level of project progress in the column installation activity can easily be measured.
- However, in order to identify and count the number of concrete columns installed at a particular point of time, a robust object recognition methodology is required.
- Without the successful recognition and extraction of the construction object of interest, it is almost impossible to understand the current level of project progress.
- This paper presents a robust image processing methodology to effectively extract the objects of interest from construction-site digital images.

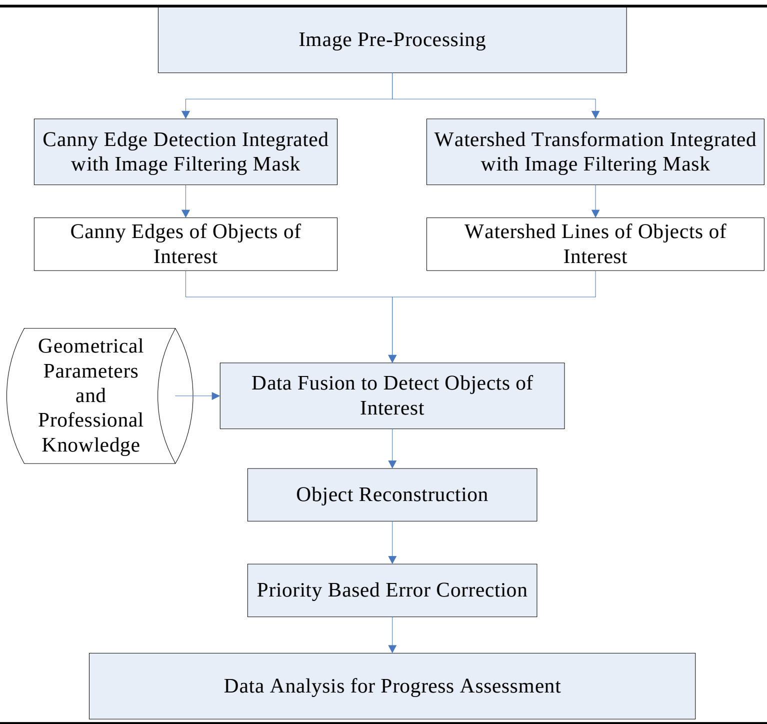


Image Pre-Processing

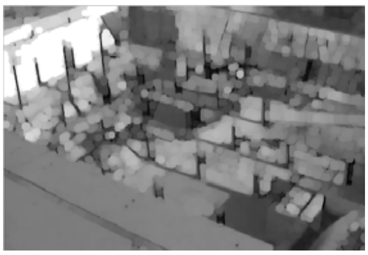
(a) Original RGB Color Image

(b) Grayscale Image of Interest

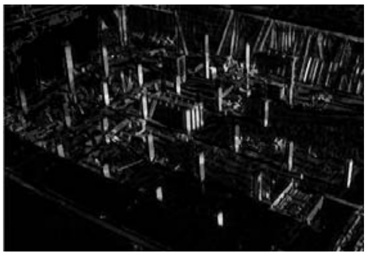
(c) Image with Light Compensated

(d) Grayscale Image of Interest

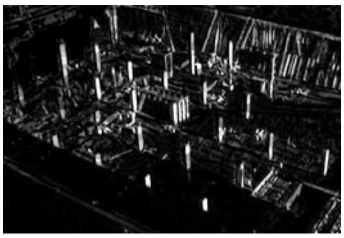
Image Pre-Processing (Cont'd)



(e) Background Illumination Image



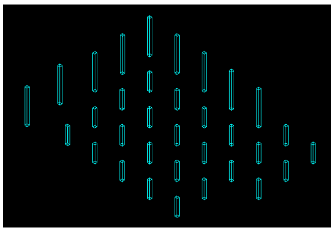
(f) Grayscale Image with Background Subtracted

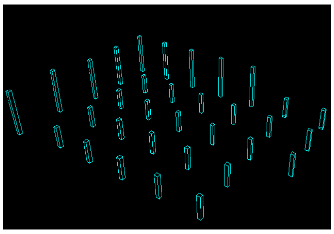


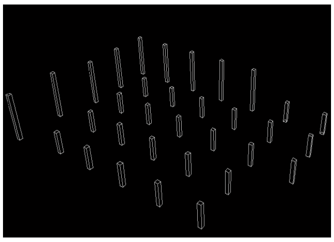
(g) Adjusted Grayscale Image of Interest

