









DEVELOPMENT AND VALIDATION OF AN AUTOMATED CENTRALIZED REMOTE SENSING SYSTEM FOR FOREST ENVIRONMENTAL ACTIVITY

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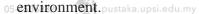




ABSTRACT

The aim of this research is to develop a remote monitoring device that could capture critical real-time data such as temperature, humidity, gaseous, fire, and rain detection that shows the current preserved natural state and habitat in the forest. The forest ecosystem is essential in supplying high natural resources for flora and fauna. This unprotected resources are exposed and susceptible to the threat of illegal logging which can lead to unhealthy phenomenon and irreplaceable assets. The methodology is to employ the rapid prototyping modeling in developing this prototype and also to include a system model that explains the implementation of the temperature, humidity, and hydrogen gaseous variables. All the readings were recorded in real-time for data management and statistical analysis by using SPSS, as well as to analyze the model based on Technology Acceptance Model (TAM) by AMOS. The paired sample T-Test and two-group MANOVA analysis showed that there are significant between mean temperature and humidity. The prototype was implemented at selected locations in the Royal Belum forest to monitor and gather data at two phases. The field experiment was conducted in April 2015. The data consisted of 60 samples for temperature, humidity and hydrogen gaseous from both the upper and the lower parts of the forest. The findings also proved by regression and covariance analysis that the lower part of the forest was more significant than the upper part of the forest area. The results obtained from this research would definitely benefit the monitoring bodies or relevant authorities in applying the system that capable to protect and preserve the forest in its natural

































PEMBANGUNAN DAN PENGESAHAN SISTEM PENGESAN AUTOMATIK BERPUSAT BAGI AKTIVITI PERSEKITARAN HUTAN

ABSTRAK

Tujuan penyelidikan ini adalah bagi membangunkan peranti kawalan pemantauan bagi

mengumpulkan data kritikal secara langsung seperti suhu, kelembapan, gas, dan pengesanan api dan hujan yang menunjukkan keadaan semasa alam semula jadi yang dilindungi dan habitat di dalam hutan. Ekosistem hutan adalah penting bagi membekalkan sumber semula jadi kepada flora dan fauna. Sumber yang tidak dilindungi ini terdedah kepada risiko pembalakan haram yang secara tidak langsung mengundang kepada fenomena yang tidak sihat dan khazanah yang tidak dapat dipulihkan. Metodologi kajian ini terdiri daripada model prototaip berterusan yang digunakan untuk membangunkan prototaip dan juga termasuk sistem model bagi penerangan mengenai pelaksanaan terhadap pembolehubah kelembapan, dan gas hidrogen. Kesemua bacaan dihantar secara langsung untuk pengurusan data dan analisis secara statistik dengan menggunakan perisian SPSS dan menguji model yang dibangunkan berdasarkan Technology Acceptance Model (TAM) oleh AMOS. Dapatan kajian berdasarkan analisis persampelan berpasangan ujian T dan MANOVA dua kumpulan menunjukkan bahawa terdapat perbezaan signifikan diantara mean suhu dan kelembaban. Prototaip ini dilaksanakan di lokasi-lokasi yang terpilih di dalam hutan Royal Belum untuk pemantauan dan kutipan data melalui dua fasa. Eksperimen kajian telah dijalankan pada April 2015. Sampel data terdiri daripada 60 pensampelan bagi suhu, kelembaban dan gas hidrogen daripada bahagian atas dan bahagian bawah hutan. Dapatan kajian dibuktikan melalui analisis regresi dan kovarian mendapati bahagian bawah hutan adalah lebih signifikan berbanding bahagian atas hutan. Dapatan kajian daripada kajian ini diharapkan mampu memberikan manfaat kepada badan-badan pemantauan atau pihak berkuasa yang berkenaan dalam menjaga hutan di dalam habitat semula jadi.









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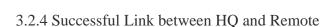
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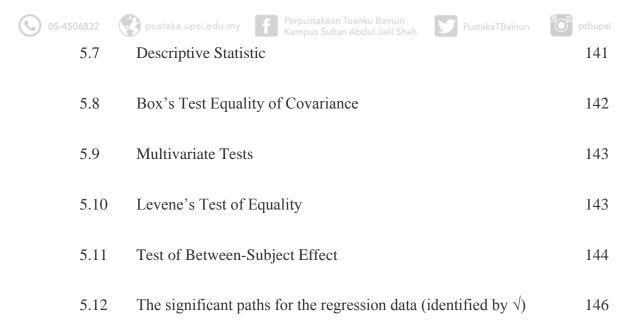
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LIST OF ABBREVIATIONS

