Implementation of the RS232 communication trainer using computers and the ATMEGA microcontroller for interface engineering Courses

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Abstract. RS232 of serial communication is the communication system in the computer and microcontroller. This communication was studied in Department of Electrical Engineering and Department of Computer Engineering and Informatics Department at Politeknik Negeri Medan. Recently, an application of simulation was installed on the computer which used for teaching and learning process. The drawback of this system is not useful for communication method between learner and trainer. Therefore, this study was created method of 10 stage to which divided into 7 stages and 3 major phases. It can be namely the analysis of potential problems and data collection, trainer design, and empirical testing and revision. After that, the trainer and module were tested in order to get feedback from the learner. The result showed that 70.10% of feedback which wide reasonable from the learner of questionnaire.

1. Introduction
The curriculum has developed through three phases in its history: becoming the National Curriculum in 1994, the Core and Institutional Curriculum in 2000/2002, and lastly the Higher Education Curriculum in 2012 [1]. These changes are part of a dynamic with the noble goal of preparing a new generation that are professionals in their chosen field and are ready to face challenges in this age of global competition. Subsequently, a statement in Presidential Regulation No. 8/2012 on the Indonesian National Qualification Framework (KKN) is defined as a competency qualification skill framework that can match, equalize and integrate between the field of education and the field of job training and work experience in the provision of appropriate work competence recognition with job structure in various sectors. The application of KKN in Higher Education is mandated by the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 73 Year 2013. So the level of diploma three (D3) Polytechnic according to KKN is the fifth sequence. Graduates of D3 programs are expected to be proficient in both operator and technician positions in the workplace. Therefore, in their course of study, the proportion of practicum courses should be higher than that of theoretical courses.

The observations performed on students who have completed the Interface Engineering course show that the students are able to program, use, and apply computers with microcontrollers for data control, observation, and acquisition functions. However, to further hone these skills, an appropriate
learning media is required in order for students to directly apply the knowledge that they have learnt in the classroom. Such a learning media can be in the form of a trainer. In the Interfacing course, the trainer can be used as a means of practice for the students which directly improve their computer programming skills with microcontrollers. The aim of this study was to develop a trainer that allows students of Interface Engineering courses to deepen their knowledge and practical skills in order to achieve the standard qualification of Diploma 3 graduate competency. The trainer is also expected to provide lecturers with a useful tool for delivering Interface Engineering courses. The trainer is designed to focus on RS-232 communications, a serial communication standard that is defined as the interface between data terminal equipment and data communications equipment using serial binary data exchange. RS-232 Communications was introduced in 1962, and the Electronic Industries Association published three modifications to the RS-232 standard in 1997 and renamed it EIA-232. The RS-232 Standard is used for direct data communication between two computers. After that, the graduates have provision and able to compete in the world of work, as well as expected. They can create the design which can support teaching and learning activities as well as facilitate lecturers In Engineering Interface courses. Therefore, the design of RS232 serialized input and output control instrument trainers were equipped with a worksheet guidance manual. It tested to the students to find out how much the students respond to the learning activities and assessment of the trainer. Problem Statement:

- How to build microcontroller devices.
- How to get RS232 communications working between your computers and measuring device.
- How to arrange the worksheet in accordance with the stages of learning.
- How to explain text and worksheet on the microcontroller devices.
- How to create a questionnaire to learn activities aimed at meeting learning goals and the assessment tasks

The purpose of this study:

- To produce lead, page the instrument which capable of determining push-button button.
- To create an effective learning for student this conducted experiments using trainers.
- To develop the type of training and worksheet.
- The advantage of this study
- To develop media interactive engineering courses in Department of Electrical Engineering and Department of Computer Engineering and Informatics Politeknik Negeri Medan.
- To guide the reader can be use of RS232 communication which is the basis of SCADA application development (Supervisory Control and Data Acquisition).
- To learn RS232 communication with computer and microcontroller this can be used as material subject for the student.

