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Design and Development of A remote Process control trainer Kit for educational purposes

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Abstract: **The training Kits is the best option for training specialists in the automation and control, which allows you to work out practical skills and actions in non-standard situations. A process control trainer kit is one of the important kites which are widely used in several engineering disciplines such as Mechatronics Engineering. A Remote Access process control lab is provided utilizing the benefits of Microcontroller applications and LabView server/Client configuration using WiFi connection or Internet connection. To realize such this solution, a PIC microcontroller DAQ device with LabVIEW software linked to a standard PC is designed and developed. Furthermore, a process control trainer kit is fabricated in which temperature and level are controlled over wireless Network connection.**

Keywords: **Process control, trainer kit, PIC based DAQ, LabVIEW, On/Off controller, WiFi connection.**

I. INTRODUCTION

All engineering and scientific programs have laboratories, which are a crucial component of the educational process. In addition to providing examples of course concepts and ideas, laboratories also bring the course theory to life so that students may learn how unforeseen circumstances and natural phenomena effect measurements and control algorithms in the real world. However, a laboratory's setup comes at a significant cost, and maintaining one may be challenging. The laboratory must be set up, instructors must conduct lab lessons, and lab results must be graded. Given that laboratories are only open when both teaching assistants and equipment are accessible, these time-consuming and expensive procedures lead to a relatively limited utilization of laboratory equipment.

The remote Access lab enables doing lab tests every day of the week, 24 hours a day. Students may access experiments from their homes or dorm rooms thanks to it. Additionally, it is beneficial for a professor to examine a classroom presentation more closely and make a research demonstration available to students and others on sporadic schedules. When a professor uses a remote laboratory to derive a complicated equation for a particular application, he wanted his students to experiment with various parameter settings to reveal the true nature of the model. Additionally, it enables seeing an electronic circuit in use and even gives the user control over the operational conditions.

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II. LITERATURE REVIEW

In work [1] a digital device with remote control A training gadget has been created and put into use, it is based on the microcontroller QFN ATmega328, logic gate an IR detector and integrated circuits (ICs). In this work a simply set up an elevated bench with the board facing the students and demonstrate logic gates using a remote transmitter. Students can use this board to instantly check the validity of logic gate truth tables using the wireless transmission mechanism described in this article

In work [2] a trainer kit as a learning medium for was made in line with the fundamental skills of motorcycle electrical. In order to improve comprehension of the fundamentals of motorcycle electrical lighting systems, this work intends to provide Trainer Kit Quality Control (TKQC) on motorcycle electrical abilities.

In work [3] suggests a hybrid learning method that combines online learning with the suggested training toolbox for practical work. A PLC-based industrial automation training kit that simulates drilling, painting, stamping, and transporting things both manually and automatically has been designed.

In work [4], a portable education training kit is designed and implemented for Industrial Automation, it was shown that this portable PLC training kit is the best for teaching smart sensor applications for IR 4.0 since it is under 10 kg in weight and just 470 370 270 mm in size, which is similar to a cabin-size suitcase.

In work [5], the authors create an electromagnetic control system training kit with a modular design that can be used as learning material, and thoroughly assess the learning material using three different methods, including a functional-based test, expert judgment, and user-based assessment. Additionally, the learning media were deemed practical for use in the learning process by specialists in media design and learning material quality. The consumer gave the educational media a feasible rating as well.

III. THEORETICAL BACKGROUND

Process control (see figure 1) is a branch of engineering that deals with methods for bringing process conditions to and maintaining desired values while minimizing the occurrence of undesired situations[6-9]. Any system where material and energy streams are created to interact and transform one another is often referred to as a process. Examples include producing steam in a boiler, separating crude oil into gas, gasoline, kerosene, gas oil, and residue by fractional distillation, sintering iron ore into pellets[10-12], and polymerizing propylene molecules to create polypropylene. Determining desirable values is included in process control in the broad sense[12-16].