A/D Analog to Digital

AC Alternate Current

CFS Central Forest Spine

CLASlite Carnegie Landsat Analysis System

DC Direct Current

GFCD Global Forest Change dataset

GIS Geographic Information System

GPS Global Positioning System

GSM Global System for Mobile Communication

I/O Input/Output

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ptbup

ID Instructional Design

IHR Indian Himalayan Region

LCD Liquid Crystal Display

MANOVA Multivariate of Covariance Analysis

MODIS Moderate Resolution Imaging Spectroadiometer

PLC Programmable Logic Circuit

PPM Part Per Million

RP Rapid Protoyping

RS Remote Sensing

RX Receive

SMS short message service

SPSS Statistical Package for Science Sosial



















TXTransmit

USB Universal Serial Bus

VCF Vegetation Continuous Fields





























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CHAPTER 1

INTRODUCTION



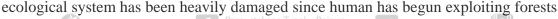








The ecosystem and the natural environment of the Earth have gradually becoming eradicate due to negligence and total lack of control by human population, thus affecting our rainforest ecosystem that is not just for shelter to the biodiversity of flora and fauna, but on the contrary and more crucially, to establish an equilibrium ecosystem to us human too. Moreover, it would be incapable for rainwater to be stowed, filtered down to the ground, and flowed to the dam without the rainforest. In fact, the Royal Belum Forest is the oldest rainforest in the world and it has been thriving for more than 100 million years. The rainforest covers about 117, 500ha of land in Perak and it is the biggest in Malaysia (Malaysia Natural Heritage, 2013). It contributes rainwater to water catchment areas at Ahning, Pedu, and Muda dams. Unfortunately, the present forest













disorderly, especially through illegal logging, which has become a primary factor of deforestation.

As a result, it has created widespread environmental damage, irreversible climate change, contamination of air and surrounding rivers, recurrent avalanches, as well as deterioration of the colony regions and the living conditions among Aborigines (Singh & Abdullah, 2013). Furthermore, an interesting study by Daily (2007) revealed that half of the land on the Earth has been used up by human. Besides, nearly 30% of carbon dioxide occasioned from human acts has filled up the earth. Thus, crucial inquiry has to be carried out urgently in order to conserve the ecosystem of our Earth. In fact, two methods are available to prevent illegal logging activity. The first method is enforcing stricter forest preservation regulation to punish those who commit it, while the second method is tightening the observation of illegitimate forest harvest. Nonetheless, conventional method for monitoring large-scale forests, which saves time and labor resources is by keeping the ranger manually patrolling the area. Moreover, the desolate state of the forest ecosystem is also making it too harsh to constant patrol. Therefore, the purposes of this study had been to maintain the ecosystem of the Earth by preserving and regulating our treasured forest, especially the Malaysian rainforest at Royal Belum Forest, through a new technology that could assist in alerting real-time, as well as to provide faster response to the authority to act on these illegal activities.

Furthermore, the concept of ecosystem complexity, consisting of mapping and modelling including their overtime rate of changes is the main issue in biogeography and spatial ecology. Besides, remote monitoring has been recognized as one of the most dominant methods to map abiotic and biotic ecosystems' components for example, land











use, soils, land cover and vegetation as well as estimating their changes over time (Rocchini et al., 2013). In addition, remote sensing and alerting have existed since a long time and they have been used to enhance the quality of monitoring and alerting. Moreover, because of the advancement of wireless sensor technology and innovation in communication, it is now likely for business users to implement this technology for their productions (Hema, Murugan, & Priya, 2014). In addition, providing cellular network saturation into rural areas has made remote sensing a better option. Therefore, applying remote sensing to forestry and agricultural sectors is recommended as it is feasible.

The research depicts the development of an automated centralized remote monitoring system for detecting rainforest activities. The main focus for developing this device was to measure current temperature, humidity, and hazardous gas, such as carbon monoxide, butane, propane, methane, and smoke. In addition, the device could detect fire and rain, where all the data gathered from the device were transmitted to GSM by sending messages in near real-time and then, the data were sent to database, which after that, displayed all the data captured on the website that had been developed. The device was also equipped with GPS functionality to track the location of the device by its latitude and longitude. The implementation of the device was done within the Royal Belum preserved forest. In fact, the sensor had the main role in this research as the data gathered had to be accurate and validated by calibrating the sensor. After obtaining the real calibration of the sensor, the device was compared with a multifunctional environment meter and a handheld gas monitor to ascertain the validation of the data values.









