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Enhance Control Mobile Compiuting Improvement in Quality Data Acquisition in Simulation

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Abstract

This research is a research and development (R&D) process with software design and testing using the v-model software development life cycle (SDLC) method, consisting of stages: (1) requirements modeling, (2) architectural design, (3) component design, (4) code generation, (5) unit testing, (6) integration testing, (7) system testing, (8) acceptance testing. Unit testing method using a white-box technique with base-path test, flowgraph, independent path on "DigiChip" software. Testing integration, system, acceptance with black-box techniques. The functional suitability aspect was tested with a feature run test questionnaire and a test case. The maintainability aspect is tested by measuring maintainability index (MI), duplication source code, line of code (LoC), cyclomatic complexity (CC). The portability aspect is tested by installing on various hardware configurations, various versions of the Android OS kernel. The material and media test used a material expert and media expert questionnaire. The usability aspect was tested using the USE Questionnaire and the calculation of Cronbach's Alpha through SPSS. This paper describes the main advantages of this DAS module which is that it can be manufactured at a very affordable price and provides good performance as is commonly used in industrial control systems. In motor control systems, alternative data acquisition system (DAS) modules can use the LabVIEW interface. The DAS module is controlled by the ATmega64 AVR micro controller which will communicate in both directions with LabVIEW using the serial communication method. Which is used to obtain 8-bit digital input, 8-bit digital output, 8 analog input channels, and also 2 analog output channels. Digital inputs can be used for 0-5V and 0-24V voltages. The digital output is made open collector with a "low" voltage of 0.276V. For analog inputs and analog outputs, this system has an average error of 14.47mV for the input range of 1-5V; 72.34mV for the 0-10V input range; 0.037mA for 4-20mA input range, and 16.2mV for 0-10V output range. This system is not designed for use in applications that require real-time accuracy and fast accuracy.

Keywords
control system, interface, labview

I. Introduction

The development of science and technology (IPTEK) is increasingly In today's complex world, technology has an important role in almost all aspects needs of human life. Likewise, the development of the world of digital technology, mobile technology, and the

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development of computer technology has now developed in handheld form. Device technology development computers in an increasingly practical form, making various computer features that can be enjoyed only in the palm. The development of technology and information at this time is very rapid and bring changes to human life (Lubis, 2019). As with other areas of life, technology is used to make changes, so also with the legal system as technology in making changes (Hartanto, 2020). The power of technology including digitalization and automation continues to grow and change the pattern of production, distribution, and consumption (Pramusinto, 2020).

The problem here is along with the development of handheld technology towards a more expert, Of course, there needs to be harmonization and adaptation in mastering and operating. The progress of a nation lies in how far the progress of science and technology is compared to other nations. Public technology users must have the ability to use, especially when choosing as a technology creator society. Of course, needed more ability in mastering science and technology. This matter will certainly lead to demands for the quality of human resources (HR) and various other supporting resources.

Technology is used as a learning tool and learning media, in The world of education will provide new nuances and images. Automatically Of course, it must be supported by wise behavior in using technology mobile/handheld in a productive, educative direction and not the other way around, that is, in a counterproductive direction. Technology is born to provide something useful and facilitate all the necessities of life for mankind. Wise behavior in using technology must be the main priority in giving birth to the generation and human resources (HR) that have a high level of quality in a nation.

Educators and students have many views about mobile/handheld devices can be used as a means of entertainment and communication only. Even though the use of mobile device technology in a different direction more educative needs to be raised. One of them is as a means simulation-based learning media or commonly called media simulator technology. The level of practicality, efficiency, economy, and safety, of course, is a more important point in simulation-based learning media. Hope this will be very helpful overcome students' low learning motivation when faced with the problem of limited tools, materials, time (classroom/lab/workshop study hours) and a learning system that must take turns/groups.

A mobile device which is a personal computer device (PC) is of course owned personally by each student. Learning activities personally and independently without having to depend on practicum hours, tools, and practical materials provided by the school can be overcome. Students will have the portion of study hours is more and can study anytime anywhere. As well as in the problem of low student motivation in reading books and procurement of learning resources in the form of books. This can also be overcome by using a mobile device as a means of reading that is packaged in the form of e-books, digital books, and photo books, so that it will be more practical, economical, and provide more interest in reading. Mobile devices always in the pocket and grip of their users, so that students can carry out learning activities more easily, anytime, anywhere in reading.

The application of control systems in industry is one of the most important media, the need for data retrieval and processing is becoming more complex, more varied, and more numerous. Therefore, we need a device that can handle these needs, one of which is a system called the Data Acquisition System (DAS) (S. Aryza et al., 2018).