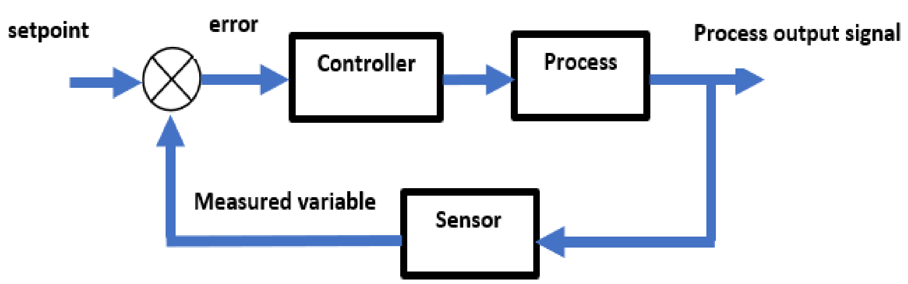

Figure 1. The general block diagram of process control

Block Diagram of Process Control shows the description of the process that is controlled and monitored using the trainer kit. Here, the temperature within the tank and the Level are adjusted remotely and then the student can monitor the process of tank filling or draining and the temperature of the water in the tank . The controller in the experiment is On/Off controller and this type of controller is used for simplification.

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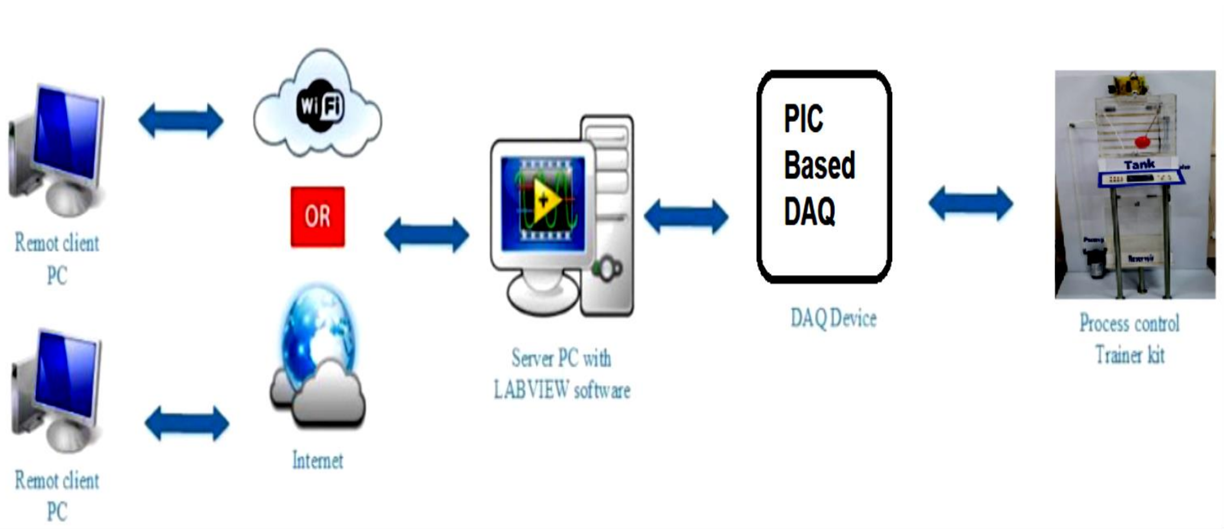

Figure 2. The illustration of the flow process

An illustration of a process control using wireless network connection is shown in Figure 2. As shown in this Figure The trainer Kit is controlled and monitored via wireless communication using LabView server/Client configuration with the help of PIC based DAQ designed by the Authors.

IV. METHODOLOGY

An experiment, demonstration, or process that is running locally on a LabVIEW platform but has the capability of being observed and managed via the Network is referred to in this work as a remote laboratory. To publish data from the development environment to the Web LabVIEW is used [17]. The learner has unlimited access to the virtual lab and may conduct experiments from anywhere at any time. By altering the experiment's conditions and analyzing the outcomes, they can also notice the signals. The teacher can observe and interact with the students as they do their experiment. It is well recognized that remote laboratories are valuable in educational settings since they save time and money for distant students while also saving the institution money on staff and equipment. Additionally, it enables many teams to use the same equipment for study through the Internet. The trials demonstrated both the viability of technological solutions and the accuracy of their application in this study [18].

