DESIGN OF ENERGY HARVESTING POWERED WIRELESS SENSOR NETWORK FOR MACHINERY HEALTH MONITORING

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

MAY 2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
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Tajuk Projek : Design of energy harvesting powered wireless sensor network for machinery health monitoring

Sesi Pengajian : 2017/2018

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Thanks to my supervisor, family and all lecturers who willing to guide me and support me throughout this final year project.

ABSTRACT

Wireless Sensor Networks or WSN mainly consists of huge amount of miniature sensor nodes or SNs with certain limitation of computer resources which capable for sensing, gathering, data processing and wireless communication. Since most of the SNs are powered by traditional batteries, it can be inconvenient due to their limited lifespan. In this project, a thermoelectric generator (TEG) is used as thermal energy harvester with the intention to extend the SN lifespan. Since the output voltage produced by this TEG is insufficient to power up the node, a DC-DC step-up converter circuit based on MAX757 integrated circuit is designed to step up the output voltage produced from TEG up to 3V. Besides, the sensor node is programmed and configured by using the MEMSIC Mote View software. The SN consumed an average power of about 25mW in the active mode and 60μW when it is in sleeping mode. This node is able to transmit data whenever there is at least a temperature gradient of 15℃ between the hot and cold surface of TEG. This project is conducted indoor by utilizing two SNs with one of them is powered by traditional battery and the other one is powered by TEG. The measured data is collected for every 10 minutes and displayed in Mote View, where the data is analyzed and compared.

ABSTRAK

Rangkaian Sensor Tanpa Wire “Wireless Sensor Network” atau WSN terdiri daripada pelbagai jenis nod sensor (“Sensor Node”) atau dikenali sebagai SN yang kecil dengan had keupayaan komputer dalam penginderaan, mengumpul maklumat, pemprosesan data dan mengutamakan komunikasi tanpa wire. Kebanyakan SN dijana oleh bateri dan ini menyebabkan kesukaran serta menyekat keupayaan SN untuk berfungsi dalam keadaan baik malah jangka hayat bateri adalah singkat. Dalam projek ini, kajian terhadap Thermoelectric Generator (TEG) telah diguna sebagai sumber penuaian tenaga terma dengan tujuan meningkatkan jangka hayat SN. Memandangkan voltan keluaran yang dijana oleh TEG ini tidak memenuhi keperluan voltan SN, satu litar DC-DC penukaran dan peningkatan telah direka bentuk berasaskan MAX757 litar yang diintegrasikan untuk menjana voltan sehingga 3V. Kemudian WSN diprogramkan dan diconfigurasikan dengan menggunakan perisian MEMSIC’s MOTE VIEW. Purata kuasa elektrik yang diguna oleh SN adalah 25mW dalam keadaan aktif dan 60μW dalam keadaan rehat. Nod in berupaya untuk menghantar data pada situasi kecerunan suhu antara 15°C pada permukaan berusur TEG. Projek ini dikaji dalam makmal dengan penggunaan dua SN yang setiap satu menggunakan kaedah penjanaan kuasa yang berlainan. Di antara kedua-

dua SN yang diimplikasi dengan kaedah penjanaan kuasa yang berlainan , salah satu SN menggunakan kaedah penjanaan kuasa menggunakan bateri manakala SN yang satu lagi menggunakan kaedah penjanaan kuasa menggunakan teknologi TEG. Setiap 10 minit, data yang diukur akan direkodkan dan ambil dan dipaparkan di perisian Mote View. Data yang dikumpul dari kedua-dua SN dianalisis dan dibandingkan.

ACKNOWLEDGEMENTS

First of all, I would like to express an appreciation to people supporting and aiding me to complete this study and report. Thank to my family members for encouragement and support me in term spiritual and advises to complete my project with any concern.

Nevertheless, a thousand thanks to my supervisor, Prof. Madya Dr. Kok Swee Leong who contributes in suggestion in term of knowledge and experience, helped me along my final year project. PM Dr. Kok Swee Leong always gave good motivation and suggestion to complete this project.

Lastly, a big thanks to Ali Mohammed Abdal-Kadhim for sharing the ideas and knowledge for the circuit design and provide guide to finish the project in time. He had given me a lot of encouragement and tips to improve my project. Last but not least, I would like to thanks PSM lab assistant, Encik Imran Bin Mohamed Ali who help and guide during etching process.

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LIST OF SYMBOLS AND ABBREVIATIONS

WSN	:	Wireless Sensor Network
SN	:	Sensor Node
TEG	:	Thermoelectric Generator
ADC	:	Analog-Digital Converter
L	:	Inductor
C	:	Capacitor
MAX	:	Maxim Integrated
DC	:	Direct current
V	:	Voltage
A	:	Ampere
M	:	Mega
C	:	Giga
m	:	Millie
W	:	Watt
Hz	:	Hertz
MHM	:	Machinery Health Monitoring

MCM	:	Machinery Conditioning Monitoring
RCS	:	Rohrback Cosasco System
DARPA	:	Defense Advanced Research Project
QoS	:	Quality of service
bps	:	Bit per seconds
I/O	:	Input and Output
MPR	:	Minnesota Public Radio
MIB	:	Management information base
ISM	:	International Safety Management
MDA	:	Management Data Acquisition
UART	:	Universal asynchronous receiver-transmitter
I^2C	:	Inter-Integrated Circuit
s	:	Second
GND	:	Ground
S	:	Seebeck Coefficient
T	:	Temperature
K	:	Thomson coefficient
IoT	:	Internet of Things
Wi-Fi	:	Wireless Fidelity

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CHAPTER 1

INTRODUCTION

Energy harvesting technique is one of the alternative way to replace the battery as it will deplete with time. However, it is quite challenging for us to power an electronic devices by using the energy harvesting technique. Therefore, an energy harvester is used with the help of a power conditioning circuit to power the sensor devices in order to prologue the life span of sensor.

1.1 Project Background

In this modern day, most of the electronic devices and systems included wireless sensor nodes are powered by electrical power source such as battery. However battery's life span is short termed. When the batteries deplete, they definitely need to be replaced over certain period. In remote area, people unable to access the places hence battery replacement is impossible, especially for hazardous environment. In