DETECTION OF SURFACE CRACK IN BUILDING STRUCTURES USING 1D LOCAL BINARY PATTERN (LBP) ALGORITHM AND K-NN CLASSIFIER

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A project report submitted in fulfilment of the
requirements for the award of the degree of
Master of Engineering (Computer and Microelectronic System)

School of Electrical Engineering
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JULY 2021

DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

ACKNOWLEDGEMENT

There are several people who helped and guided me throughout the progress of this project. I would not able to reach my goals without their valuable assistance in the completion of this project. Thus, it is my pleasure to thank everyone who had contributed to this project.

I would especially like to thank Dr. Musa Bin Mohd Mokji. As my supervisor, he has always given me his invaluable advice and professional guidance throughout the development of the project. He has given out his precious time and his enormous patience to help me to solve many problems that I had faced during the progress of this project. I am grateful for his insightful suggestion and explanation on how to proceed with my project. I could not have imagined having a better supervisor in my development of final year project.

I would like to give my deepest thanks and appreciation to my friends. They have provided me extensive personal guidance, suggestion and inspiration during the progress of this project. Besides that, I would like to offer my regards and blessing to my family for their love, encouragement and full of support from the beginning until now.

ABSTRACT

The purpose of this project is to develop a building crack detection using the 1D-LBP algorithm and K-NN classifier. Surface cracks in building structures are treated as critical indicators of major structural problems and durability. The appearance of monolithic construction was also destroyed by the cracks. It takes a lot of time to detect the surface cracks manually. The way of detecting cracks manually is based on the experience of the person, and thus it is mainly a subjective judgment of the inspector. Therefore, automatic detection and classification of surface cracks is the highest priority task because it provides fast and reliable detection and analysis. There are a lot of feature extraction methods and classification methods for crack detection. Classic local binary pattern (LBP) is one of the most useful feature extraction methods. Moreover, the K-Nearest Neighbour (K-NN) classifier is a widely use classifier due to its simplicity. Due to the current methods in feature extraction are still improving, this project proposed a new characteristic extraction method to increase the performance of crack classification. In this project, the performance of a classification system with the one-dimensional local binary pattern algorithm (1D-LBP) and the K-Nearest Neighbour (K-NN) classifier. There are two stages in the classification system. Firstly, the 1D-LBP algorithm will extract the normalized crack images features and save the data in a text file. Secondly, the K-NN classifier is used to classify the 1D-LBP based features from the first stage. There are two classes for the classifier to classify, which are positive crack versus negative crack and severe damage crack versus less severe damage crack. The classification performance is affected by the 1D-LBP based information and the value of K in the K-NN classifier.

ABSTRAK

Tujuan projek ini adalah untuk mengkaji pengesanan retak bangunan menggunakan algoritma 1D-LBP dan pengklasifikasi K-NN. Retak pada muka struktur bangunan dianggap sebagai petunjuk kritikal terhadap ketahanan struktur bangunan. Retak juga akan memusnah penampilan bangunan. Kerja mengesan retak akan mengambil masa yang banyak jika kerja itu dijalankan secara manual. Cara mengesan retak secara manual perlu berdasarkan pengalaman orang yang menjalankan kerja ini dan penilaiannya adalah subjektif. Oleh itu, pengesanan dan klasifikasi retakan permukaan secara automatik adalah tugas keutamaan kerana cara secara automatik akan mendapat pengesanan dan analisis yang cepat dan tepat. Terdapat banyak kaedah pengekstrakan ciri dan kaedah klasifikasi untuk pengesanan retak. Corak binari tempatan klasik (LBP) adalah salah satu kaedah pengekstrakan ciri yang paling berguna pada masa kini. Tambahan pula, pengkelasan K-Nearest Neighbor (K-NN) adalah salah satu teknik yang banyak digunakan kerana teknik ini mudah and tidak kompleks. Walaubagaimanapun, kaedah tentang pengekstrakan ciri tersebut masih boleh diperbaikikan untuk mendapat prestasi yang baik. Projek ini mencadangkan kaedah pengekstrakan ciri baru untuk meningkatkan prestasi klasifikasi retak. Dalam projek ini, prestasi sistem klasifikasi dengan algoritma corak binari tempatan satu dimensi (1D-LBP) dan pengelasan K-Nearest Neighbor (K-NN). Terdapat dua peringkat dalam sistem klasifikasi. Pertama, algoritma 1D-LBP digunakan untuk mengekstrak ciri gambar retak yang dinormalisasi dan menyimpan data dalam teks mengikut subjek dan kombinasi untuk dinilai untuk peringkat seterusnya. Kedua, pengklasifikasi K-NN digunakan untuk mengklasifikasikan ciri berasaskan 1D-LBP dari peringkat pertama. Dua kategori akan dikasifikasi, iaitu antara bangunan yang ada retak dengan bangunan yang tiada retak dan bangunan yang ada retak besar dengan retak yang kecil. Prestasi klasifikasi dipengaruhi oleh maklumat berasaskan 1D-LBP dan nilai K dalam pengelasan K-NN.