V. DESIGN AND DEVELOPMENT

1. Hardware development

The work consists of two main parts: Hardware and software, where we use hardware to apply the experiments and connect them to the internet, while the software part is used to create the interface and simulation of the trainer kit, as shown in figure 3. below.

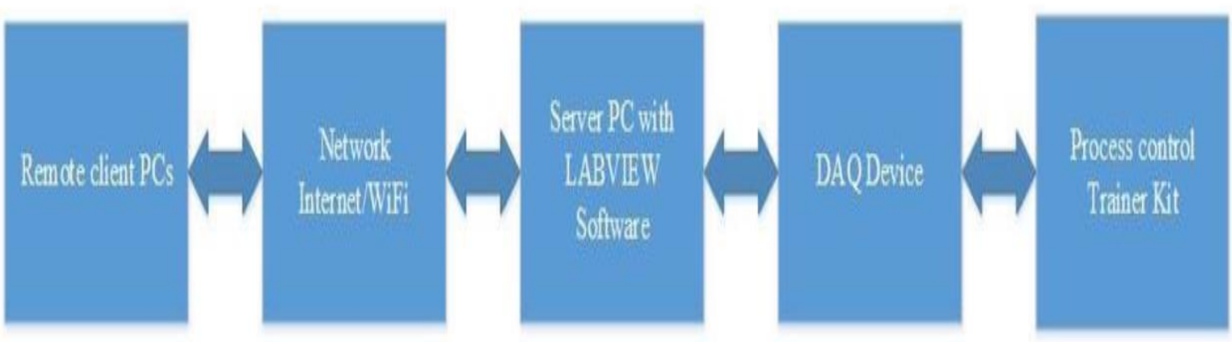

Figure 3. Trainer kit schematic diagram

where:

Remote PC

Which are used by the experiments users to apply it on the training kit, where they can apply it, control its inputs and outputs, observe its changes, and read the results.

Internet/ wifi connection: The user can control the training kit remotely, whether by worldwide internet or using local wifi connected to the experiment.

Server PC with LabView: Where the user, by the LabView - programmed interface, can control the experiment, in the condition of having it on a server.

DAQ device: DAQ hardware acts as the interface between a computer and signals from the outside world. It primarily functions as a device the digitalizes incoming analog signals so that a computer can interpret them.

Training kit: it is the tank with control and measurement components. Also there is a camera is connected to the tank which allow student to monitor the change in the process.

Software development.

Software programming was on two parts: PIC part, and LabVIEW part, where the system is constructed of two parts: data receiving, and then controlling and viewing.

PIC program was used with the designed DAQ device, using MikroBASIC programming language, to achieve the next following algorithm, in figure 4.

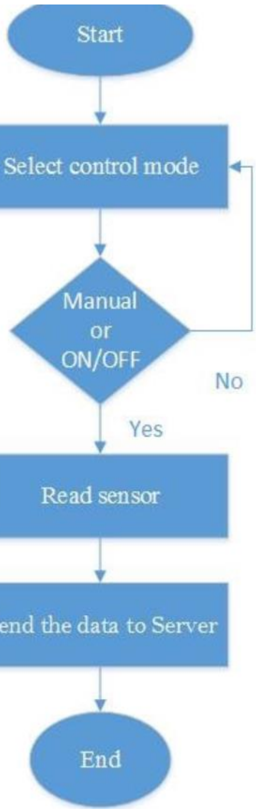

Figure 4. sensing flowchart using MikroBASIC on pic

when the program starts, DAQ device selects control mode to read sensors and send them to the server which has the LabVIEW to control its inputs and outputs.

LabVIEW part is used to control data sent by DAQ, which are inputs of the system, to control the experiment remotely, as LabVIEW is installed on a server. The flow chart of our LabVIEW program is shown in figure 5.

