DESIGN AND CHARACTERIZATION OF STRAIN SENSOR FOR LANDSLIDE EARLY WARNING DETECTION VIA IOT PLATFORM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEDICATION

There have been many inspirer who have walked alongside me during the last four years until I finished my final year project. They have guided me, placed opportunities in front of me and showed me the doors that might be useful to open. I would like to thank each and every one of them. I would especially like to thank Mr. Mazran bin Esro, my Final Year Project supervisor. Without your encouragement the road would have seemed lost and lonely place. I would also like to thank Universiti Teknikal Malaysia Melaka, for their financial and practical support. A very big thank you must also go to my parent for their mentally supports. Thank you for believing in me.

ABSTRACT

Landslides are among several phenomenon which causes serious damage to roadside, highways and properties. This happens usually during monsoon season where heavy rainfall could trigger the landslide and causing damages without warning. Landslides near the highways could cause injuries and fatal accidents to the road user. Therefore, the land near these critical areas need to be closely monitored. This project involved the design and characterization the strain sensor to detect the soil movement and provide early warning of possible landslide to happen. The soil movement sensor is designed using strain gauge and supported by vibration sensor with amplifiers. The system will implemented and monitored via IoT platform. Four strain gauges are connected in the form of Wheatstone-bridge arranged on a steel rod to sense the compression and tension difference translated in the form of voltage. Then the data are transmitted to IoT platform for analysis to predict the soil movement which could indicate a possible landslide.

ABSTRAK

Tanah runtuh adalah antara beberapa fenomena yang menyebabkan kerosakan serius di tepi jalan, lebuh raya dan hartanah. Ini berlaku biasanya semasa musim tengkujuh di mana hujan lebat boleh mencetuskan tanah runtuh dan menyebabkan kerosakan tanpa amaran. Tanah runtuh berhampiran lebuh raya boleh menyebabkan kecederaan dan kemalangan maut kepada pengguna jalan raya. Oleh itu, tanah berhampiran kawasan kritikal ini perlu dipantau dengan teliti. Projek ini melibatkan reka bentuk dan pencirian sensor ketegangan (strain sensor) untuk mengesan pergerakan tanah dan memberi amaran awal kemungkinan tanah runtuh akan berlaku. Sensor pergerakan tanah direka menggunakan tolok terikan (strain gauge) dan disokong oleh sensor getaran dengan penguat. Sistem ini akan dilaksanakan dan dipantau melalui platform IoT. Empat tolok terikan disambungkan dalam bentuk Wheatstone-bridge yang disusun pada batang keluli untuk merasakan pemampatan dan ketegangan yang diterjemahkan dalam bentuk voltan. Kemudian data dihantar ke platform IoT untuk analisis bagi meramalkan pergerakan tanah yang mungkin menyebabkan kemungkinan tanah runtuh.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	:	Internet of Things
LED	:	Light-emitting Diode
PGA	:	Programmable Gain Amplifier
ARM	:	Advanced RISC Machines
PWM	:	Pulse Width Modulation
USB	:	Universal Serial Bus
AC	:	Alternating Current
DC	:	Direct Current
GPIO	:	General-purpose Input/Output
RISC	:	Reduced Instruction Set Computer

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

Overview of this project, objective and the scope of work of the project are discussed in this chapter. Problem statement and the objectives will be proven and analysis with appropriate methodology. Thus, in this chapter also involved the importance or significant of the project.

1.1 Project Overview

This project involved the design and characterization the strain sensor to detect the soil movement and provide early morning of possible landslide to happen. The sensors are designed with strain gauge, vibration sensor as additional sensor and amplifiers and requires proper calibration. The data will implemented and monitored via IoT platform. Four strain gauges are connected in the form of Wheatstone-bridge and then connected to amplifier to get the result. The results are in the form of analysis in

realizing the objectives. The sensor are placed in different configuration are connected to AD623 amplifier and multimeter. Then the strain gauge are characterized and analyzed to detect the soil movement before a landslide occur. The result are obtained as the strain gauges connected to HX711 and Arduino microcontroller to perform the graph presentation using IoT platform.

1.2 Problem Statement

A landslide can lead to demolition and well-known geo-hazard that constantly affecting many countries especially during monsoon season. Two decades ago, rainfall had triggered many landslides throughout Malaysia that struck the citizens, mostly near the hillside areas where number of properties are damaged, human death and injuries have been reported. For instance, landslide tragedy that occurred at Genting Highland on 30 June 1995 had killed 20 lives and more than 20 persons injured. Another landslide incidents occurred in North-South Expressway near Gua Tempurung had caused extremely big loss and the cost of repair amount to ten million Ringgit Malaysia based in newspaper article, Utusan Malaysia, 2002a. There was an incident about the residents of Taman Idaman Serendah have been evacuated to Sekolah Rendah Agama Serendah, Nov 26, 2016. Therefore it is important to take a necessary action provided the residents were given an early warning. Solution to this issue is proposed by this project with a title 'Design and Characterization of Strain Sensor for Landslide Early Warning Detection via IoT Platform'. This is because this technology can give the early warning detection of landslide by using IoT platform.

