UNIVERSITI TEKNOLOGI MARA

AUTOMATIC DETECTION OF UNDERGROUND UTILITY USING GROUND PENETRATING RADAR (GPR) DATASET

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ABSTRACT

Complete and accurate information regarding subsurface material such as underground utility is becoming increasingly important nowadays. With the right information and updates on the underground utility such as location, type, depth and material; catastrophic events such as underground utility damage caused by miss digging and disruption to existing utility services can be avoided or at least minimised. Based on the study, Ground Penetrating Radar (GPR) is one of the latest non-destructive geophysical technology and most widely used in detecting underground utilities. GPR has the ability to detect both metal and non-metal, however, it is unable to identify the type of underground utility object. Many researchers come out with their own techniques to interpret the GPR image. The current method requires experience in interpretation. Thus, in this study, a new method to detect underground utility by utilising the Normalised Cross Correlation (NCC) template matching technique is proposed. This technique will reduce the dependency on experts to interpret the radargram, less time consuming and eventually save cost. Upon detection, the accuracy of the system is assessed. From the accuracy assessment performed, it is shown that the system provides accurate detection results for both, depth and pipe size. The RMSE for the buried pipe depth obtained by using the proposed system is 0.110 m, whereas the highest percentage match obtained is 91.34%, the remaining 8.66% mismatched might be due to the soil condition, velocity or processing parameter that affected the radargram. Based on the assessment, the developed system seems capable to detect the subsurface utility if the radar image and template image used is acquired using the same antenna frequency, point interval and similar GPR instrument. Three Geographical Information System (GIS) software (ArcGIS, Quantum GIS and SAGA GIS) have been compared and used in achieving the objective. The final outputs of the study include portraying the detected utility in 3D view.

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TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Introduction

The development of underground utility mapping and the technologies used in detecting the underground utility are briefly discussed in this chapter. This chapter outlines the importance of detecting the underground utility, the aim of the study, the research objectives, and the significance of the study.

1.2 The Technologies Behind the Underground Utility Mapping

Lack or inaccurate information can cause the underground utility to be damaged during excavation and construction (Vine, 2014). With the right information and updates on the underground utility such as location, type, depth and material; catastrophic events such as underground utility damage caused by missdigging and disruption can be avoided or at least minimised (Jamil et al*.,* 2012). There are a number of accidents which occurred in consequence of excavation activities. Most of these have resulted in fatalities. Some of the victims were construction workers and some of them were civilians who were around the area during the incident (Pipeline Safety Trust, 2015).

In recent years, various non-destructive techniques emerged for the purpose of detecting underground utilities. This technology is distinguished by the principles of each device. Currently, the techniques to detect underground utility rely on radio-location (Farrant et al., 2008), magnetic (Jamil et al., 2012), sonic or acoustic (Hao, 2011), cable detector, robotic crawler (Jiang et al., 2005; Kim, 2011), radio frequency (Mishra, 2017), pipe and cable locator (PCL) (Hashim et al., 2016), and Ground Penetrating Radar (GPR) (Cheng et al., 2013). However, each method has its own advantages and limitations. Based on the study, GPR is one of the latest non-destructive geophysical technology (Cheng et al., 2013; Radulescu et al., 2015) and is most widely used in detecting underground utilities (Bell, 2014). The GPR technique