The main task of the DAS is to acquire a signal from the sensor, which is usually an analog signal, convert it into a digital signal and give it to the next system that will take advantage of the digital signal, for example, a controller that controls a robot or industrial plant (Solly Aryza, 2018). Some optional functionality is sometimes also available in the DAS module such as filters, modulators, and so on. The DAS is usually controlled by a program, either running as an embedded system or an application on a personal computer (PC). One application program that is quite well known in the industrial world is LabVIEW which was created by the National Instruments company (Adityawarman, et al, 2016)

In addition to making LabVIEW, National Instruments also produces several types of watersheds that can be used by LabVIEW. The problem is that most of these watersheds are sold at high prices, making it a bit difficult for experimental activities in independent research. This paper describes one way to create a watershed that can be accessed by LabVIEW as an alternative, a watershed produced by National Instruments (Nanang Kurniawan, 2018)

II. Review of Literature

2.1 Learning Media

Computer systems can deliver learning directly directly to students through interacting with subject programmed into the system, and this is what is called teaching with the help of a computer. Learning activities with computers, or better known as Computer-Based Instruction (CBI), is the term commonly used for all learning activities that use computer in whole or in part based learning

Computer Science (CBI) is a new learning concept that has currently, there are many kinds of designs and implementations in the world education and learning (Indriana, 2011:107). The current CBI learning model has developed into various types of various models, such as: Computer-Assisted Instruction (CAI) and experiencing improvement to Intelligent Computer Assisted Instruction (ICAI). With Characteristics of different functions also appear Computer Assisted Learning (CAL), Computer Based Learning (CBL), Computer Assisted Personalized Assignment (CAPA), and Intelligent Tutoring System (ITS) (Indriana, 2011:103). The various forms of the program can be in the form of tutorials, exercises and repetition of previously studied subject matter, game and simulation.

According to the type, learning resources can be classified as follows: (1) Sourced from humans (teachers, peers, experts, media producer); (2) Sources of printed materials (books, magazines, journals, encyclopedias, newspapers, catalogs, dictionaries, textbooks, etc.); (3) Audio media and visuals (television, radio, OHP, LCD, tape recorder, video, CD/VCD/DVD player, movie, etc.); (4) Computer media (floppy disks, CDs, VCDs, DVDs, hardware & computer software, internet); (Sanaky, 2013:21). Media technology computer-based learning are ways of producing and conveying materials by using devices that source microprocessor. Computer-based technology is distinguished from other technologies because it stores information electronically in digital form, not as printed or visual material.

Computer-based learning media the emphasis is on continuous efforts to maximize learning and teaching activities as cognitive interactions between students, subject matter, and instructor (in this case the computer that programmed).

Learning media has another meaning according to Indriana that what is meant by learning media are all materials and physical tools that may be used to implement teaching and facilitating student achievement towards goals or objectives learning. Learning media includes traditional materials such as whiteboards, handbooks, charts, slides, OHP/OHT, real objects, and video recording or film.

In addition, in the form of materials and several advanced methods such as computer, DVD, CD-Room, internet, and interactive use of video conferencing facilities (Indriana, 2011:16). Learning Media is a tool that functions and can used to convey learning messages, as an intermediary in the learning process to enhance effectiveness and efficiency in achieving teaching goals.

Learning is a process communication between learners, teachers, and teaching materials. No communication will run well without the help of means to convey message/material (Sanaky, 2013:3). Stimulus forms can be used media, including human relationships or interactions, reality, moving pictures or not, recorded writing and sound with five form of stimulus, will help students learn the material lesson.

The substance and core of the learning media are:

(1) the form of channels, which are used to convey messages, information and materials lessons to the recipient of the message;

(2) various kinds of components in learning environment that can stimulate learners to learn; (3) form of physical tools that can present messages and stimulate learners to learn; and

(3) forms of communication and methods that can stimulate learners to learn, both print and audio, visual, and audio visual.

2.2. Design Mobile Computing

In making a DAS module, several electronic circuits must be integrated, such as signal conditioning circuits, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), multiplexing/demultiplexing circuits, microcontrollers and computer programming. This data acquisition module is designed to have input and output in the form of digital and analog data. The following is a block diagram of the whole system (Engineering, 2014).

