Development of Internet Reactor Laboratory Using Kartini Reactor for Training and Education

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***Abstract*— The Internet Reactor Laboratory (IRL) that is under development consisted of broadcasting the training courses via an internet to remote facilities or institutions, is presented. The IRL consisted of the database server (Web Server), with data format SQL, operating system LAMP, and the method used AJAX & J-query. Requirement process for conducting reactor physics laboratory using Kartini reactor remotely is provided by a class instructor. The preliminary introduction of IRL was soft-launched at the end of 2014 in Nuclear Youth Summit (NYS) program where the NYS participants in the hotel at the downtown city of Yogyakarta can see the process of Kartini reactor operation and communicate with reactor operators. For more comprehensive services in the future, the improvement on the laboratory exercises arrangement is a necessity. Through IRL it is hoped that in the future, Kartini reactor will contribute to regional nuclear education and training programs.**

Keywords*— *IRL, internet, reactor, laboratory, nuclear, education & training

I. INTRODUCTION

Understanding science and knowledge of nuclear technology by the community can be done by utilizing information technology and nuclear facilities available. The goal of increasing understanding of nuclear science and technology for the present and future to the community can be bridged by the young generation, especially college students. But the problem of the vast geographical location and the limited availability of nuclear facilities such as in Indonesia, the need for broader information, science and nuclear technology development can be implemented by utilizing the latest information technology. This is in line with the International Atomic Energy Agency (IAEA) program as a settlement for a country with nuclear facilities, especially research reactors, to be able to provide experimental research reactor experience for university students in science and technology, IAEA member states that do not have research reactors such as countries in the Asia-Pacific region [1,2].

The IRL concept was first developed by the US Department of Energy funded with a research reactor consortium where North Carolina State University has successfully demonstrated through an internet computer network, sending experimental practice from its PULSAR research reactor to other college students in the USA [3]. The demonstrations included data and parameter displays of operation and PULSAR reactor kinetics for its students.

One of the three research reactors owned by Indonesia is the Kartini reactor located in the city of Yogyakarta. The Kartini reactor is a TRIGA type reactor (Training, Research, and Isotope production General Atomic) and is main tool for nuclear analysis techniques, basic research in science and technology of nuclear reactor, and for education and training in nuclear reactor technology. The technology of nuclear reactor involves a variety of knowledge such as physics (basic, modern physics and reactor physics), water and radiation chemistry, engineering (machinery, nuclear, physics, I&C, electricity, civil/structural) and other supporting sciences. As a means of education and training, Kartini reactor was used for practical work of science and engineering students in completion of their studies at universities including lab exercises and experiments [4,5].

In addition, Kartini reactor serves as a means of education to the general public (including high school students and university students) where people can visit and get an explanation of the type, function and mode of operation of a reactor in general and especially about Kartini reactor itself. As an important learning tool of nuclear science and technology, Kartini reactor can be developed in accordance with the latest information technology development [6]. The use of information technology such as a website for reactor science learning such as Internet-based reactor learning or as a reactor laboratory through the internet, called Internet Reactor Laboratory (IRL).

II. DESCRIPTION OF INTERNET REACTOR LABORATORY (ILR) CONCEPT

Internet reactor laboratory (IRL) is a means of learning about nuclear physics in this case by utilizing Kartini reactor as a tool and material of education and training. The topic of learning is about understanding theoretical physics of nuclear physics especially the reactor physics and practice of such understanding through interactive Website tools so that the distance problem between Kartini reactor user (user) and reactor owner/operator (host) can be

shortened for efficiency and effectiveness of education and training implementation. The IRL is designed for users at higher education levels.

Indonesia has a very wide area and the location of universities spread in various regions. The study of science and nuclear technology, especially education and training in the practice and operation of research reactors, can utilize Kartini's remedial facilities remotely (IRL). The existence of this IRL facility can make its own regional excellence in the spreading of nuclear technology for higher education. In classrooms consisting of users (e.g. students) and instructors/mentors (e.g. lecturers) interact on line with Kartini reactor operators (host) via website. The lecturer gives explanation and knowledge about reactor physics theory in class using the theoretical window at website URL in selected menu. Interaction with the Kartini reactor operators is carried out for the selected experiments which have been approved for implementation as a prior request. Approval of request is made after the user and host make a memorandum of understanding regarding the purposes of utilizing this IRL for the user [5].

The reactor physics experiment is carried out by the laboratory operators located at the reactor operating site in the Kartini reactor building. Experimental results are presented in a graphical form or in the form of physics and reactor operating parameters. IRL development increases Kartini's reactor capability in serving education and training. Through the use of IRL, it is expected that geographical problems are not an obstacle in order to understand the operation and kinetics of nuclear reactors to students in universities located far from the Kartini reactor site. The concept of IRL is illustrated in Fig. 1.

