LEMBAR PENGESAHAN

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2015 2nd International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE)

Conference Program

Friday, 16th October 2015

07.30 – 08.00	Registration				
08.00 – 08.45	Opening Ceremony				
	Photo Session				
08.45 – 09.00	Coffee Break				
09.00 – 09.50	Invited Speaker 1: Razali Ismail, Universiti Teknologi Malaysia *Novel Device Architectures and Carbon Based Materials for Future Nanoelectronics* Moderator: Teguh Prakoso, Diponegoro University				
09.50 – 10.40	Invited Speaker 2: Bambang Riyanto Trilaksono, Institut Teknologi Bandung *Distributed Consensus Control of Robot Swarm with Obstacle and Collision Avoidance* Moderator: Aris Triwiyatno, Diponegoro University				
10.40 – 11.30	Invited Speaker 3: Lukito Edi Nugroho, Universitas Gadjah Mada *Context-Awareness: Connecting Computing with Its Environment* Moderator: Wahyul Amien Syafei, Diponegoro University				
11.30 – 13.30	LUNCH BREAK				
13.30 – 15.00	Parallel Session				
	ROOM A	ROOM B	ROOM C	ROOM D	ROOM E
15.00 – 15.15	Coffee Break				
15.15 – 17.30	Parallel Session				
	ROOM A	ROOM B	ROOM C	ROOM D	ROOM E
17.30 – 18.30	BREAK				
18.30 – 20.00	Gala Diner				

Saturday, 17th October 2015

08.00 – 10.15	Parallel Session				
	ROOM A	ROOM B			
10.15 – 10.30	BREAK				

Sunday, 18th October 2015

08.00 - ...	Cultural program (city tours) (* with additional arrangements)

Parallel Session Day 1

Friday, 16th October 2015

Room A (Hall, 5th Floor) **Moderator: Rinta Kridalukmana**		
Parallel Session 1 (13.30 – 15.00)		
1	GRN-5	Optimization of Photovoltaic Farm Under Partial Shading Effects Using Artificial Intelligent Based Matrix Switch Controller *Antonius Rajagukguk, Dedet Candra Riawan, Mochamad Ashari*
2	GRN-6	Feature Extraction and Classification for Detection Malaria Parasites in Thin Blood Smear *Hesti Khuzaimah Nurul Yusufiyah, Hanung Adi Nugroho, Teguh Baratha Adji, Anan Nugroho*
3	GRN-7	An Epileptic Signal Preictal Ictal Using PCA, K-Means, K Nearest Neighbors *Siswandari Noertjahjani, Risanuri Hidayat, Samekto Wibowo, Adhi Susanto*
4	ICT-1	Exploring the Perception of Indonesian Students on Mendeley Reference Management Software in Academic Writing *Muhammad Basri, Andi Anto Patak*
5	ICT-30	Multiplying Cipher Images on Visual Cryptography with ElGamal Algorithm *Alexander Edi Suranta Kacaribu, Ratnadewi Ratnadewi*
6	ICT-31	Vowel Pronunciation in Indonesian Language Recognition Using the Lips Angle Measurement and Lips Area *Ratnadewi Ratnadewi, Adhi Fajar Sakti Wahyudi, Anisa Fardhani Prasetyaningtyas*
Parallel Session 2 (15.15 – 17.30)		
1	GRN-1	A Mobile Diabetes Educational System for Fasting Type-2 Diabetics in Saudi Arabia *Mohammed Alotaibi*
2	ICT-2	Time Series Forecasting Using Exponential Smoothing (To Predict the Number of Visitor of the Website of Sebelas Maret University) *Rini Anggrainingsih, Gilang Romadhon Aprianto, Sari Widya Sihwi*
3	ICT-3	Model of Human Resources for Health Information Systems *Bens Pardamean, Timor Utama, Diah Rostanti Fadilah*
4	ICT-4	CANREG 5 Networks for Indonesia *Bens Pardamean, Teddy Suparyanto, Diah Rostanti Fadilah*
5	ICT-7	Fuzzy MADM for Major Selection At Senior High School *Fata Nidaul Khasanah, Adhistya Erna Permanasari*
6	ICT-8	Sentinel Web: Implementation of Laravel Framework in Web Based Temperature and Humidity Monitoring System *Lathifah Alfat, Aris Triwiyatno, R. Rizal Isnanto*
7	ICT-9	Impact of Service-Oriented Architecture Adoption in Information System *Erick Fernando, Derist Touriano, Rico Rico*
8	ICT-10	Crosscutting Concerns Refactoring in Agent Framework *Maman Somantri, Lukito Edi Nugroho, Widywan Widyawan, Ahmad Ashari*
9	ICT-32	Electromyography (EMG) Signal Compression using Sinusoidal Segmental Model *Florentinus Budi Setiawan, Siswanto Siswanto*

