PLC Fiddle Software Review as an Instrumentation and Automation Learning Tool

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Abstract. A software is needed that can be used for beginners in learning instrumentation and automation. One of the main diagrams and learning of these two concepts is the Ladder Diagram. For beginners it is easier to use software that is ready to use without having to install the Personal Computer. One software that can be used is PLC Fiddle. Through this paper, we provide an overview of what features are in the PLC fiddle. And explained how to use these features for learning instrumentation and automation, for beginners. We provide several Online Video Tutorials for learning PLC Fiddle

1. Introduction
In some study programs, Programmable Logic Control (PLC) is taught to students. One of the diagrams that is more than 100 years old is the Ladder Diagram [1]. In the process of designing an automatic system, the logic used can be modeled using a ladder diagram.

Ladder diagrams are an important learning content. This is confirmed by the increasingly rapid development of automation [2]. Cloud robotics is one of the developments in this automation field [3]. Cloud technology continues to develop, one of which can be applied in the learning process. Amid the threat to employment due to increased automation [4], competent human resources in the field of automation are increasingly needed.

The model is an imitation of the real system [5]. The model is made with certain assumptions. The model is validated and verified [6] so that the attributes that exist in the model are useful for understanding the behavior of real systems. Likewise with the ladder diagram. Ladder diagrams are used because they are useful for users who want to understand how an automated system works.

Ladder diagrams serve as a language that makes it easy to communicate with each other. Automated systems design work involves several people with multiple skills. With the same language, it will facilitate the process of understanding the ideas that are owned by other people in the team. The idea of automatic features of the system would be very complicated when expressed in a narrative. It is difficult to make and difficult to understand. There is a risk of inconsistency in the narrative. These ideas need to be made using standard language.

Students are able to build their logic about automatic processes. However, ladder diagrams, as a new language, certainly have a difficulty level to learn. Some applications can be used as a learning tool. One such facility is the PLC Fiddle.

There are several applications that can be used as a PLC teaching tool, for example Petri Nets [7][8][9]. Several papers have also discussed evaluations of applications used to implement PLC [10][11]. Evaluation was also carried out on the application of PLC in industrial Automation [12]. Apart from application and software, an evaluation of the framework [13][14] and the PLC learning method...
[13] has also been carried out. However PLC Fiddle has some useful features for novice users. There is no research yet that examines PLC Fiddle as a tool for PLC learning. We could only find one study that applied the PLC Fiddle [15]. This paper is intended to evaluate and test the PLC Fiddle application as a tool for PLC learning.

2. Method and Algorithm
This research was conducted with the help of students in a class. The subject taught is Industrial Electronics. Through these courses, it is hoped that students will be able to understand the role of electronic technology in Industry. The number of participants is around 25 students.

In one of the teaching agendas, students are taught about the PLC concept. Then students are asked to make an Electronics Diagram. One of the electronics diagrams that are required to be made is the Ladder Diagram. Students were initially asked to make ladder diagrams on paper. Ladder diagrams are introduced using several examples. The next stage is the learning process using PLC Fiddle.

Each participant is asked to use their personal computer to use PLC Fiddle. In the early stages of the learning process using PLC Fiddle Playground. The next stage is to follow the learning flow at Code School.

In addition, evaluation of the PLC Fiddle feature was also carried out. Through the learning process, and recording students' responses, several suggestions for improvement to PLC Fiddle were obtained.

The algorithm or process in this study follows the PDCA cycle: Plan, Do, Check, Action. The research process follows the following flow:
1. Planning Teaching Method based on evaluation of previous learning
2. Search for suitable learning tools
3. Implementation of Learning Facilities
4. Evaluation of learning tools

3. Result and Discussion
PLC Fiddle has the advantage that it can be accessed online. Users do not have to do the installation first and can directly use the PLC fiddle. This is considered an advantage because some PLC applications require an installation process which is sometimes a hassle for students. The installation is also related to the Personal Computer specifications that are owned. The installation process takes a long time and uses limited lesson hours.

![Figure 1. PLC Fiddle Playground](image)

PLC fiddle has two main windows namely Playground and Code School. In the learning process for beginners, Playground is not used too much. This is because there are several icons and features that may be unfamiliar to beginners. Beginners can start learning from the School code. There are several simple tabs that contain icons on the ladder diagram. Contacts for Control, Coils for Load, Math for mathematical functions that may be used in ladder diagram arrangement. Compare and Time / Count shows the determination of the conditions for performing a particular process.