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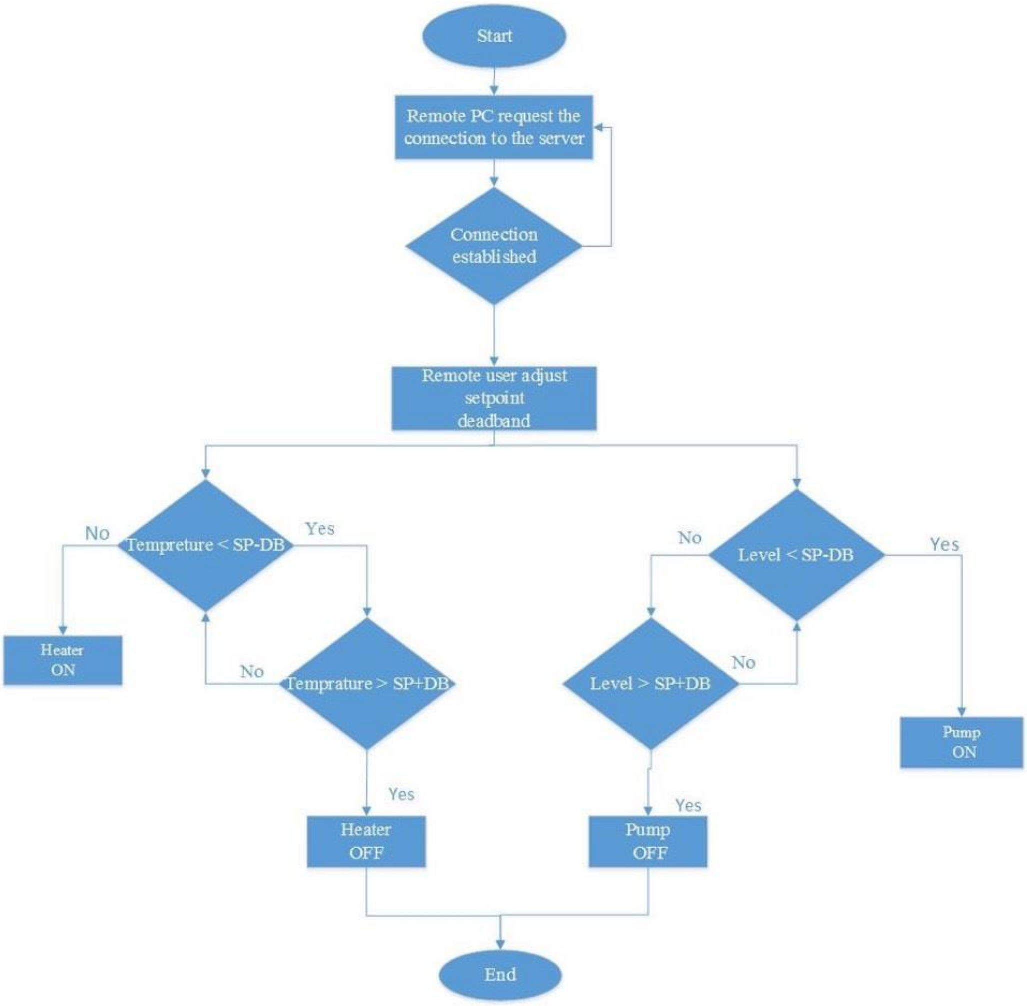

Figure 5. LabVIEW program flowchart

Simply, when the system is connected - to the internet or through a local wifi , LabVIEW asks the user remotely to adjust the needed level and temperature setpoint of the process [20]. Once it's inserted, the system compares the inserted the setpoint to the actual. LabVIEW activates a pump and a heater to adjust level and temperature [21-23].The LabVIEW Interface would look like as in figure 6:

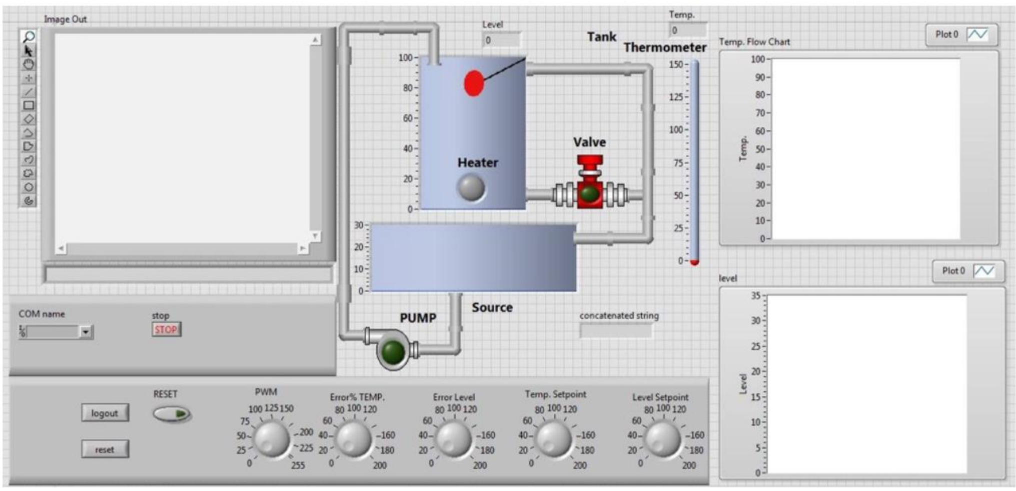

Figure 6.

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And the program is shown in figure 7:

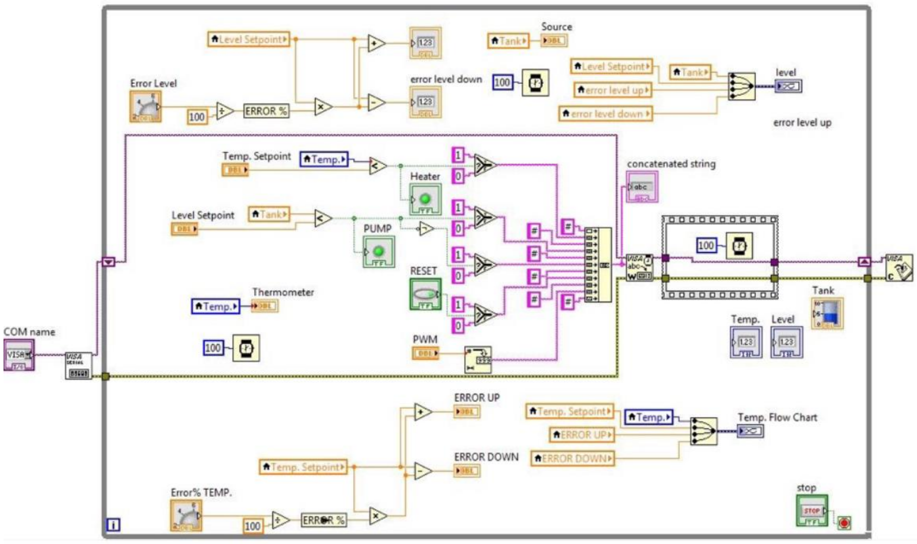

Figure 7. Training kit LabVIEW interface

Experimental setup

Figure 8.z Experimental setup

As shown in figure 1.z the experimental setup consists of the following parts

Item	**Function**
Thermistor NTC 10k 3905	**To measure the temperature in the tank**
Float sensor	**To measure the level in the tank**
Vision Camera	**For remote monitoring of the process**
Servo Motor	**to change the position of camera to enable the student to watch the real experiment parts remotely**
Solenoid Valve:	for discharging a main tank when the student finishes the experiment
Diaphragm Pump	**To fill the tank**
Heater	**heat the water in tank**

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VI. CONCLUSIONS

This kit could be improved in many ways, one of them is connecting it online using Internet, which we were not able to achieve because of the high cost. We found that designing the kit is easy and could be done using low costs, without using ready expensive systems of universal companies. The kit could be added to any lab by designing it's experiments interfaces easily, and adding them to it, which opens doors to the remotely-control of labs. On the other hand, only one person could control the experiment and change its values. However, using XBEE could show the experiment to more than 65 thousand students worldwide, which gives it an advantage over wifi or limited-numbers routers, though both of them could be controlled remotely.

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