Room B (Hall, 5th Floor) **Moderator: Munawar Agus Riyadi**		
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1	EL-1	Two Phase Flow Imaging Using Infra Red Tomography *Sallehuddin Ibrahim, Muhammad Abu Bakar Sidik, Mohd Amri Md Yunus*
2	EL-2	Design of Self Balancing Pitch Control in Fixed Wing Unmanned Aerial Vehicle with Fuzzy Logic Controller *Aris Triwiyatno, Wahyul Amien Syafei, Teguh Prakoso, Budi Setiyono, Aristya Panggi Wijaya*
3	EL-3	Intensity Average Value of Image Segmentation for Infrared Image of Environmental Condition *S.R. Sulistiyanti, M. Komarudin, L. Hakim, A. Yudamson*
4	EL-4	FPGA-Based System for Countinous Monitoring of Three Human's Body Vital Signs *Aminuddin Rizal, Munawar Agus Riyadi, Darjat Darjat*
5	EL-5	Robust Control Design for a Spindle of Lathe Machine *Moh Khairudin*
6	EL-6	Smart Controller Design of Air to Fuel Ratio (AFR) and Brake Control System on Gasoline Engine *Aris Triwiyatno, Enda Wista Sinuraya, Joga Dharma Setiawan, Suroto Munahar*
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1	EL-7	Design of Prepaid Energy Meter Based on PROTEUS *Heribertus Himawan, Catur Supriyanto, Adrin Thamrin*
2	EL-8	The Development of Track Record Application for Conservation Activity and Wildlife in Indonesia *Arie Vatresia, Jonathan Sadler, Rendra Regen Rais*
3	EL-9	A High Speed Low Power Reading Scheme in DRAMs Using Resonant Tunneling Diode *Ahmed Lutfi Elgreatly, Ahmed Ahmed Shaaban, El Sayed M. El-Rabie*
4	EL-10	Control System of Train Speed Based on Fuzzy Logic Controller *Reza Dwi Utomo, Sumardi Sumardi, Eko Didik Widianto*
5	EL-11	Comparison Methods of Noise Elimination for Pregnancy Image Processing *Moh Khairudin, D. Rahmawati*
6	EL-12	Maximum Power Point Tracking Simulation for a Photovoltaic System *Susatyo Handoko, Tejo Sukmadi*
7	EL-13	Design of Multisensor IMU for Land Vehicle *Wahyudi Wahyudi, Ngatelan Ngatelan*
8	EL-17	Performance Enhancement of Directional Coupler Using Split Ring Resonator *Vidya Noor Rachmadini, Achmad Munir*
9	EL-18	Reconfigurable Radiation Pattern of Microstrip Antenna Using Shorting Post *Meutia Yunita, Achmad Munir*

Room C (Hall, 4th Floor) **Moderator: Oky Dwi Nurhayati**		
Parallel Session 1 (13.30 – 15.00)		
1	TE-1	Energy Detector Threshold Under White Gaussian Noise Channel in Cognitive Radio System *Nasrullah Armi, Chaeriah Bin Ali Wael, Muhammad Arshad, Dadin Mahmudin, Pamungkas Daud*
2	TE-2	Modeling and Simulation of OFDM Scheme for Radio Over Fiber (RoF) *Fauza Khair, Fakhriy Hario P, I Wayan Mustika, Budi Setiyanto, Sevia Mahdaliza Idrus*
3	TE-3	Spectrum Sensing Performance in Cognitive Radio System *Nasrullah Armi, Chaeriah Bin Ali Wael, Muhammad Arshad*
4	TE-4	Performance of AOMDV Routing Protocol Under Rushing and Flooding Attacks is Manet *Sukiswo Sukiswo, Muhamad Rifqi Rifquddin*
5	TE-5	SDN Based Data Center Designs Using Cisco ACI Architectures *Atif Khan*
6	TE-6	Multi-Objective Cuckoo Search Algorithm for Task Scheduling in the Cloud Environments *Farnaz Sharifi Milani, Nima Jafari Navimipour*
Parallel Session 2 (15.15 – 17.30)		
1	EL-15	Property Investigation of Nanofiber Polyaniline as Active Material for Biosensor *Ngurah Ayu Ketut Umiati, Mochammad Facta, Kuwat Triyana, Kamsul Abraha*
2	TE-7	Investigation and Comparison of Expert Cloud and E-learning Systems *Nima Jafari Nanimipour, Batool Zareie*
3	TE-9	Adaptive Blind Equalization for Differential SC-FDMA System *Ziyan Jia, Ming Wu, Lianfeng Shen*
4	TE-11	Basic Study of Multiple Symbol Differential Detection for SC-FDMA System *Ziyan Jia, Qiuye Li, Lin Shen*
5	TE-12	Performance Analysis of Transceiver 4 x 4 Space Time Block Coded MIMO-OFDM System *Subuh Pramono, Tommi Hariyadi, Budi Basuki Subagio*
6	TE-14	Managing Bandwidth Resource for Vehicular Ad-hoc Networks *Sami S. Alwakeel, Agung B. Prasetijo*
7	TE-15	Measurement System of Temperature, Humidity and Air Pressure Over 433 MHz Radio Frequency. an Application on Quadrotor *Budi Setiyono, Sumardi Sumardi, Rafdito Harisuryo*
8	TE-21	Development of Capacitor-based Tunable Frequency Selective Surface for Wireless Communication *Achmad Munir, Abraham Mangaraja Huring*
9	TE-22	Compact SRR-based Microstrip BPF for Wireless Communication *Zenal Aripin, Kusnandar Kusnandar, Asep Najmurrokhman, Achmad Munir*