1.2.1 Table of Event Chronology

Table 1.1: Tragedies Chronology[1]

DATE	INCIDENT
1 May 1961	Landslide happened in Ringlet, Cameron Highlands, Pahang.
21 October 1993	The man-made Pantai Remis landslide caused a new cove to be formed in the coastline.
11 December 1993	48 people were put to death when a block of the Highland Towers collapsed at Taman Hillview, Ulu Klang, Selangor.
30 June 1995	20 people were terminated in the landslide at Genting Highlands at the slip road near Kuala Lumpur–Karak Expressway in Karak Highway.
6 January 1996	Landslide in the North–South Expressway (NSE) close to Gua Tempurung, Perak.
29 August 1996	A mudflow near Pos Dipang Orang Asli settlement in Kampar, Perak, 44 people were killed in this tragedy.
15 May 1999	A landslide near Bukit Antarabangsa, Ulu Klang, Selangor. Most of the Bukit Antarabangsa civilians were trapped under the rubble. Only two victims survived — an Indonesian maid and a child.
20 November 2002	The Affin Bank bungalow of chairman General (RtD) Tan Sri Ismail Omar collapsed due to an early morning landslide in with a fatality in his family at Taman Hillview, Ulu Klang, Selangor.
December 2003	Rock fall in the New Klang Valley Expressway (NKVE) near the Bukit Lanjan interchange caused the expressway to be closed for more than half a year.
31 May 2006	Four people were terminated in the landslides at Kampung Pasir, Ulu Klang, Selangor.
26 December 2007	Two people, the villagers were buried alive in landslide, which demolished nine wooden houses in Lorong 1, Kampung Baru Cina, Kapit, Sarawak.

12 February 2009	One contract worker was killed in a landslide at the construction site for a 43-storey condominium in Bukit Ceylon, Kuala Lumpur.
21 May 2011	16 people of 15 children and a caretaker of an orphanage were killed in a landslide caused by heavy rains at the Children's Hidayah Madrasah Al-Taqwa orphanage in FELCRA Semungkis, Hulu Langat, Selangor.
29 Dec 2012	88 residents of bungalows, shophouses and double-storey terrace houses in the Puncak Setiawangsa, Kuala Lumpur were instructed to move out due to soil movement. A resident, Siti Mahfudzah Shahril, 34, said she was shocked at the sound of a siren and rushed out to see a landslide of about 50m high.
4 Jan 2013	Construction at the Kingsley Hill housing project at Putra Heights has been halted temporarily following a landslide at the site that caused several vehicles to be submerged in mud.
11 November 2015	Landslide occurred at km 52.4 of the Kuala Lumpur–Karak Expressway between Lentang and Bukit Tinggi, Pahang and Gombak–Bentong old roads. The Lentang–Bukit Tinggi stretch of the expressway was closed to traffic.
26 November 2016	A landslide occurred in Taman Idaman, Serendah, Selangor. About 340 civilians are evacuated.
21 October 2017	- Tanjung Bungah, Penang. 11 people died due to landslide. - Kota Kinabalu, Sabah. Kinabalu Mountain cliffs. Landslide occured due to flood.

1.3 Objectives

The followings are objectives of the project:

i) To characterize and analyse strain gauge sensor to detect the soil movement before a landslide.

ii) To design and develop a technology that can detect the resistivity of landslide by using strain gauge and microcontroller.

iii) To monitor the occurrence and resistance of landslide via IoT platform.

iv) To analyses the effective sensors placement for optimum sensitivity.

1.4 Scope of Works

This project "Design and characterization of strain sensor for landslide early warning detection via IoT platform" is proposed to detect the possibilities of landslide occur mostly at highlands that are near houses, facilities and roads. This project aims to detect any resistances of highland movement that shows the sign of landslide and be notified through mobile device of user. The resistances will be detected and measured by using strain gauge and powered by Arduino UNO.

Basically the main components that will be implemented in this project are strain gauges, instrumentation amplifier, microcontroller of Arduino UNO, stainless steel rod and other basic components such as resistor and voltage source. The resistors in this case is crucial to make a Wheatstone bridge. The strain gauge is chosen as the best sensor for this project is because strain gauge is a sensor which the resistance are varies with any forces that are applied. It converts any force, any pressure, tension or torque and weight conversion in the form of electrical resistance which can then be measured. Strain gauges typically measure very small and precise mechanical strain. Consequently, changes in resistance are also very small and thus cannot be measured