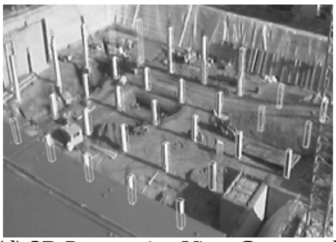
(h) Median Filtered Grayscale Image of Interest

Imaging Filter Creation Process

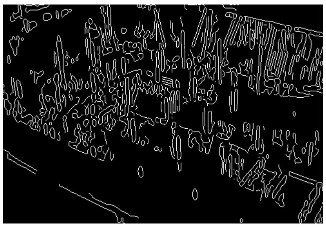

(a) 3D Isometric View of Objects of Interest

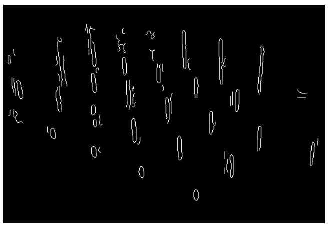

(b) 3D Perspective View of Objects of Interest

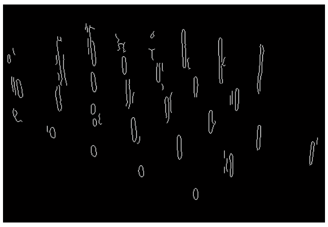

(c) Binary Image of Calibrated 3D Perspective View

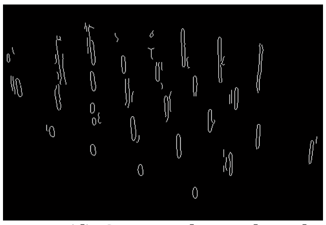

(d) 3D Perspective View Compared with Grayscale Image of Interest

Edge Based Image Segmentation Algorithm

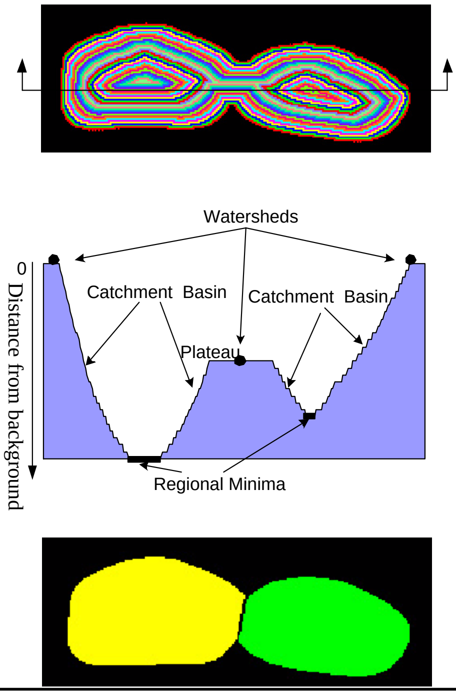

(a) Canny Edges Created by optimal T_H and T_L


(b) Canny Edges Filtered by Imaging Mask

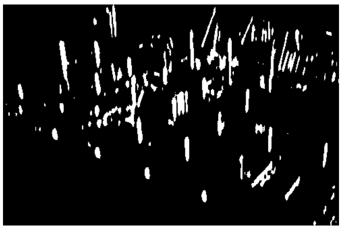

(c) Canny Edges with Small Noise Removed


(d) Canny Edges Filtered Based on Size parameters

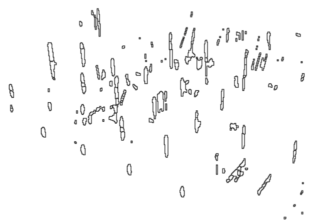
Watershed algorithm



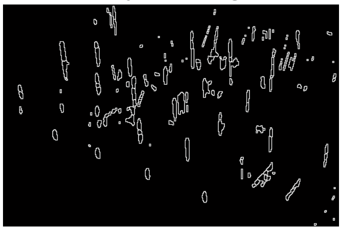
Watershed Transformation Based Image Segmentation Algorithm