Room D (Hall, 4th Floor) **Moderator: Hermawan**		
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2	PS-2	A Three-phase Power Flow Analysis for Electrical Power Distribution System with Low Voltage Profile *Lukmanul Hakim, Muhamad Wahidi, Umi Murdika, Federico Milano, Junji Kubokawa, Naoto Yorino*
3	PS-3	Design of Photovoltaic Powered Converter to Provide AC Controlled Voltage Source *Slamet Riyadi*
4	PS-4	Smart Monitoring of Electrical Quantities Based on Single Board Computer BCM2835 *Gigih Forda Nama, Dikpride Despa, Muhamad Komarudin, Mardiana Mardiana, Ady Kurniawan*
5	PS-5	Assessment of TRV Parameters and Overvoltages in Three-Phase Ungrounded Faults *Alejandro Marmolejo, Mirko Palazzo*
6	PS-14	Morphological Analysis of Epoxy Resin After Electrical Tracking *Juningtijastuti Juningtijastuti, Abdul Syakur*
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1	PS-6	The Comparative Study of Buck-Boost, Cuk, Sepic and Zeta Converters for Maximum Power Point Tracking Photovoltaic Using P&O Method *Jimmy Trio Putra, Sarjiya Sarjiya, M. Isnaeni BS*
2	PS-7	Impact of High Penetration of Photovoltaic Generation on Voltage Fluctuation of Transmission and Distribution Systems *Jimmy Trio Putra, Sarjiya Sarjiya, M. Isnaeni BS*
3	PS-8	Study on Surface Resistance of Epoxy Resin Filled Silicon Rubber and Silica Due to Electrical Tracking *Abdul Syakur, Tumiran Tumiran, Hamzah Berahim, Rochmadi Rochmadi*
4	PS-9	Blackout Risk Assessment for IEEE 30 BUS System *Muhammad Usman Cheema, Muhammad Usman Aslam, Adnan Bashir, Maria Komal, Naila Kousar Rao*
5	PS-10	Involving Generator Capability Curves in Optimal Power Flow *Hermagasantos Zein, Yutra Sabri*
6	PS-12	Harmonic Current Elimination in Industrial Power Systems *Deria Pravitasari, Deria Pravitasari, Eka Firmansyah, T. Haryono*
7	TE-17	HoMeTrack: RFID-based Localization for Hospital Medicine Tracking System *Kurnianingsih Kurnianingsih, Muhammad Anif, Helmy Helmy, Anton Satria Prabuwono*
8	TE-18	Ontology-based Context Aware for Ubiquitous Home Care for Elderly People *Kurnianingsih Kurnianingsih, Lukito Edi Nugroho, Widyawan Widyawan, Lutfan Lazuardi, Khamla Non-alinsavath*

Room E (Hall, 4th Floor) **Moderator: Dania Eridani**		
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2	ICT-15	Virtual Sensor for Time Series Prediction of Hydrogen Safety Parameter in Degussa Sintering Furnace *Dede Sutarya; Adhi Mahendra*
3	ICT-16	Expert System Applications for Early Diagnosis Teeth and Oral Disease in Children Septya Maharani; Nataniel Dengen; Galih Yudha Saputra; Dyna Marisa Khairina; Heliza *Rahmania Hatta*
4	ICT-17	Department Recommendations for Prospective Students Vocational High School of Information Technology with Naïve Bayes Method *Dyna Marisa Khairina; Fajar Ramadhani; Septya Maharani; Heliza Rahmania Hatta*
5	ICT-18	Data Acquisition and Processing of Movement and Position for AUVs with Experiment Results *Nanang Syahroni; Hari Suparno; Henggar Budiman; Jae Weon Choi*
6	ICT-19	Feature Extraction for Classifying Lession's Shape of Breast Ultrasound Images Using Adaptive Median Filter *Hesti Khuzaimah Nurul Yusufiyah; Hanung Adi Nugroho; Teguh Adji; Anan Nugroho*
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1	GRN-2	Review: Interoperability Model of eGoverment Services *I Wayan Ordiyasa*
2	ICT-12	Autoregressive Integrated Moving Average Modeling in the Financial Market *Peihao LI; Chaoqun Jing; Tian Liang; Mingjia Liu; Zhenglin Chen; Li Guo*
3	ICT-13	User Experience Model in the Interaction Between Children with Special Educational Needs and Learning Media *Tri Sagirani; Lukito Edi Nugroho; Paulus Santosa; Amitya Kumara*
4	ICT-23	Application of Liver Disease Detection Using Iridology with Back-Propagation Neural Network *R. Gelombang Alam Nusantara Putra Herlambang; Ajub Ajulian Zahra*
5	ICT-24	Geographic Information System of Islamic School in Cilacap *Isti Dewi; Ike Windasari; Kodrat Satoto*
6	ICT-25	Portability Characteristic Evaluation Academic Information System Assessment Module Using AIS Quality Instrument *Umi Laili Yuhana; Istiningdyah Saptarini; Siti Rochimah*
7	ICT-27	Statistical Methods' Application in Comprehensive Sustainability Index and Its Application in Regional Sustainability Measurement *Mingjia Liu*
8	ICT-28	Study on the Correlation of Web Repository Ranking to the Green Campus Ranking of Indonesian Universities *Adian Rochim; Riri Fitri Sari*