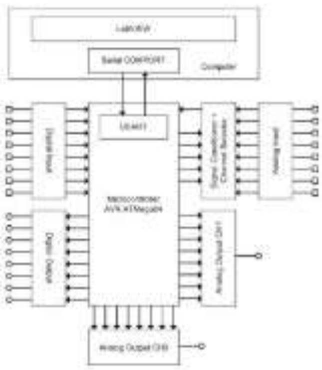

Figure 1. *Data Acquisition System Block Diagram*

The way the system works is as follows. The computer running LabVIEW functions as a master that sends commands and the microcontroller functions. In this system, the microcontroller used is the AVR ATmega64 microcontroller. The microcontroller has never had the initiative to send data to a computer (Adityawarman, et al, 2016).

Several command formats have been set in the microcontroller, so when LabVIEW sends a command, the microcontroller will check the command, compare it with the existing format and run the procedure according to the command given by the working system (Indar Sugiarto et al., 2008).

There are eight digital inputs provided in this study where each input pin is isolated by a TLP521-1 photocouple to minimize damage caused by errors when using digital inputs-outputs that do not comply with hardware limitations. The following is a circuit used for digital input (Indar Sugiarto et al., 2008).

Just like digital inputs, the number of digital outputs that exist in the data acquisition device made is eight. The use of TLP521-1 as an effort to isolate the output from other circuits is also carried out. Therefore, the ground terminal on the digital outputs should be separated from the ground points of other circuits (Choudhuri & Agrawal, 2015).

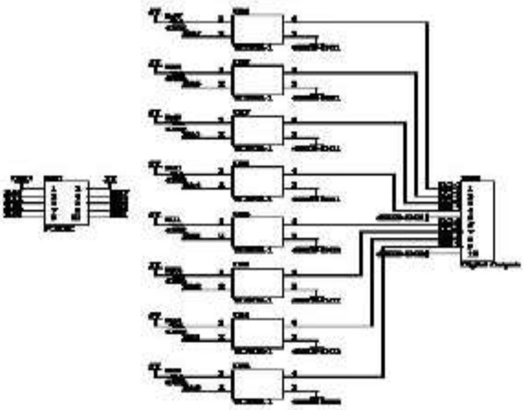

***Figure 2**. Circuit Open Loop Control System*

The data acquisition system created in this study has eight analog input channels with a resolution of 10 bits. This analog input is designed by utilizing the internal ADC of the ATmega64 microcontroller and signal conditioning circuit. For input in the form of current, in the device there are two separate channels that can be used. The following is a block diagram of the multiplexing and demultiplexing system used (Andi Aulia Rahman, 2019). If Rf is 15kΩ and Ri is 12k, the RSPAN is:

$$R_{SPAN} = \frac{Vb - Va}{\frac{Rf}{Ri}(Ib - Ia)} \quad (1)$$

$$R_{SPAN} = \frac{5 - 1}{\frac{15000}{12000}(0{,}02 - 0{,}004)} \quad (2)$$

$$R_{SPAN} = \frac{4}{1{,}25 \times 0{,}016} = 200\Omega \quad (3)$$

There are two span-zero circuits used in this data acquisition system (see Figure 3 below), for the input range of 1-5V and for the input range of 0-10V. The span-zero circuit used is the following circuit.

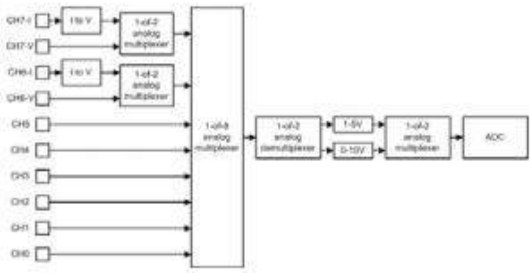

***Figure 3.** Analog Input System Block Diagram*

It should be noted, because the ADC reference voltage uses 2.56V, all span-zero circuits are adjusted for 0-2.56V ADC inputs. To find the elements of a span-zero circuit with an input of 1-5V, a straight-line equation must be obtained first.

If Rf is set at 1kΩ and Vos = 0V, the remaining resistor can be calculated as follows,

$$Ri = \frac{Rf}{m}$$

$$Ri = \frac{1000}{0{,}256} = 3906{,}25\Omega$$

The value of Ros does not need to be searched because based on the results of the above equation, the offset voltage is not needed in this circuit.

The software implemented on the AVR ATmega64 microcontroller was created using a program from ATMEL, namely AVRStudio.

This program is designed to check every command/data that LabVIEW sends. The following is a flowchart used in compiling a program on a microcontroller (Faroqi, et al., 2017).