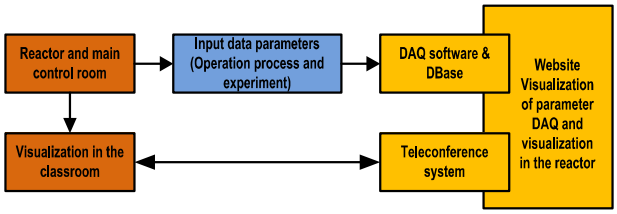

Fig. 1. Illustration of IRL concept

IRL completeness includes teleconference system and software for data acquisition systems. The data of reactor operating process parameters can be visualized at the same time (real time) at the time of reactor kinetics experiment. To participate in the IRL, the institution that wishes to utilize the research reactor should have two things: teleconference equipment and data acquisition software. The atmosphere and situation of the main control room, operating data and experiments can be displayed in the classroom by the instructor as a user through the software and delivered to the student. Instructor as a class Informer (lecturer) can explain parameter data (process operation and or experiment) to the audience (student). Monitored data can be collected through existing data base so that it can be displayed and repeated as necessary [6].

III. Methods & Implementation Of IRL

The concept of IRL by utilizing Kartini reactor is done through a concept similar to IRL in PULSAR reactor from North Carolina State University. Fig. 2 shows the implemented concept of IRL by utilizing Kartini reactor. Based on the acquisition data received by the computer the process of data reception by the software at NTC (Nuclear Training Centre) and collected on the computer data base server. The availability of such data base is in the public IP available on *Batannet*. Principles of operating and/or experimental data parameters from NTC and data base sent are made through a switching hub connected to the router and together audio/visual information from the camera IP can be sent to the client PC through the router as an IRL service over the internet.

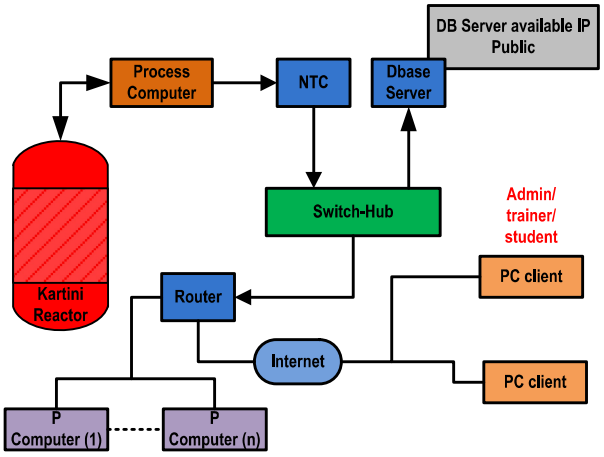

Fig. 2. Implementation of IRL concept using Kartini reactor

Internet connection interaction that occurs is between admin-trainer-students in order to access the IRL. Fig. 3 shows the instructor-student-operator interaction process as a practical way of querying the data parameters of the reactor and or experimental operation [6].

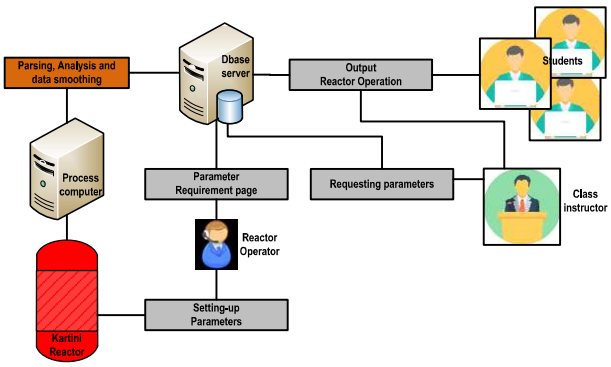

Fig. 3. Interaction of relationship between student, classroom instructor (lecturer) and reactor operator

IV. Result And Discussion

It has been successfully prepared IRL equipment that needs to be provided include cameras, servers, and monitors including data acquisition readiness from computer Kartini reactor process. The hardware and software applications are depicted in Fig. 4. The need for dedicated web servers and servers for data acquisition is established to facilitate access and security of acquired data. Data is obtained from computer data acquisition and used by the web server as the data provider on the internet