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Smart Monitoring of Electrical Quantities Based on Single Board Computer BCM2835

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***Abstract*— Electricity network needs to be monitored, especially for Voltage (V) measurement, current (A), power factor (cos θ), power (W), and energy consumption (kWh). Monitoring is important, in order to know the quality of electricity supply in the system, identifying disruption events, and to calculate the amount of electrical energy consumption periodically. To achieve the objectives mentioned above, we have made device that can be monitor the electrical quantities in real time, recorded data was stored in to database system, and web application processed this data and shown the statistic reports through a web interface. This research was conducted on the 3 phase electricity at The Integrated Laboratory of the Electrical Engineering Department University of Lampung. Monitoring of voltage, current and energy consumption was done by using a step-down transformator as a voltage sensor, ACS712-30A as current sensors for capture the flow measurement, and TEM015-D4250 kWh meter for measuring energy consumption. Power and Power Factor value was obtained by some of scientific calculation. We used Python programming language for data processing measurement and calculation, running on BCM2835 Single Board Computer. The results of measurements include voltage, current, power factor, power, and the amount of energy consumption was stored in to data base, and data report can be accessed online using web browser.**

Keywords*— *3-phase electrical networks, voltage sensors, current sensors, kWh meters, energy consumption, BCM2835 single board computer.

I. INTRODUCTION

Electric energy has an important role in promoting the economy of the community, a lot of equipment that requires electricity to operate, both in scale household and industrial scale. The quality of electrical energy such as voltage, current, and power factor is very important to know, because it can affect the performance and service life of the load or equipment used.

In addition, the amount of electrical energy consumption every day, every week or every month as well needs to be known in order to determine the measures to make savings in electrical energy consumption and in turn is expected to reduce the cost of utility bills.

To achieve objectives above, it should be created a system that can monitor the amount of electricity that include voltage, current, power factor, power and huge consumption of electrical energy that can record data during the monitoring done and access it remotely in WEB facilities that would be more effective and efficient in terms of monitoring and control.

In this research, system monitoring is done by using a digital meter kWh equipped with current sensors and voltage sensors for current and voltage of monitoring. Furthermore, power and power factor are calculated based on information obtained from third such equipment.

Single Board Computer programming BCM2835 or commonly called by the name Raspberry pi is used in programming. results of the measurements can be directly displayed and recorded in a database. Raspberry pi can also be directly connected to the Internet like a PC, thus monitoring can be done from distance.

II. LITERATURE REVIEW

A. Electric Current .

Electric current is the amount of charge that flows in a conductor in one second (coulombs per second) [6] which is measured in amperes (A). Electric current can be formulated with the following equation: [6]

$$I = \frac{Q}{t} \quad (1)$$

Where: I = electrical current in amperes (A)
Q = electric charge in coulombs (C)
t = time in seconds (s)

B. Voltage.

Electric voltage is the potential energy difference between two points in volts (V). The voltage can also be interpreted as joule per coulomb [6]

$$V = \frac{E}{Q} \quad (2)$$

Where: V = Voltage in volts (V)
E = Energy in joules (J)
Q = Charge in coulombs (C)

C. Electric Power and Electric Energy.

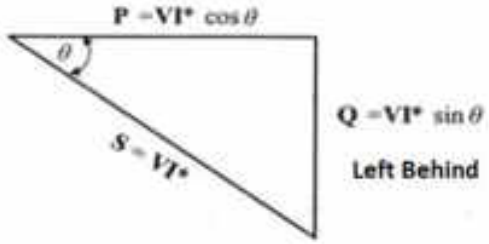
Electric power is the amount of electrical energy that flows every second or joules per second [6] in watts (W). Electrical power is defined by the following equation: [6]

$$E = P.t \quad (3)$$

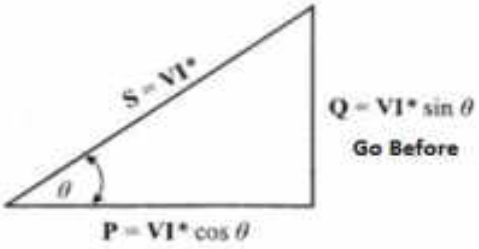
$$P = \frac{E}{t} \quad (4)$$

Where: P = Power in watts (W)
E = Energy in units of joules (J)
t = time in seconds (s)

Electrical energy is defined as the rate of power consumption multiplied by time. [1] Unit for electrical energy on international standards is Joule (J), but in everyday life is better known as kilowatt-hour (kWh). Power in the electrical system of Alternative Current (AC) is divided into; complex power (S) with the unit VA, active power (P) with the unit Watt and reactive power (Q) with a unit of Volt Ampere Reactive (VAR). [1]. Relations between the three types of power above can be explained with sketches power triangle as shown in Figure 1.



a) power triangle with inductive load.



b) power triangle with capacitive load.