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K-NN	-	K-Nearest Neighbor
1D-LBP	-	One-Dimensional Local Binary Pattern
RGB	-	Red Green Blue

CHAPTER 1

INTRODUCTION

1.1 Problem Background

A wide variety of loadings are determined the safety and the lifespan of civil infrastructures, such as service loads, self-weight and environmental loads during the lifetime. Eventually, the loadings have high chances cause structural damage that will bring in economic loss and put human life at high risk. Therefore, regular inspections of civil infrastructure systems are enforced by law in many countries to evaluate structural quality to prevent further damage. Building cracks are one of the most common items in the inspection process and severe defects in concrete structures because the effective loading area is tended to be reduced and thus increasing the stress and subsequent failure of the concrete [1]. Although cracks originated at the section's surface, it is difficult to detect visually if the crack width small [2]. Each mode of cracks will yield diverse damage and failure modes in concrete structures [3].

Nowadays, the most common and widely used method in practice for crack monitoring in concrete structures is manual visual inspection. However, there are few drawbacks to manual visual inspection, such as labour-intensive, costly, time-consuming and not as accurate as possible as the investigation depends on the inspector's skill. Thus, many research efforts have been carried out to develop automatic methods for building crack detection with minimal human intervention to avoid the drawback and increase the efficiency and accuracy of building crack detection.

1.2 Problem Statement

Surface cracks in building structures are treated as critical indicators of major structural problems and durability. The way of detecting cracks manually is based on the experience of
the person, and thus it is mainly a subjective judgement of the inspector, which is inefficient in terms of both cost and accuracy. Besides, manual detection is time-consuming. Therefore, automatic detection and classification of surface cracks is the highest priority task because it provides fast and reliable detection and analysis. The information can be used to determine the appropriate rehabilitation method to fix the damaged structures and prevent further failures.

1.3 Research Objectives

The main objectives to be achieved through this project are:

i. To use the feature extraction method for the high accuracy classification result.

ii. To classify and evaluate the building crack level based on the classification result.

1.4 Scope of Research

In this project, the classification and evaluation of the level of building crack have been carried out by using the 1D-LBP algorithm and K-NN classifier. Python is the main programming language that will be used throughout the whole project. A set of localized and normalized build crack images have been used for classification. Then, the features of the images are extracted by using 1D-LBP algorithms. The data is stored in a text file with class labelling. After that, the data is split into train data and test data. The K-NN classifier is applied for matching with the train data and test data to get the accuracy of the 1D-LBP based features. The performance of the 1D-LBP based features will determine the result in the K-NN classifier.

1.5 Report Outline

Chapter 2 is described the related work proposed or presented by other researchers. Background studies about this project are mentioned in the chapter. Chapter 3 is explained the methodology for the project. Methods and procedures that involve software are explained systematically. There is no result and discussion in this report.

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