III. Research Methods

3.1. Software Construction (Software Construction)

Software development is a detailed work of the process software development which includes the design process, concept, programming, program integration, debugging, and program run-test. In the software development process, the route map is used as a guide in the analysis of user needs. This of course leads to products that are generated to have a more usable value. Most aspects prominent in the software development process are systematic and algorithm in building the desired system. More than a system you want to build has a large scope, of course, this is more detailed skills are needed in building systems that concerned. In the end, a product is expected to have a high systematic value and according to user needs.

There are four important aspects in the process of building a software products (Rizky, 2011:196), including;

1. Minimizes Complexity

In the software development process, there are always two angles a different point of view, i.e. from the device developer's point of view software and from the user's point of view. Generally developer software, especially programmers, view a process business as a complex process in programming activities. One way to minimize complex processes is to object-oriented programming to form a standard.

2. Anticipating Change

Especially in a software development project that complex and large-scale and takes quite a bit of work time, specification changes are very likely to occur. Then developer should not be defensive but on the contrary, that is anticipatory.

3. Verify

Verification here is meant in the scope of verification at the level programming activity. For example when in a project development in the form of a team or involving many programmers, then in the software development process must be intertwined solid cooperation so that the software that is built really free from error.

4. Setting Standards

Standards in software development should be set since the analysis and design process. For example, by using the notation UML (Unified Modeling Language) since the beginning of the analysis process and design, so that when programming activities are carried out, can be easily implemented by programmers.

3.2. Software Testing (Software Testing)

The software testing process is an activity to maintain software quality from the beginning of the device development process the software. This is done to ensure software quality made whether it is by the technical requirements at the beginning of the design specified product. The software testing process of course carried out continuously until perfection is obtained expected. It would be wrong if a software development team assume that the software built by them has been perfect. Even giant vendors like Microsoft, Oracle, and IBM never thought software had reached the perfect level (Rizky, 2011:235).

The definition of the paragraph above can be concluded that there are two words: the key, namely the requirements that must be met by the software (software) requirements) and software quality. Various The stages that must be carried out in software testing include: verification (verification) and validation (validation), (Galin, 2004:133) follows is the full definition;

a. Verify

It is a software inspection process from the side developer, whether the product made is by the initial design product design process. This of course concerns the design aspect of graphics, programming instructions, algorithms, etc. At this stage, the product continues to experience refinement until it is by the designs expected to start.

b. Validation

Is a software inspection process from the requirements side, or in this case the user side of the product? As a means to get feedback from the user side, that whether the product the software that has been made is in line with expectations user. In this stage, the software product continues to undergo refinement and improvement to comply with the user's needs.

Continuous software testing process step by step is very priority. As an effort to prevent the emergence of various problems during the software development process, these include errors, faults, failures and accidents (incidents). Standards that must be met from a product software are free from failure, fault, error problems, and incidents (Rizky, 2011:241).

1. Failure

A software failure to perform a process that should be a requirement of the software. Failure is the last effect of the fault event.

2. Fault

In a software testing environment, a fault may not be will be detected unless an action will make it appear in a software process. This means that the fault is the potential of an error occurs, and when the error occurs as a result of an action users, there will be failure or failure in the process software.

3. Error

Is a state of the system caused by an action users which ultimately lead to failure in execution of a software function? Error or error is as a result of a fault or damage which is then triggered by user behavior.

4. Incident

In the context of software testing, incidents are the result of the end that occurs as a result of continuous and unsustainable errors repaired or detected in the software development process. This must be addressed immediately, even though this condition is usually will take a lot of time for the repair process. Because If the source of the problem is not detected, the user will give a verdict on the quality of the software overall have poor performance. Even though it could be an incident the problem arises because only a few system units have a problem.

IV. Discussion

From the results of the design as described above, testing was carried out on digital inputs, digital outputs, analog inputs and analog outputs. Testing of digital inputs is done by two methods. The first method is to create a simple program in LabVIEW that displays status of each input pin. The purpose of the following experiment is to determine the threshold voltage of the digital inputs that have been made. The following is a front panel display of the program to display the status of digital inputs. The second method used is to use the input in the form of a square wave from a function generator then the input wave will be compared with the wave read on the microcontroller input pin.

Table 1. Test result

Function Generator			Hasil Pembacaan		
Frek (Hz)	+ pulse (µS)	- pulse (µs)	Vpp (V)	+ pulse (µS)	- pulse (µs)
1	504000	504000	5.01	504000	504000
10	50000	50000	5.01	50000	50000
100	5000	4900	5.01	4700	5200
1000	500	500	4.15	360	640
1100	450	450	3.92	310	590
1200	420	410	3.76	290	540
1400	350	360	3.37	250	460
1600	320	310	3.05	210	410
1800	280	276	2.66	180	376
2000	240	236	2.27	156	324
4000	124	122	1.01	76	172
6000	82	82	0.54	50	114
8000	62	62	0.39	28	96
10000	48	48	0.31	40	60

From table 1 above, it can be seen that when the input frequency is higher, there will be a decrease in the voltage at the input pin of the microcontroller.