Figure 1. Power Triangle [1]

The components of the power triangle can be written as follows: [1]

Active power : $P = VI * \cos \theta$ (W) (5)
Reactive power : $Q = VI * \sin \theta$ (VAR) (6)
Complex power : $S = VI *$ (VA) (7)
Power factor : $\cos \theta = p.f$ (8)

If the circuit is inductive, the current phase will be left out of phase voltage, if the circuit is capacitive, the current phase will precede the phase voltage, whereas if the circuit is resistive then the current will be in phase with the voltage that the phase angle (θ) = 0. The angle θ determines the value of power factor (pf), whereas pf is the cosine of the angle θ value. Pf value is often used as an indicator of the quality of the power supply system. System good if pf value = 1 or close to the value of 1.

D. Related Works.

Previous studies that a reference in this research are: research that explains how to do an online monitoring of the power system using the sample data recorded on the PMU (Phasor Measurement Unit) are placed at various locations [2] [3] In addition to the other preliminary studies related to monitoring server system and Internet connection Mini-Based Single Board Computer BCM2835 also be referenced in this study [4][7][14]. On work [8] describe Design of Data Recorder kWh Meters Distance-Based Microcontroller has produced a device to calculate the energy consumption of the household. Device made consists of two parts: a transmitter and a receiver. Transmitter is applied on the kWh meter, while the receiver is used to see the results of the calculation of a distance using wireless. To get the value of the energy consumption is only used current sensors, and to process the data used microcontroller and subsequently also been no previous research on the electrical connection and monitor the temperature [5] Data monitoring results are stored in a MySQL database and can be viewed on the web in graph form. On works [9][10] presented the electricity measurement research based on microcontroller. The principal of Electrical measurement was also discuss on paper [11][12][13].

III. RESEARCH METHODOLOGY

A. System Block Diagram

Power source 3-phase kWh meters into the digital, then to the current sensor and a voltage sensor, connected to the electrical load is used. KWh meter readings can be sent directly to the Raspberry Pi, while the current sensor readings and sensor voltage to go through the ADC first before being sent to the Raspberry Pi. Furthermore, Raspberry Pi is a place made to store the results of monitoring programs into the database and displays it to the WEB. System block diagram is shown in Figure 2.

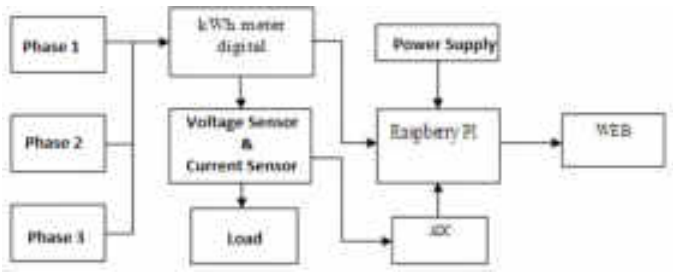


Figure 2. Block Diagram System

B. Hardware Design

1) Voltage Sensor Circuit

In designing the sensor voltage, step-down transformers are used to lower voltage from the high voltage level to a low voltage level. Because the output of transformers is still in AC voltage while Rasbery Pi was designed using a DC voltage source, required signal conditioning circuit which is a rectifier and voltage divider functions to obtain a DC voltage so that the voltage can be read by ADC. Then it will be converted into a digital signal to be transmitted to the Raspberry Pi. Voltage sensor networks are made as shown in Figure 3.

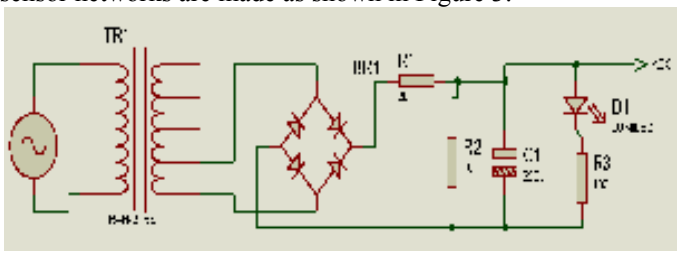


Figure 3. Voltage Sensor Circuit

2) Current Sensor Circuit

30A ACS712 is used in current sensor circuit, this sensor will provide an output voltage that is linear with current changes measured. ACS712 output signal depending on the input signal. In this experiment, the measured current is AC current so that rectifier diode should be added in order to obtain a DC signal and the output can be read by ADC. Maximum sensor output voltage is 5V because of that it should be lowered to 3.3V voltage level (the voltage that is safe for Raspberry Pi) using a voltage divider circuit. Capacitors are used as filters to get a good output signal. Sensor networks was made as shown in Figure 4.

