DEVELOPMENT OF AUTOMATIC LOW COST LIGHT MEASUREMENT SYSTEM

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DEVELOPMENT OF AUTOMATIC LOW COST LIGHT MEASUREMENT SYSTEM

YEAP KAR SOON

TESIS INI DIKEMUKAKAN UNTUK MEMENUHI SEBAHAGIAN DARIPADA SYARAT MEMPEROLEHI IJAZAH SARJANA MUDA SAINS DENGAN KEPUJIAN

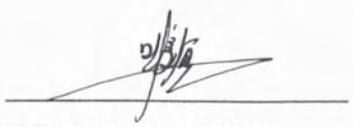
PROGRAM FIZIK DENGAN ELEKTRONIK
SEKOLAH SAINS DAN TEKNOLOGI
UNIVERSITI MALAYSIA SABAH

MAC 2005

DECLARATION

I affirm that this thesis is the result of my own work except where material is taken from the work of others, in which case it is acknowledged.

28 MARCH 2005



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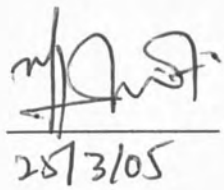
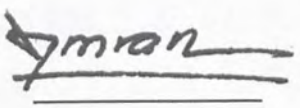
   (Madam Zulistiana Zulkifli)



2. **EXAMINER 1**
   (Dr. Fauziah bt. Hj. Aziz)

3. **EXAMINER 2**
   (Ms Teh Mee Teng)

4. **DEAN**
   (Prof. Madya. Dr. Amran Ahmed)



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ABSTRACT

A very simple and low cost visible light sensing instrument is developed. The proposed system uses a low cost light dependent resistor (LDR) as a sensor, an ADC0808CNN as a converter which can be interface to windows PC. The windows PC is use to display, collect and analyze data. The LDR (Unknown Specification) photoconductor cell used in the lighting system is compatible with a model of DSCD01 LDR (Dick Smith Electronics part no. Z4801) and used its resistance (R) to lux (L) equation. The approximate relationship between illumination (lux) and variable (volt) is calibrated and used. User can choose either lux or volt as unit when recording. The Graphic User Interface (GUI) data acquisition program is designed to start and stop recording data automatically. Data are saved to the variation of time in Microsoft excel file for later analysis. The proposed light measurement system was compared with a commercial calibrated international standard lux meter to measure its performance .The system proposed in this work gives a maximum range of 4.68V or 500,00 lux and the tolerances show ± 1 bit or 0.02V in the obtained result. The system sensitivity in reference unit of volt is higher than the system sensitivity in reference unit of lux.

ABSTRAK

Satu pengesan cahaya mudah dengan kos rendah telah direkacipta. Cadangan system menggunakan satu "Light Dependant Resistor" LDR yang berkos rendah sebagai pengesan cahaya., satu ADC0808CNN digunakan sebagai penukar analog ke digital yang berantaramuka dengan computer. Windows PC adalah program untuk memapar, mengumpul dan menganalisis data yang diperoleh. Modal DSCD01 LDR (Dick Smith Electronics part no. Z4801) boleh dibanding dengan LDR (spesifikasi yang tidak diketahui) sel fotokonduktor yang digunakan dalam system pancaran cahaya dan persamaan modal untuk pertukaran unit rintangan (R) ke keamatan cahaya (L) digunakan. Hubungan antara iluminasi (lux) dan variasi (volt) telah dikalibrat dan diguna. Pengguna diberi pilihan sama ada menggunakan unit (lux) atau (volt) semasa membuat catatan. Program Graphic User Interface (GUI) data acquisition telah direkacipta untuk memulakan dan mengakhirkan catatan data secara automatik. Data adalah disimpan dalam variasi masa dalam bentuk fail Microsoft Excel untuk analisis lanjutan. Persembahan rancangan system dibanding dengan Meter lux komersial piawai antarabangsa yang terkalibrat. Rancangan system dalam kerja ini memberi julat maksimum 4.68V atau 500,000 lux dan mempunyai toleransi ± 1 bit atau 0.02V dalam memperoleh keputusan. System pengukuran yang berujukan unit volt menunjukan sensitiviti yang lebih tinggi berbanding dengan system pengukuran yang berujukan unit lux.

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LIST OF SYMBOLS AND NOTATIONS

Unit of light

lm	Lumen (unit of photometry)
lux	unit of Illuminance

Electronics

DC	Direct Current
C	Capacitance
I	Current
V	Volt
R	Resistance
W	Watt
GND	Connect to Ground

Items

ADC	Analog to Digital Converter
CdS	Cadmium Sulphide
CD	Compatible Disc
IC	Integrated Circuit
L.E.D	Light Emitter Diode
PC	Personal Computer
LDR	Light Dependant Resistor

Digital

n	Number of bits in ADC
LSB	List Significant Bit
MSB	Most Significant Bit
t_H	Time for output become high level
t_L	Time for output become low level
TTL	Transistor-transistor Logic

Resistance

Ω	Ohm
R_a	External Resistor a in 555 circuit
R_b	External Resistor b in 555 circuit
R_v	Variable Resistance
R_{pc}	Photocell Resistance

Voltage

V_{cc}	Supply Voltage
V_{ref}	Reference Voltage for ADC
V_{out}	Output Voltage from voltage divider circuit
V_m	Measurement Voltage (Calibration)

Powers of Ten

μ	micro
nm	nano
m	mili
k	Kilo
M	Mega

Others

%	Percentage
^oC	Celsius
Hz	Hertz
F	Frequency
s	Second
min	minute

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The measurement of light intensity is not like the measurement of physical quantities such as weight or displacement because light is not a physical object. It is a visual phenomenon, a part of the process of vision. If we attempt to measure it we must not lose sight of that fact. Hence, a research study was proposed to develop a light measurement system and collecting light data into a Windows PC.