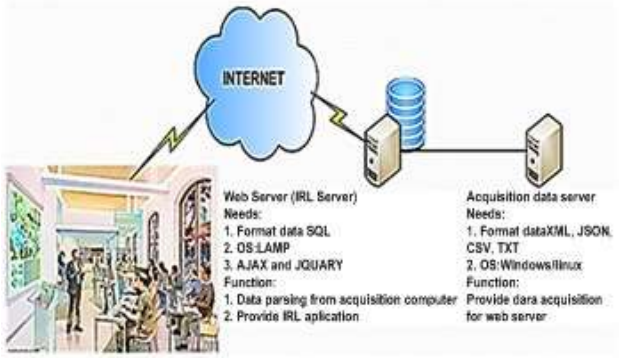

Fig. 4. Device required and installed in Kartini IRL

Fig. 5 shows the review process and workshop involving relevant stakeholders to get input related to teleconference as well as camera testing. The determination of IRL components is based on several things such as server capacity, camera type, monitor required. Status of IRL activities delivered in the workshop so that progress and needs, especially in preparation for soft launching, can be held well. Related parties involved in this IRL trial are the Dissemination and Partnership Center (PDK), the Center for Information and Nuclear Strategic Areas (PPIKSN), the Education and Training Center (PDL), the student's practical assignment and the IRL team of the Center for Accelerator Science and Technology (PSTA).

The IRL website software was created to include the interaction between the instructors (lecturer) with the processes that exist in the reactor operation for the client (student) as well as some protocols for the experiment. At present pre-loaded protocols include general protocols; operation of the reactor with a record of information on start-up check list activities; reactor criticality; reactor power calibration; and control rod calibration. The website software is also provided access for the client to obtain approval of access by request to the w ebsite administration. Once registered then the client can access the protocols. The protocol can be used as a theoretical and procedural discussion of reactor kinetics operations and experiments. However, for a more detailed explanation as well as discussions for the understanding of operation materials and reactor kinetics, a classroom instructor (lecturer) is still required to explain it. Thus the learning through the internet can be implemented.

The situation and conditions in the reactor, the interaction between the student-instructor-operator, can run through the internet by applying a teleconference system that is connected separately or attached to the IRL Website. Separation and camera involvement in the website can be done because teleconference uses IP address from the camera.

Fig. 5. IRL test teleconference and workshop

The IRL system has been successfully tested, and the soft launching was held during the Nuclear Youth Summit at Royal Kuningan Hotel, Jakarta on November 22, 2014. Fig. 6 shows some moments at the event as a manifestation of IRL's performance. The explanation is performed to display the IRL website by describing what is IRL, how reactor operation practice, preceded by check list information for start-up of Kartini reactor operation.

Fig. 6. Soft launching of IRL through Nuclear Youth Summit (NYS) 22 November 2014

The reactor operation is shown by teleconference for the interactive process while the IRL website shows the operation process by displaying the position of the control rod and reactor power. The operator in the main control room can explain the ongoing process in the reactor power operation after the check list for the start-up is completed by the operator on duty. The reactor operation has taken place according to the required critical power level at 100 kW.

The results of soft launching provide valuable inputs for satisfactory service improvements for interested parties (stakeholders). These inputs include: audio issues, process and material explanations by the instructor (lecturer) in the classroom, video quality installed in the Kartini reactor's main control room, selection of shooting angles and the need to install other cameras to show other things during the lab work, attractive reactor parameter display, practicum module and experimental scenario sequence as a material explanation of the process and materials for instructor (lecturer), attractive video display, require availability and reliable network for online interactive. While related to hardware: server hardware location, public IP must be entered into Batan website, repository by HD 3 terra, cloud, need more camera (available 3 unit camera only). Everything must be integrated with software and the web.

There are 13 input requirements i.e.: primary temperature 3 items, secondary 4 items, reactor water tank 1 item, water level 1 item, blower pressure 3 items, and the negative pressure of building 1 item. Recommendations associated with software: software acquisitions need to be constantly updated, software testing, and need website supervision by staff with an informatics background.

Integrated implementation of the education and training programs in nuclear engineering involves the IRL makes it possible to conduct practical exercises much effective and easier. Several researchers prove that the use of computer and information technology for the university graduates to adapt themselves to real reactor environment, help make it easy to understand [7,8,9]. The reactor experimental procedures from references [10,11,12] have been adopted, and in-house developed software such as *CPEM* [13] useful

for the future development of Kartini IRL will be integrated further.

V. CONCLUSION

The IRL based on Kartini reactor has successfully been developed. A pre-assessment activity for problem identification in the framework of further IRL development has also been studied. The initial IRL realization based on Kartini reactor has been successfully executed at NYS-2014 in Jakarta. The distance of Yogyakarta where the Kartini reactor is located, with Jakarta, has been shortened by providing an understanding of the reactor operating online and interactively via a website according to the protocols contained therein.

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