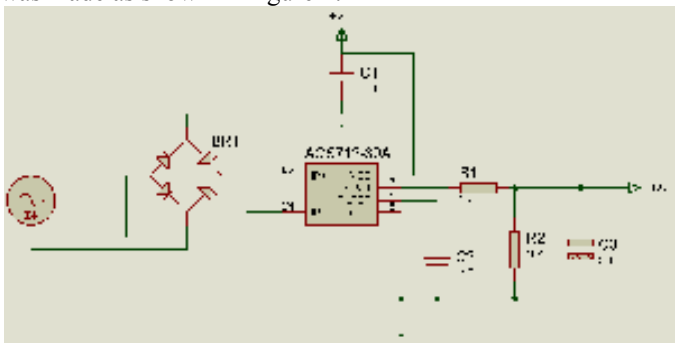


Figure 4. Flow Sensor Networks

3) kWh Digital Meter

kWh meter with TEM015-D4250 type is used in this study. kWh meter is used to measure the energy consumption so that the power value can be determined by dividing the value of kWh between time.

4) BCM2835 Single Board Computer

Single Board Computer BCM2835 or commonly called the Raspberry Pi is a credit card-sized computer developed by the Raspberry Pi Foundation, which has a function similar to most PC.

Monitoring is done on a scale electric power 3-phase network, hence the required sensor 3 respectively. Of all these sensors will get the voltage V (Volt), current I (Ampere), power factor pf (cos θ), load power P (Watt), and E energy consumption (kWh) for each phase. The value of voltage, current and power consumption can be seen in sensor readings. While the power factor and power is the result of calculation . connection between sensors and Raspberry Pi is shown in Figure 5.

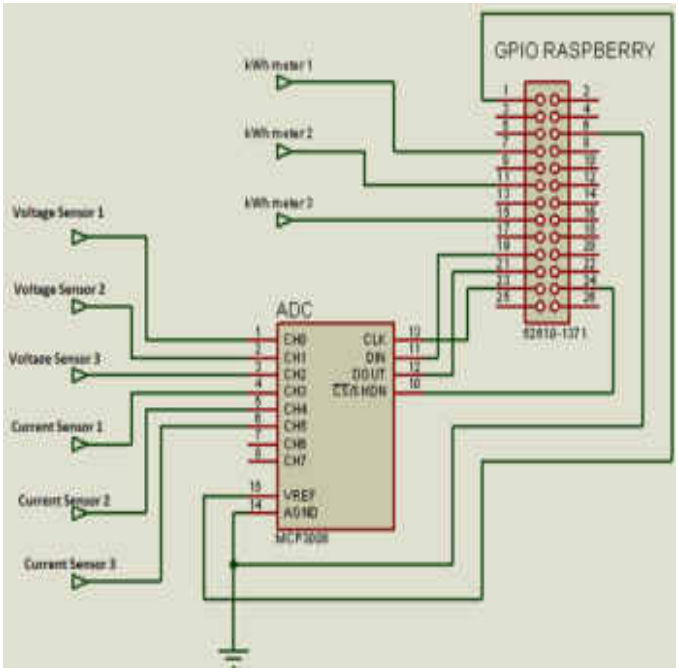


Figure 5. Connection Sensor with Raspberry Pi (BCM2835)

C. Program Design

The program used is Programming Python by using the Raspberry Pi. The program includes:

- Reading of the measurement sensor,
- The calculation to obtain the desired quantity,
- Record the results of measurements in a database and displays in WEB

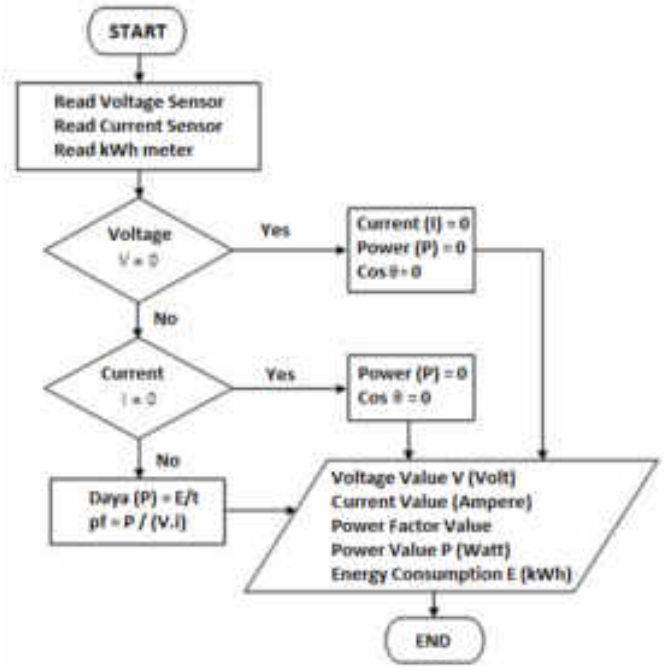


Figure 5. Flow Chart Program.