This research contains a combination of hardware instrument and software system. The hardware instrument involves a simple and conventional electronic circuit device. A low cost LDR photoconductive cell is used and builds to measure light in a wide range of intensity level. The LDR sensor spectrum curve and example of light reading are given to illustrate the performance and sensitivity of the LDR sensor.

The software system enables a Windows PC to display and collecting light data. The software system is created using application programming software to run the display and recording.

Data that is collected to a PC is essential to the instrumentation, measurement, and analysis process, because many phenomena that must be measured occur much too rapidly to be analyzed in real time. Furthermore it is necessary to replace what human fail to do such as high calculated speed, easy to retrieve data, data and drawing can be update easily, enable connecting to networking which is safe time and energy.

This research covers a wide range of technical parts such as designing, building, testing, calibrating, interfacing, programming and measuring. All the procedure is important to achieve the research goal. Some comments regarding current and future development of the designed are included.

1.2 RESEARCH GOAL

My research goal is to make a simple light measurement electronic circuit, measure the level of brightness and convert it to digital data than store the data into the PC using designed application programming software.

1.3 RESEARCH OBJECTIVE

1. To design a device which can convert light source into electrical signal data.
2. To measure and record the level of brightness over a period of time.
3. To design data logging application software which can interface with the hardware device.
4. Calibrate voltage signals into unit of light (lux).

5. To record the output signal from the light detector into a Windows PC.
6. 2 experiments are conduct to prove the designed lighting system give good indication of relative light intensity from low light level to high light level.
    a. As part of a weather study to monitor sunrise and sunset times.
    b. Inverse square light intensity experiments using a point source of light.

1.4 RESEARCH SCOPE

Simple and conventional items are use in the electronic circuit device. The device uses a low cost Light Dependence Resistance (LDR) as a sensor. The system is designed to work in air only, it is not waterproof. The data sampling rate is depending on the capability of the PC. For the research purpose, the light sensor system is not requiring high data rate. By operating the system, simply plug the device into any Windows PC, run the application software and are ready to collect and display data.

The research is done in the visible light range. The measurement is done in University Malaysia Sabah (UMS) Lab Kota Kinabalu, Sabah, (Indoor) and Kingfisher Kota kinabalu, Sabah, (Outdoor).

The proposed system is use for educational purposes only. It is not appropriate for industrial or commercial applications.

REFERENCES

Deitel, H, M & Deitel, P, J & Nieto, T, R. 1999. Visual Basic 6. Prentice Hall, New Jersey.

Fairchild Semiconductor, 1998Datasheet:DM74LS245. http://dezdepcomp.8m.net/ic%20station/DM74LS245.pdf. (30 September 2004)

Fetters, J, L. 1998. *The Handbook of Lighting Surveys & Audits*. CRC Press, USA.

Floyd, T, L. 2003. *Digital Fundamentals, Eight edition*. Prentice-Hall, USA.

Forouzan, B, A. 2003. Data Communication and Networking, third edition. McGraw Hill, New York.

Greame, J, G. 1996. *Photodiode Amplifiers*. McGraw-Hill, USA.

Hanly, J, R & Koffman, E, B. 2004. *Problem Solving and Program Design in C, Fourth Edition.* Pearson Education, Inc, New York.

Hecht, E. 1998. *Optics, Third edition*. Addison-Wesley Longman, In, USA.

Maryati Mohamed, Atsuko Takano, Benoit Goossens and Rajah Indran. 2003. *Lower Kinabatahgan Scientific Expedition 2002*. Universiti Malaysia Sabah, Kota Kinabalu.

Matias.F. A.A & Vila.M. M.D.C & Tubino. M, 2003. A simple device for quantitative colorimetric diffuse reflectance measurements. Sensor and Actuators B **88** : 60-66.

Messenger, R & Ventre, J. 2000. *Photovoltaic Systems Engineering*. CRC Press, New York.

Minnaert, M. 1993. *Light and Color in the Outdoors*. Springer-Verlag, New York.

National Semiconductors, 2000. Datasheet: LM555 TIMER. http://cache.national.com/ds/LM/LM555.pdf. (30 September 2004)

National Semiconductors, 2002. Datasheet: ADC0808CCN. http://www.national.com/ds/AD/ADC0808.pdf. (30 September 2004)

Noltingk, B, E. 1995. *Instrumentation References Book, Second Edition*. Butterworth-Heinemann Ltd, Britain.

Sapoval, B & Hermann, C. 1995. *Physics of semiconductors*. Spinger-Verlag, New York.

Smith, W, J. 2000. *Modern Optical Engineering, Third Edition*. McGraw-Hill, New York.

Sombatsompop.N, Intawong.N.-S, Intawong.N.-T, 2002. Design and construction of photo-conductive light pressure sensor for highly viscous fluids. *Sensor and Actuators A* **102**: 76-82.

Steffy. G. R, IES, FIALD, 1995. *Lighting the Electronic Office*. Van Nostrand Reinhold, USA.

Uiga, E. 1995. *Optoelectronics*. Prentice Hall International, USA.

Wilson & Hawker, 1996. *Optoelectronics: An Introduction*. Prentice Hall International, New York.

Yoshi Ohno and Magdalena Navarro. 1998. *New Photometric Calibration Programs at the National Institute of Standards and Technology*. National Institude of Standard and Technology (NIST), Gaithersbug, MD 20899.