2. Literature Review

2.1. RS-232 Communications

RS-232 communication is one of the many protocols used in electronic devices today. It is a serial protocol, which means only one bit of data is transmitted at any given time. The standard defines only two wires, one used for the signal and the other for grounding, but sometimes three wires can be found. The cabling for RS-232 connections is relatively inexpensive, and can even be taken from unused network cables. The standard does not define a maximum cable-length, but allows up to 15 meters at 19.2 KHz. In practice, however, cable lengths used in data communications exceed the provisions set in the standard, and communications occur at higher rates [2]. RS232 is a Serial Asynchronous Communication Interface Adapter device introduced by electronic industries adapter, RS is short for Recommended Standard.
2.2 Microcontroller
A microcontroller is a chip in the form of an Integrated Circuit which can receive an input signal, process it and produce an output signal according to the program loaded into it. The input signal, which comes from the sensor, provides the microcontroller with information from the environment. Meanwhile, the output signal is addressed to an actuator attached to the microcontroller, and provides an effect to the environment [3]. Put simply, a microcontroller can be likened to the brain of a device that is able to interact with the surrounding environment. A microcontroller chip contains a microprocessor, memory, Input / Output paths, and other complementary devices. The speed of data processing on the microcontroller is lower compared to microprocessors used in computers today, in which the processing speeds are in the order of GHz. Meanwhile, the speed of microcontroller operations generally ranges from 1 - 16 M-Hz. The same applies for RAM and ROM capacity. Personal computers have RAM in the order of GB, while microcontrollers have RAM in the order of bytes or Kbyte. Examples of microcontroller families include the MCS-51 (AT89), MC68HC05, MC68HC11, AVR (ATMEGA), and PIC 8 families. The microcontroller used in this study is of the AVR ATMEGA type 8535 [4].

3. Method
These stages that have been grouped into 3 phases [5]. Each stage can be known as below:

- The first phase is analysis of problems and data collection, preliminary study or preliminary observation was conducted by question and answer methods to the students which obtain information related to the quality of learning media Interactive Engineering courses. After that, the results of preliminary observation are deemed necessary to create a learning-based media Trainer in the course.

- The second phase is to design instructional media, design of instructional media was achieved by existing conditions. The development of learning media should be referring to the syllabus which can developed by learning media in order to support teaching and learning activities as well as training. This phase to improve knowledge and skills of RS232 communication programming in the interfacing course and obtained the product.

- The third phase is to test empirical and final revision, instructional media product was tested to the Telecommunication Engineering students. This experiment carried out by learning based on class lectures then data was generated from learners' responses to the designer trainer and job sheet in the final stages. If the trainer and job sheet were satisfied then it will be done final revision.

3.1. Measurement and Observation
The observations carried out by trainer device that has been made to run as well as success. This can be proved by compatibility of existing data in the microcontroller and on the computer. If produces of RS232 communications similar to the same data then it can are running well and correctly. Moreover, the measurements were performed to find out the quality of trainers and job sheets based on a 15 of questionnaire students who took Interface Engineering courses.

3.2. Design Research
Design research performed in order to clarify how the designer form of the trainer and worksheet can be explained for each section. Design trainer divided into 2 part as follow Mainboard and Trainer Program. The main-board consists to ATMEGA8535 microcontroller, display, header connector to connect input and output instruments to the microcontroller port, as well as TTL to RS232.
3.3. Collection Analysis and Data Technique
Collection data selected to fill up the student questionnaire who are active and understand interfacing courses. The data can have obtained in the student questionnaires and trainer questionnaires in form job sheet. After that, data will be analysed using three levels of assessment such as less, enough, and good. Thus, the average of the rating results of questionnaire can refers to the Likert scale which the criteria can feasible in 81% -100% [6]. The following is the content of the questionnaires used in this study:

- Assessment of learning activities using trainer module.
- Assessment of the worksheet used in the lesson.
- Assessment of the trainer device used in the abbreviated learning.

4. Results and Discussion
4.1 Pre Questionnaire and Discussion
The product was consisted into two step which are the trainer device with worksheet. The assembled trainer device can be shown in figure 1. The description of figure 1 is as follows:

![Figure 1. Photo of assembled trainer.](image)

The description of figure 1 is as follows:

- The size of the PCB of the minimum system (in the form of existing images of microcontroller, capacitor components and other components and there is a collection of sockets) is 8cm long and 5.5 cm wide.
- The size of the proto-board board (white image) is 3.5 cm wide and 9.5 cm long.
- The letter A shown in a proto-board board whose function is to place the components contained in the worksheet.
- Letter B shown in a port or pin to connect to a proto-board board useful to connect between microcontroller and its components.
- Letter C shown in a port or pin that is useful for downloading programs from computer to microcontroller and used to enable serial communication.
- Letter D shown in the terminal for the power supply.