From Figure 5., output of the system is the value of Voltage, Current, Cos θ, power, and large energy consumption, can be explained as follows:

- Rated voltage obtained from the voltage sensor readings.
- The current value obtained from the current sensor readings ACS712-30A.
- Energy consumption value obtained from kWh meter digital readings.
- Value kWh is the product of power by time, so if the value of kWh have known the value of the power can be calculated using equation (3) and (4)

$$E = P.t\ (Wh)$$
$$E = (P.t) / 1000\ (kWh)$$
$$P = E / t$$

Where: P = Power (Watts)
E = energy consumption (kWh)
t = time (hours)

Then, after the value of Voltage, Current and Power are determined then the power factor pf (cos θ) can be calculated using equation (5) and (8).

$$P = V.\ I\ Cos\ \theta$$
$$Pf = P / (V.I)$$

Where: P = Power (Watts)
V = Voltage (Volt)
I = Current (Amperes)
Pf = Power Factor (cos θ)

IV. RESULTS AND DISCUSSION

A. Voltage Sensor Testing.

Testbed was done by using the voltage sensor analog voltmeter, digital voltmeter and sensors, then comparing the results of measurements among those three instrument devices. test results as shown in Table 1. below.

Table 1. Data Results Voltage measurement

No.	Measurement Result				
	Voltmeter Analog	Voltmeter Digital	Sensor 1	Sensor 2	Sensor 3
1	190	190	189,43	192,35	190,08
2	200	201	199,75	202,77	199,77
3	210	210	209,37	212,28	210,32
4	220	221	219,33	220,89	219,44
5	231	230	229,66	231,31	230,55
6	240	241	240,34	240,82	240,24

B. Current Sensor and kWh meter Testing.

Testbed was done by providing the electrical load power value change, Burden used are incandescent lamps, fans, water heaters and irons. tested is a current sensor and kWh meter, but the voltage sensor is also used in order to obtain the value of power factor using the program. Results of this testing is shown in Table 2.

Table 2. Data Results Current and kWh Testing.

No	Measurement Result								
	I (Ampere)			Pf (cos θ)			P (Watt)		
	Sensor	Analog	Digital	Sensor	Analog	Digital	Sensor	Analog	Digital
1	1,54	1,8	1,78	0,999	0,995	0,999	391,3	390	376
2	2,2	2,2	2,2	0,966	0,992	0,997	473,68	475	465
3	3,74	3,7	3,7	0,965	0,998	0,999	800	818	797
4	5,28	5,2	5,28	0,999	0,999	0,999	1125	1165	1145

Based on the data of voltage, current, power and power factor measurement indicates that the results of measurements using sensors have a small scale difference results if compared with the results of measurement using an analog measuring device and digital measuring devices, so that the sensors are made fairly used for monitoring system of electrical quantities on the panel.

C. Testbed Environtment.

Testbed performed on 3-phase electrical panel in the Integrated Laboratory of Electrical Engineering Unila floor 2nd. The first step is to install the hardware that made the three-phase electrical panel before going to the load, then make the database as a repository for monitoring results using Python programming, and the final step is to show the existing data in the database to the web in graphs. In this test, the Database was made into 5 tables for each measurement, include Voltage, Current, Power, Power Factor and Energy Consumption measurement. The measurement results are displayed in graphical form. Monitoring charts for each of the measurements is shown in Figure 6, Figure 7, Figure 8, and

Figure 9. The graph is the result of monitoring on May 27, 2015 at 16:15 until May 29, 2015 at 05:59.

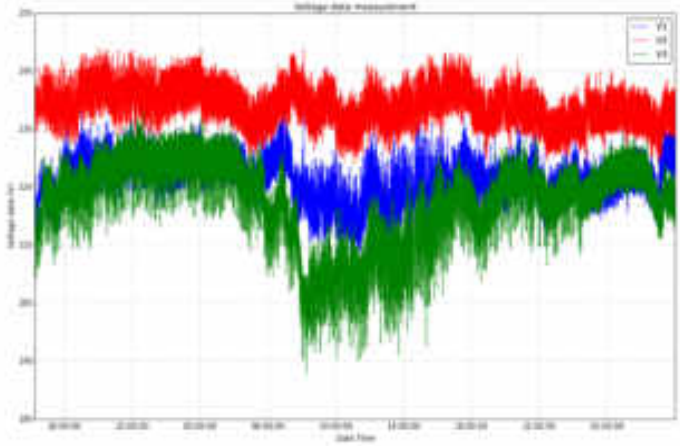


Figure 6. Voltage Monitoring Graphs

From the graph of voltage monitoring results shown in the figure 6., it appears that inter-phase voltage unbalance, the highest voltage contained in the second phase to reach 240 volts, while the lowest voltage contained in the third phase which reaches 200 Volts. This occurs because the load is not balanced between the three phases. If More load mounted on a phase, the voltage drop that occurs in these phases will be greater or vice versa. Loads in this term is all of loads which are connected to the three-phase power source from PLN. Voltage in phase 2 relatively constant for 24 hours while the phase 1 and phase 3 voltage during the day tended to decline compared to the voltage at night, it shows that loads in phase 1 and phase 3 during the day is greater than the loads at night.