Other tabs have important features, namely adding rungs, saving work results, removing unused icons, and branching rungs. The position of this feature in others is important but it is hidden in one of
the tabs. PLC Fiddle can put the save feature and add the rung on its own, easily accessible icon, for example in the top row. This as in other applications usually positions the save button.

In creating an icon, PLC Fiddle makes two steps. The first stage is to position the icon, be it contact, coil, and others. The second stage is to determine what name and function each icon has. For example in Figure 1. The motor functions as a load or coils. On the other hand, the motor also functions as contacts or control. This means that the coils, if they are On, will create a Contact with the same name, namely the motor, to adjust their value based on the change.

After the design process, an experiment can be carried out on changing the status of each icon variable. For example the start button can be changed from Off to On. The Stop Button can be changed from Off to On. As for the motor, because it is a load, it will be affected by changes in the start button and stop button variables.

When the evaluation was carried out, there were several notes on this feature and there were several inputs for system development. Installation of icons is good and easy to do. The variable creation on the left is a bit counterintuitive to the user. Generally in model design applications, variable determination is done right after the icon is determined. However, this is understandable because in the ladder diagram one variable allows it to be assigned to two different icons. In variables, both load and control status can be changed between off and on. This also does not correspond to reality. Loads are uncontrollable variable directly. Changes should only be done manually to control variables. Load changes can only be made due to changes in control. But of course this change requires a modification that is not simple. The logic behind this is, if a variable is assigned to load, then the variable cannot be changed manually between off and on. Although these variables are also assigned to control at the same time.

PLC Fiddle also has a feature to save designs that have been made. The save process is designed to be seamless. Users do not need to prepare an internal drive or synchronize with the cloud. When the user saves, the design results are saved, the user is given a url, and can then load it again by typing the url in the browser tab. This means that every time you make a design change, a new link will be generated. Even though sometimes the load process doesn't work, it's a fairly straightforward process for the user. Even though the user becomes required to save or note the link for later use. These links are unique to each design. What is quite unique is that the increase in the complexity of the model does not cause the generated url to get bigger.

![Figure 2. PLC Fiddle Code School](image)

Another interesting feature of PLC Fiddle is the code school. Code school is a kind of online tutorial for beginners who want to learn PLC and learn ladder diagrams. As seen in Figure 2, the code school has several learning chapters. Learning starts from simple tasks to fairly complex tasks. This quite complex task discusses the more advanced logic in ladder diagram preparation. Ladder diagrams have complete basic features. In PLC Fiddle we can create a system that uses timers, uses counters, and so on. In PLC fiddle we can also make some logic. For example, the system can be ordered on when one variable has a value greater than the other variable. All these abilities are taught to participants through code school.
In our experience as teachers, the use of code schools is quite suitable to be used as a reference for the teaching flow in class. Step by step in code school according to a general learning curve. Students do not complain about difficulties in following the teaching flow in PLC Fiddle School of code. Indeed, there are some students who need greater support. However, because the PLC Fiddle Code School system has a system for self-evaluation, students can carry out experiments independently and see directly whether the design results are correct or not.