Based on the AVR ATmega64 datasheet, the minimum voltage for a logic "high" is 3V (at Vcc of 5V). So digital inputs are only able to accommodate inputs with frequencies up to about 1600Hz. This limitation is caused by the use of the TLP521-1 photocoupler which has a time limit to reach a logic "high".

Digital outputs testing is done by creating a program in LabVIEW where the program functions as a switch controller. The front-panel view of the LabVIEW program is shown in the image below.

Figure 4. *System View*

The measurement method used in testing the analog input function is to use an input that comes from the DC Voltage Current Standard. This test is carried out to find out how much error occurs from the system that has been made. The results of testing the input voltage with a range of 1-5V are as follows.

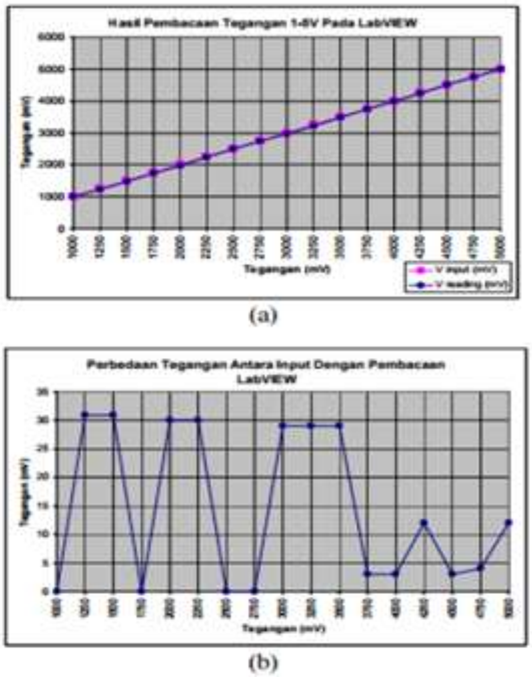

Figure 5. *The Graph of the Input Voltage Test Results Using the 1-5V Range (a) and the Input Voltage Difference Using the 1-5V Range (b)*

From the test results, it is found that the voltage difference varies. The maximum difference when the voltage reading occurs at the input voltage is 1250mV and 1500mV with a large voltage difference of 31mV. The results obtained from testing at the input voltage of 1-5V are quite good because the highest error percentage is only 2.48% at the input voltage of 1250mV.

The second test is the measurement of the input voltage by using a 0-10V signal conditioning circuit. The result is as follows.

Figure 6. *Output Voltage Graph Using Hexadecimal Input*

Figure 7. *Voltage Difference Using Hexadecimal Input*

V. Conclusion

The results of the two experiments above show that the error when using hexadecimal input is smaller than the input in the form of a slider. This is because the analog value from the slider cannot be accommodated by the DAC with a resolution of 8-bits. By using the input in the form of a hexadecimal value, it means that the DAC input is controlled with certainty, according to the desired hexadecimal value. When using the slider a maximum error of 60mV occurs when the setpoint is set to 10V. This is because theoretically if the DAC is given a maximum input (0xFF), the resulting output voltage is 9.961V.

Meanwhile, when using hexadecimal input, the maximum error is only 21mV which occurs at the 0xFF input. This error is because from the test results as described above, the following conclusions can be drawn.

- Making sub-VI using LabVIEW creates a data acquisition system that has been created can be used easily. However, this data acquisition system is not designed for applications that require high time accuracy.
- From the test results, it was found that the digital input designed using a photocoupler did not succeed in responding to input changes above 1600Hz. The digital input circuit will be "high" for voltages above 3.54V. As for the voltage 0V to 3. V, the digital input will be "low".
- By using a 12V source voltage (DVCC) at the digital output, the logic voltage
- The resulting "low" is 0.276V. Meanwhile, when the digital output is conditioned to logic "high", the voltage is 12V. • The data acquisition system created can be used to measure voltages in the 1-5V and 0-10V ranges with an average voltage difference (ΔV) of 14.47mV for the 1-5V range and 72.34mV for the 0-10V range.

- The average current difference (ΔA) at 4-20mA current measurement is 0.037mA.
- Conversion time required by ADC is 2.33μS.
- The average voltage difference at the analog output is 16.2mV when using a set point in the form of a slider and 8.184mV when using a hexadecimal input.

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