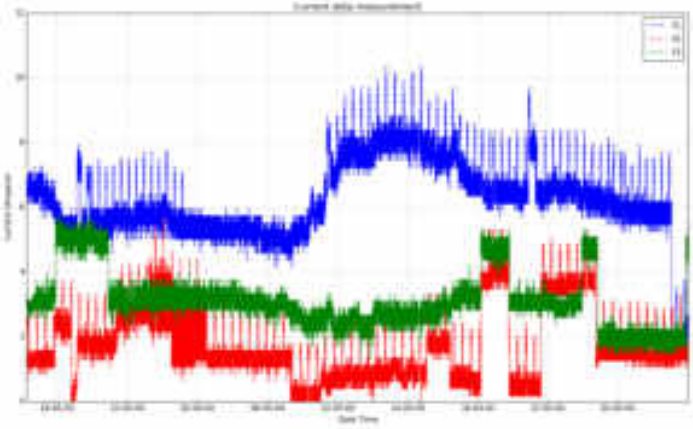


Figure 7. current Monitoring Graphs.

From the graph result of current monitoring in Figure 7, shows that the currents between phases in Electrical Engineering Laboratory is not in balance. The largest current value is allocated in phase 1 from 5 A to 9 range, the second phase is relatively constant between 2 A to 4.8 A. While the smallest currents are allocated in phase 3 with 0 A to 5 A range. Based on these three phases ,Measured current in the day is greater compare on the night. it can be happened because more activities in laboratory are done during the day while in the night were only used for lighting.

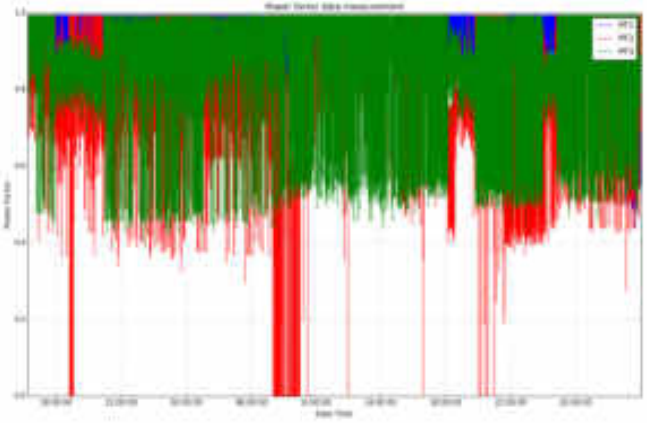


Figure 8. Power Factor Monitoring Graphs

Figure 8 is the power factor monitoring charts, where the value of the power factor is obtained from the calculation using the measurement data of voltage and current. the graph shows that the power factor phase 1 and phase 3 ranged from 0.8 to 0.99. For phase 3 power factor value decreased to 0.5 and 0.6 but did not last long. While the power factor on phase 2 looks not in stable ranging from 0.6 to 0.99. Factors that affect the value of the power factor is a reactive load, so if the value of power factor is unstable probably it caused by the changes of reactive power in load. Power factor on phase 2 several times reached a value of 0, it is because the current value at this time is 0 (can be seen in the graph Figure 4.2, while the program can not calculate the value of the power factor if the value of current or voltage is 0, so the program is automatically provide output power factor is 0.

Figure 10. Power Monitoring Graphs

Graph in Figure 10 shows that the load is not balanced between the three phases. The biggest load is allocated in phase 1 while the smallest load is in phase 2. This condition occurs because phase 1 is connected to the laboratories on the first floor. Most laboratories in first floor need large power consumption in order to operate the machines and motors. While phase two connected to less laboratories energy consumption as well.

From the results of kWh meters in monitoring consumption of electrical energy, obtained the largest electric energy consumption is in phase 1 and the smallest in phase 2. This is due to the phase 1 is connected to machines that use a lot of electricity with high power consumption, while phase 2 is connected with laboratory practicum when not much use electrical equipment with high power. Online condition of power monitoring on the web can be seen in the results are shown in Figure 10.

V. CONCLUSION AND RECOMMENDATION

A. Conclusions

After the measurement, monitoring and data analysis can be concluded that:

- The consumption of electrical energy in the Integrated Laboratory of Electrical Engineering for each phase is not in balance. This is because of the use of uneven load on each laboratory.
- From the chart patterns of energy use, it appears that electrical energy during the day more usage when compared to the night, it is because most research and activities in laboratory carried out during the daytime.

B. Recommendations

In order to make this system better, some miraculous things that needs to be done are:

- Current sensor ring type transformers should be used, so that the installation does not need to disconnect the power source to the load.
- For programming and WEB database should use assistive computer that has better specs compared Raspberry Pi, so that Raspberry Pi is only used for programming the sensor readings.
- Devices that have been made can be used for one place monitoring only, a remote control circuit can be developed in order to make it more efficient and useful. This research can be developed in order to monitor more than one electrical panel by adding sensors without adding Raspberry Pi.

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