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FEASIBILITY ANALYSIS OF AN AUTOMATED DETECTION OF PHYSICAL DEFECT VIA COMPUTER VISION

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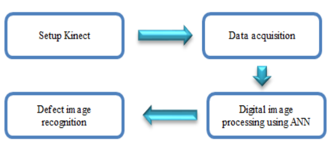
Graphical abstract



Abstract

High demand of building construction has been taking places in the major city of Malaysia. However, despite this magnificent development, the lack of proper maintenance has caused a large portion of these properties deteriorated over time. The implementation of the project - Automated Detection of Physical Defect via Computer Vision - is a low cost system that helps to inspect the wall condition using Kinect camera. The system is able to classify the types of physical defects -crack and hole - and state its level of severity.The system uses artificial neural network as the image classifier due to its reliability and consistency. The validity of the system is shown using experiments on synthetic and real image data. This automated physical defect detection could detect building defect early, quickly, and easily, which results in cost saving and extending building life span.

Keywords: Defect detection, kinect, ANN, image processing

Abstrak

Permintaan yang tinggi untuk pembinaan bangunan telah berlaku di bandar utama Malaysia. Walau bagaimanapun, kekurangan penyenggaraan telah menyebabkan sebahagian besar rumah pembinaan merosot dari semasa ke semasa. Pelaksanaan projek Pengesanan Automatik pada Kecacatan Fizikal melalui Visi Komputer adalah sistem kos rendah yang membantu untuk memerikssa keadaan dinding menggunakan kamera Kinect. Sistem ini dapat membezakan jenis-jenis kecacatan fizikal;retak dan lubang, dan menyatakan tahap keterukan. Sistem ini menggunkan rangkai neural tiruan unutk kelaskan image kerana kestabilan dan konsisten. Kesahihan sistem ditunjukkan menggunakan uji kaji ke atas data imej sintetik dan sebenar. Automatik pengesan kecacatan fizikan boleh megesan kecacatan dengan awal, cepat dan mudah, menyebabkan penjimatan kos dan memanjangkan jangka hayat bangunan.

Kata kunci: Pengesanan kecacatan, Kinect, ANN, imej pemprosesan

1.0 INTRODUCTION

Noorsidi Aizuddin Mat Noor and Chris Eves expressed their view that a high demand of building construction has been taking place from all over places in Malaysia, particularly in the state of Kuala Lumpur, Penang and Johor Bahru[1]. They stated that the current building units have skyrocketed to a huge excess of 1.3 million and increasing. The rise of the development in building constructions is inevitable in developing countries like Malaysia.

However, despite the magnificent development, the lack of proper maintenance has caused a large portion of the construction property deteriorated over the time. S.H.Zulkarnain, E.M.A Zawawi, M.Y.A. Rahman, N.K.F. Mustafa posited that the in-charge party prefers to take reactive maintenance works than proactive works[3]. Current practices show that maintenance services will only be carried out when there is a complaint or the condition become severe, however, the awareness of performing maintenance regularly is essential to increase the life cycle of the property and to minimum unexpected breakdown or deterioration effects[3].

This paper highlights on the usage of computer vision (via Kinect) in detecting building physical defect and is organized as follows. Section 2.0 shows the methodology used to develop the system, from hardware setup to the algorithm used in detecting and classifying the defect. Next, results and discussions will be shown in Section 3.0, where parts of the GUI are also being presented, and ended with a conclusion in Section 4.0.

2.0 METHODOLOGY

2.1 Kinect Setup

The overall methodology in developing the system can be seen in Figure 1. The first step in initiating the project is to setup the Kinect camera. The distinct feature of Kinect camera is that it is able to obtain depth information via a sensor. The capability of the camera to obtain not only RGB image but also depth image.

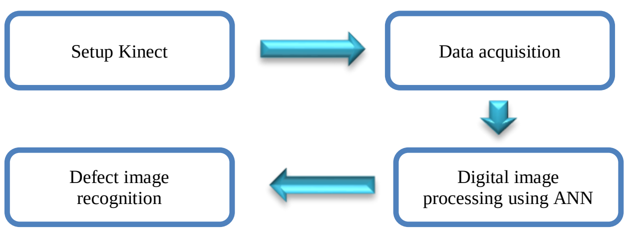


Figure 1 Algorithm architecture

After the installation of software drivers, the Kinect camera is programmed to capture images. Capturing Images using Kinect camera will give RGB image and depth image. Those images would be processed in the later stage of the project to be analyzed and classified.