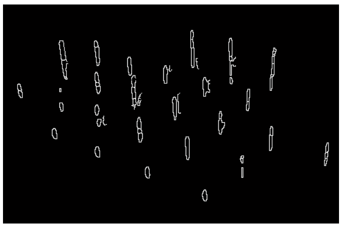
(a) Binary Version of the Preprocessed Grayscale Image



(b) Watershed Lines

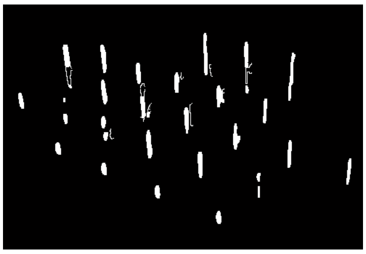


(c) Complemented Watershed Lines

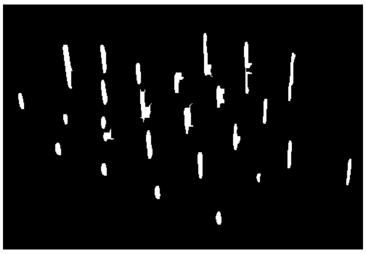


(d) Watershed Lines Filtered by Imaging Mask

Watershed Transformation Based Image Segmentation Algorithm (Cont'd)

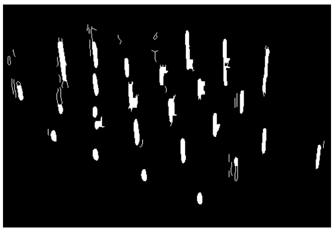


(e) Watershed Lines with Inner Holes Filled

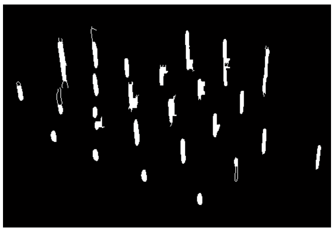


(f) Watershed Lines Filtered Based on Size Parameters

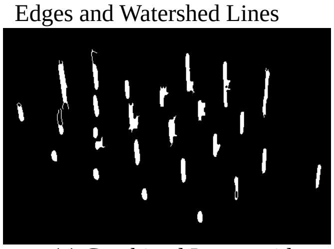
Fusion of Canny Edge Based and Watershed Transformation Based Algorithms



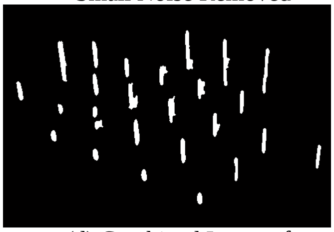
(a) Combined Result of Canny Edges and Watershed Lines



(b) Combined Image with Small Noise Removed



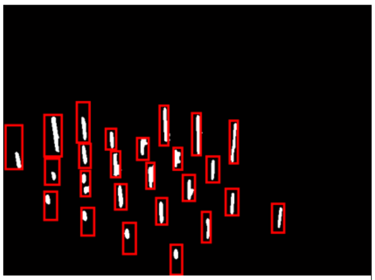
(c) Combined Image with Small Gaps Filled



(d) Combined Image after Morphological Transformations

Object Reconstruction

(a) Original Color Image



(b) Detected Objects of Interest Candidates and their Bounding Boxes

(c) Image with Objects of Interest R econstructed

Experimental Results and Conclusions

- An experiment was carried out, with randomly selected images, to investigate the applicability of the developed system in a real construction project.
- The proposed methodology with desirable lighting conditions allowed 99 columns to be correctly detected out of 101 columns, resulting in an accuracy of 98%.
- However, undesirable lighting conditions permitted only 64 columns to be correctly recognized out of 80 columns, resulting in an accuracy of 75%.
- This indicates that further works are required to improve the image processing accuracy especially under undesirable lighting conditions such as cloudy or foggy weather.
- Overall, this study shows that the image processing system developed in this research has the strong potential for automatic progress control in the construction industry.