Moreover, the microcontroller and the shield used in the development of this system have often been used by engineers to design and develop a technology that is based on the field of robotic technology. Not only that, the microcontroller that was used to develop the system displayed numerous potential for innovation of various kinds of beneficial products that can be implemented to the society. Furthermore, in this research, green energy was employed to replace electric energy. In this case, this device used the solar energy gained from the sun, which was absorbed by the solar panel, and then, the energy flowed through another shield that converted the solar energy to current before being supplied to the microcontroller used in this device. Through the use of this green energy, the rate of using electrical energy had been reduced and thus, can help save the Earth, besides offering healthy environmental conditions (Hammer et al., 2003).











This prototype highlights the initiative to prevent illegal logging. Even though the developed device cannot be compared to remote sensing with high resolution, such as satellite imagery, it is more affordable and easy to use. Besides, the combination of all of the features within the hardware and the software, such as Arduino as the main component, generated the new device. Other components, such as sensor, GPS, and GSM, played their own role towards the development of this prototype. Furthermore, if this prototype could be developed and function as specified; then the combination of separate devices, such as those at the Meteorological department, could be transformed into one single handy device that should be able to capture and measure the collected data, thus generating a new technology that is affordable as well as easy to be use compare high resolution remote sensing components, such as satellite image and radar









which is need an understanding in order to be use or if researcher is someone who is an expert a field regarding to Geographical Information System (GIS).

Deforestation can be simplify as a transformation of forest into alternate non-forested

1.2 Problem Statement

permanent land that been used as development of an urban area, gazing or for agriculture purpose (van Kooten & Bulte, 2000). The main concern about deforestation is involving emerging tropics countries (Myers, 1994) as the areas of the tropical forest has been lessening (Barraclough & Ghimire, 2000) initiating damage within biodiversity and increasing the effect of greenhouse (Angelsen et al., 1999). Food and Agricultural Organization (FAO) has suggested to establish a tree plantation in order to pustake upsuedumy. Kampus Sultan Abdul Jalil Shah be forest for timber production and consequently it does not categorize as a forest alteration to estate by way of deforestation (however it is still consider to damage the natural forests). However, tree plantation cannot be cogitate for supplying non-timber produces to be forest though rubber plantations been classify as a forest as stated by FAO. Forest dilapidation happens when the functionality of ecosystem are ruined however where the remnants of forested area rather cleared (Anon., 2010).

Deforestation happened with a frequency of 9.2 million hectares for each year since 1980 until 1990 while from 1990 until 2000, the rate increased about 6.8 million to be 16 million hectares for each year and in 2000 until 2010, the rate decreasing toward 13 million hectares for each year. The net conversion for the area of the forest throughout the last period was probably around -5.2 million hectares per annum which









the area of the loss are equal around 140km2 of forest each a day or approximately about the size of Costa Rica, though reduced than that stated in 1990-2000 which was 8.3 million hectares per annum equal to 0.20 per cent loss for the remaining of forest area each year. The recent annual net loss is 37 per cent slighter than that in the 1990s and equivalents a loss of 0.13 per cent for the remaining of forest area a day respectively during this period. By dissimilarity some smaller countries have great losses per annum plus they are in jeopardy of practically losing their entire forests in the following decade doubly if existing proportions of deforestation are continued. Undeniably, an approximate of 31 countries do not even reach to the list since they have now removed most of their forest and even the remain are completely degraded and fragmented. The changes in area of forest by region and sub-region are shown in **Table 1.1** below.



















Table 1.1 Conversion in forest area from 1990-2010 (Source: Anon., 2010)

	1990-2000		2000-2010	
Region/sub-region	1 000 ha/year	%	1 000 ha/year	%
Eastern and Southern Africa	-1841	-0.62	-1839	-0.66
Northern Africa	-590	-0.72	-41	-0.05
Western and Central Africa	-1637	-0.46	1535	-0.46
Total Africa	-4067	-0.56	-3414	-0.49
East Asia	1762	0.81	2781	1.16
South and Southeast Asia	-2428	-0.77	-677	-0.23
Western and Central Asia O 05-4506832	pustaka.upsi.edu.my 72 Perpustakaan Tuan	ku Bainun 0.17	TBainun 131si	0.31
Total Asia	-595	-0.10	2235	0.39
Russian Federation (RF)	32 n.s.	n.s.	-18	n.s.
Europe excluding RF	845	0.46	694	0.36
Total Europe	877	0.09	676	0.07
Caribbean	53	0.87	50	0.75
Central America	-374	-1.56	-248	-1.19
North America	32	n.s.	188	0.03
Total North and Central America	-289	-0.04	-10	-0.00
Total Oceania	-41	-0.02	-700	-0.36
Total South America	-4213	-0.45	-3997	-0.45
World	-8327	-0.20	-5211	-5211