2.2 Image Processing

The overall algorithm used in processing the images is as shown in Figure 2.

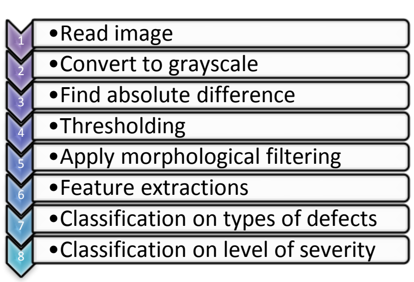


Figure 2 Digital image processing algorithm

2.3 Graphical User Interface (GUI)

Graphical User Interface (GUI) is implemented into the project to make it more appeal to the user as GUI allows the user to interact with the system in an attractive outlook, simplicity operation and apparent control. Furthermore, GUI allows non-technical user to operate the system with ease, without the need of knowing the actual mathematics behind. The GUI for this system is as shown in Figure 3.

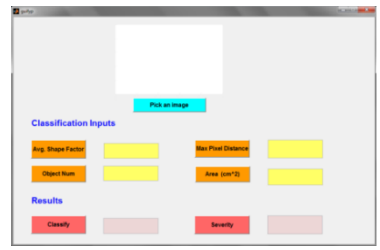


Figure 3 Graphical user interface

3.0 RESULTS AND DISCUSSION

With the implementation of the digital image processing and artificial neural network classification technique, the project has achieved the classification accuracy of 94.6%.

Results of experiment on real world images are as shown in Figure 4 and 5.

(a) (b)

Figure 4 Result for real crack image. (a) Result 1, (b) Result 2

(a) (b)

Figure 5 Result for real hole image. (a) Result 1, (b) Result 2

In the demonstration of the system, all of the photos captured are accurately classified according to its own types. And, all the results also show low level of severity on the detected physical defects, which is accurate.

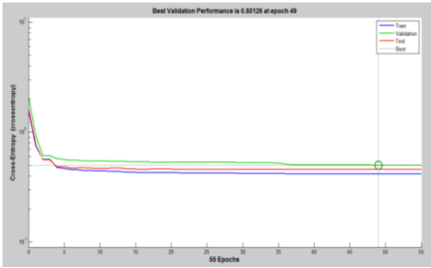


Figure 6 Performance graph

Figure 6 shows the performance graph of the overall system. The dotted line in the graph shows the position of the best validation network performance, which is at epoch 49. The learning is stopped at the minimum of the validation set error.

From the graph, cross entropy is the measure of average of input data needed between probability distributions to identify an event from a set of possibilities. The cross entropy error function is given as in (1). In other words, cross entropy measure the error that indicates the difference between the calculated output and the target output.

$$-\sum_{i=0}^{n} \ln(o_i) * t_i \qquad (1)$$

where o = data input= target output

In order to determine the performance of the system, a histogram representing the error has been developed as shown in Figure 7. The vertical axis is the frequency of error that is determined within a particular set of bandwidth, while the horizontal axis is the sets of bandwidth that is often called error size, as in (2):

$$Error\ size = Targets - Outputs \qquad (2)$$

From the graph, the peak of the histogram is at around 190, at the bin of -0.4939. This shows that the network error occur the most at that point, with around 120 errors in training data, around 40 errors validation data, and around 30 errors data in test data.

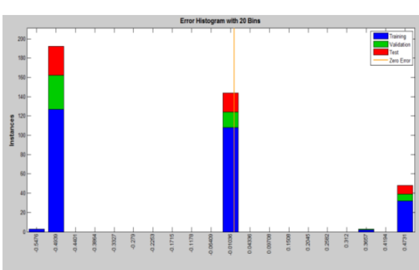


Figure 7 Error histogram

4.0 CONCLUSION

The developed system has recognized these two types of building defect (hole and crack) successfully. It can be extended further by using it to detect other types of defect. By applying the project in the conventional inspection process, the related personnel could quickly identify the defect early and easily. This could result in cost saving and extending the life span of the building construction.

Acknowledgement

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