The worksheet consists of 2 basic experimental. It can be explained that first experimental discusses about controlling the led output. Thus, second experimental discusses the input which can provide information in the form of conditions of the push button-button for open or closed conditions. The worksheet can be seen in the attachment.
4.2 Questionnaire Distribution
In this study, data collection conducted in the form of questionnaires. It was consist of 18 questions.
The questions are divided into 3 parts:
• 7 questions of learning activities using the trainer module.
• 6 questions of the worksheet used in learning.
• 5 questions of the trainer device used in the learning.
• The questionnaires was given to the Electrical Engineering and Computer Science and Informatics Engineering student, who were took Interface Engineering courses. 15 students were involved which selected randomly based on ability academic.

4.3 Discussion response

Table 1. HR for hardware trainer.

| Trial | Scale (4) | Scale (3) | Scale (2) | Scale (1) | $\sum_{i=1}^{4} n.x_i$ | HR  |
|-------|-----------|-----------|-----------|-----------|----------------------|-----|
| 1     | 0         | 0         | 10        | 5         | 25                   | 41.67% |
| 2     | 7         | 8         | 0         | 0         | 52                   | 86.67% |
| 3     | 0         | 7         | 6         | 2         | 35                   | 58.33% |
| 4     | 3         | 6         | 3         | 3         | 39                   | 65%  |
| 5     | 2         | 10        | 3         | 0         | 44                   | 73.33% |

Average 65%

Table 2. HR for job-sheet.

| Trial | Scale (4) | Scale (3) | Scale (2) | Scale (1) | $\sum_{i=1}^{4} n.x_i$ | HR  |
|-------|-----------|-----------|-----------|-----------|----------------------|-----|
| 1     | 0         | 10        | 2         | 3         | 37                   | 61.67% |
| 2     | 0         | 11        | 4         | 0         | 41                   | 68.33% |
| 3     | 0         | 12        | 3         | 0         | 42                   | 70%  |
| 4     | 0         | 10        | 4         | 1         | 39                   | 65%  |
| 5     | 10        | 5         | 0         | 0         | 55                   | 91.67% |
| 6     | 8         | 1         | 5         | 1         | 46                   | 76.67% |

Average 72.22%
Table 3. HR for learning activity.

| Trial | Scale (4) | Scale (3) | Scale (2) | Scale (1) | \( \sum_{i=1}^{4} n.x_i \) | HR    |
|-------|-----------|-----------|-----------|-----------|----------------|-------|
| 1     | 5         | 10        | 0         | 0         | 50             | 83.33%|
| 2     | 5         | 8         | 2         | 0         | 48             | 80%   |
| 3     | 0         | 11        | 4         | 0         | 41             | 68.33%|
| 4     | 6         | 8         | 1         | 0         | 50             | 83.33%|
| 5     | 2         | 8         | 3         | 2         | 40             | 66.67%|
| 6     | 3         | 3         | 4         | 5         | 34             | 56.67%|
| 7     | 2         | 10        | 3         | 0         | 44             | 73.33%|
|       |           |           |           |           | Average        | 73.09%|

5. Conclusion
This study consists to minimum ATMEGA microcontroller system module, downloader module and USB to TTL module (Transistor-Transistor Logic), while the worksheet consists of two basic experiments. The trainer device used in. The result of hardware trainer is 65%, following job sheet is 72.22% and learning activities is 73.09%. Therefore, the total rating is 70.10%. The total result of rating is 61% to 80% which is fulfil to Likert scale.

6. Recommendation
Development of RS232 serial communication as product builder trainer using ATMEGA microcontroller was required to improve casing in look neat module. The worksheet created which required to be complemented by the theoretical basis in the experimental and it can be reproduced three times in order to validate the accuracy result. The recommendation of Development of RS232 following as below: Trial 1 (Controlling the led component with Visual Basic programming and Basic Compiler via microcontroller). Trial 2 (Reading the condition of the push button-button displayed on the side of the computer).

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