Table 1. Tutorial Video of PLC Fiddle

| Name                                      | Link                                           | Viewer |
|-------------------------------------------|------------------------------------------------|--------|
| Ladder Diagram menggunakan fiddle 01 Sign Up | https://youtu.be/38pJo8s-LPQ                   | 24     |
| Ladder Diagram menggunakan fiddle 02 Contoh Siment Saklar Lampu | https://youtu.be/O-xcU3OmSxk                   | 53     |
| Ladder Diagram menggunakan fiddle 03 Contoh Penggunaan Relay | https://youtu.be/_bDI7NanDhQ                   | 16     |
| Ladder Diagram menggunakan fiddle 04 Off Button | https://youtu.be/qtgI88NNGa4                  | 20     |
| Ladder Diagram menggunakan fiddle 05 Latching | https://youtu.be/oAF6-efIYO8                   | 24     |
| PLC fiddle Counter 03                     | https://youtu.be/gS1lxDeAZ0U                   | 77     |
| PLC fiddle Counter 04 AND gate+Counter    | https://youtu.be/a8ACfXboMU                   | 27     |
| PLC fiddle Counter 05 OR gate             | https://youtu.be/ZRANCdAzQF0                  | 26     |
| PLC fiddle Counter 06 Reset Counter       | https://youtu.be/jGvvJVlYGbgg                 | 125    |
| PLC fiddle Counter 07 Uji Coba Mandiri    | https://youtu.be/Spq0BjhUL7EE                 | 20     |
| PLC fiddle Numbers 01 equal Function      | https://youtu.be/bzmHezh5yo4                  | 20     |
| PLC fiddle Numbers 02 More Than Function  | https://youtu.be/_5sFpySG908                   | 2      |
| PLC fiddle Timer 00 Delay Up              | https://youtu.be/i1CKchMbCXU                  | 21     |
| PLC fiddle Timer 01 Retentive Timer       | https://youtu.be/Spq0BjhUL7E                   | 59     |
| PLC fiddle Timer 02 On saat Timer Berjalan| https://youtu.be/2jRtAKMfnKw                  | 11     |
| PLC fiddle Timer 03 Flip Flop Fault Light | https://youtu.be/0P4MoiKAeng                  | 27     |
| PLC fiddle Timer 04 Off Delay Timer       | https://youtu.be/0NJ6nhpFW1Q                   | 32     |
| PLC fiddle Timer 05 Off Timer+Counter     | https://youtu.be/wfYLy1K4Klg                   | 24     |
| PLC fiddle Timer 06 Timer dengan AND logic| https://youtu.be/jGvvJVlYGbg                  | 52     |

From some of the guides found in PLC Fiddle we made a video tutorial that follows the flow of the code school. The flow is not changed because it has learning stages that are relatively easy for students to follow. In Table 1, you can see a list of videos that have been made along with the YouTube link. In total there are 19 videos that have different views. The number of videos is relatively small. This could be due to low video quality or PLC Fiddle is not yet popular with PLC practitioners, students and teachers.

PLC-fiddle is not yet a design standard in the industry. It could be that the PLC fiddle does not become teaching content. There is an increasing interest in universities to create teaching content according to Industry needs. One of them is by adjusting the use of teaching software.
PLC-Fiddle still has an advantage when it comes to beginners and students who want to keep a simple version of the application in PLC design. The PLC Fiddle feature is not as complete as other PLC applications. Even a PLC Fiddle can be difficult to integrate with some other applications. The data generated from the PLC fiddle design cannot be downloaded and then used in other applications.

PLC Fiddle still has its own advantages as an educational application. From the PLC Fiddle design practice, students will be able to understand how the logic and way of thinking of PLCs are. This is more needed in the educational process. In the educational process for some study programs, students are not required to be skilled in designing PLCs. The main requirement is that students have knowledge in PLC and understand the relationship between PLC and other systems. Meanwhile, if students have the ability to be skilled at designing PLCs, that is also good for student careers.

Audience retention is 28.6%. This can be caused by several things. One of them is that it could be that the video quality is bad so that the viewer when they first play the video, after a few minutes of watching it, decide not to continue because of the poor quality. Another cause could also be because from the initial video clips, users can understand the contents of the video. Or it could be because the PLC Fiddle application is not yet popular so when people access the video about PLC Fiddle, people decide not to continue because PLC Fiddle is an unpopular application for him.

4. Conclusion
PLC Fiddle is an application that can be used in a learning context. As for professionals who wish to design a PLC, PLC Fiddle is not recommended. This is due to the incompatibilities of PLC Fiddle to operate across platforms. PLC Fiddle has the advantage of being easy to use for the first time. Students do not have to go through a complicated installation process to start practicing logic in programming. Learning objectives will be achieved, in an educational context. However, for certain training software used in Industry, PLC Fiddle is not suitable.

Several studies can be developed next. Some of them are conducting studies on other software. In addition, an experimental process of learning methods can be carried out with PLC Fiddle and then compared with other applications, to find out which software is more effective. A more detailed research can also be carried out on how to make improvements to PLC Fiddle using standard design methods such as QFD (Quality Function Deployment), System Engineering method, and other methods.
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