

*Engineering EdTech platform
The College of applied technical science Nis, Serbia
Academy of Technical and preschool teacher studies*

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**Engineering EdTech platform for interactive student and employee
training**

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Functional description of an integrated solution to the teaching process management with respect to the central PID system and laboratory equipment

The suggested solution comprises three functional units, and they are as follows:

- a. Teaching process management system
- b. The central PID system
- c. Laboratory equipment integrated with a course software and hardware

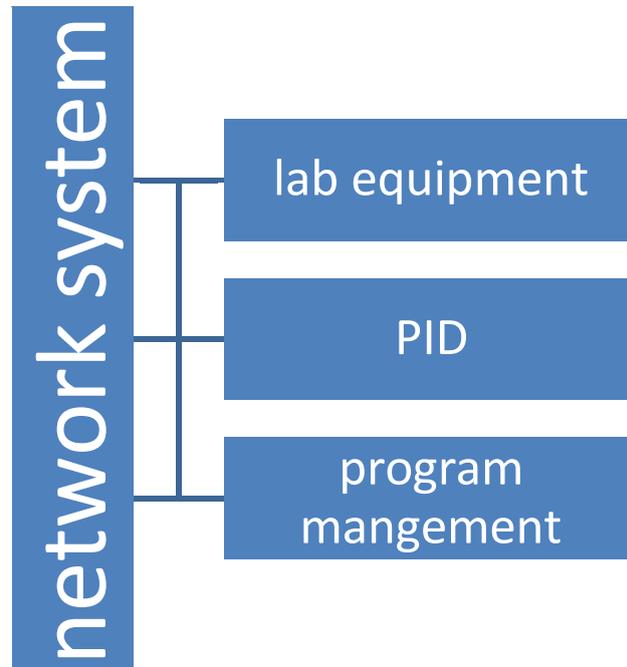


Figure 1. Block shema

Functional description of the teaching process management software

Teaching process management software should support Windows, Linux, Android, IOS, and Mac, which implies that the said functionalities are self-understood in Windows, whereby some of the functionalities do not have to be supported in other operative systems. Teaching process management software generally needs to support the work with both subsystems (the central PID and working with laboratory equipment).

Interactive education and learning should support the following possibilities:

- The teachers' ability to transfer display screen to students' computers
- The teachers' ability to transfer the voice to students' computers
- Demonstration of a specific content to a specific student
- Network display of a video content to all students
- Network display of a camera content to all students
- Interactive board which involves all students

Control and assistance for students:

- Monitoring and controlling students' computers
- Internet access control
- Media access control (CD, USB, Disc)
- Application control
- Print control
- Display control (possibility of a screen blackout during the lesson)

Execution of remote commands on students' computers

- Starting an application
- Opening a remote site on a student's computer
- Remote computer startup
- Computer shutdown
- Computer restart
- Closing applications

Remote computer parameters setting:

- Display, desktop and network setting need to be enabled
- Proxy server, wifi network, etc.

Group collaboration:

- Simultaneous management of the entire computer group
- Group learning
- Group chat

Assessment of students' knowledge:

- Quiz questions
- Survey

File management:

- File distribution to students
- File collection from students

Functional description of the central PID system

Suggestion 1.

The central PID system should comprise the following components:

- A software which should function as a PID regulator with the following characteristics:
 - every student has their own central PID system log in account
 - all exercise results obtained by a student are logged in during the exercise and they are available to course teachers or assistants

- the software needs to enable the expansion of the number of potential exercises at the request of the software provider
 - the object of management can be managed through the network, so that every student can do the exercise from his/her local computer
 - the application needs to be compatible with the teaching process management software and course software, and working with it needs to be demonstrated to students by means of a group presentation without any interference.
- The hardware (managing object) presented by a network device which can be accessed from any computer and which controls the PID parameters.

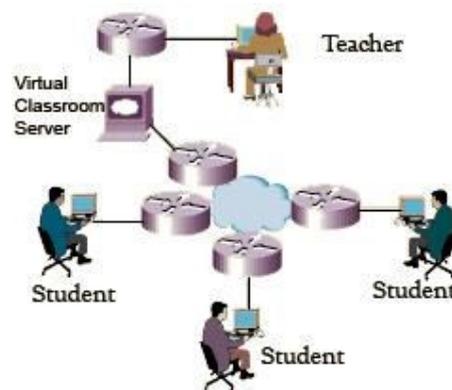


Figure 2. Virutel clasrrom

Description of the PID system for thermal control:

1. An air tube made of plastic. The effective tube length should be at least one meter long and transparent, so that students can see the sensors and other elements which are in the tube.
2. The fan should enable air flow through the tube. The fan can be controlled either by a potentiometer, or by software. The fan speed is measured by a signal voltage which is in the range between 2V and 5V. The normal fan speed is to be defined as the maximum speed. (It is not necessary to be aware of the volumetric flow rate).
3. The air is heated by an electric heater. The power supply of the heater must be controlled via voltage in the range between 0V and 5V, which connects and disconnects the main voltage on the heater through the PWM. The presence of PWM signal must be indicated by a light indicator. The PWM device needs the 24 VDC power supply, which is obtained from an AC/DC converter.
4. The thermal sensor: two thermal sensors must be built into the system. Both sensors need to be equally calibrated. Sensor signals need to be the voltage ones and in the range between 1V and 5V. This voltage range needs to correspond to the thermal range between 20 °C and 60 °C, with a linear relationship between the ranges.
5. The analogue I/O device needs to be able to accept the abovementioned voltage ranges. This control, too, needs to be enabled through the Ethernet network for all students from their management software which simulates the work of the PID regulator.
6. The system should secure at least 16 work posts for students.



Figure 3. PID control units

It is necessary to produce a management system which will represent a smaller version, or at least a smaller portion, of a real process which can be encountered in the waste management field. Students should be enabled to become interactively acquainted with the management and malfunction diagnoses in the processes within the waste management field, as well as to become familiar with a continual regulation of the real time system state by adjusting parameters of the controller and monitoring the system response.

Envisaged opportunities

- The acquisition of measurement with different sensors
 - Digital sensors, incremental encoder
 - Analogue sensors, Pt probes and thermocouples
- Output setup (manual control)
 - Digital, analogue, PWM
- Automatic control (PID)
 - Setting and changing controller parameters
- The analysis of the influence of an integral action and sudden transition from manual to automatic regime and vice versa
- Graphical presentation of the system status
- Exporting and keeping data for the purposes of off-line processing
- Easy upgrade

Solution

By examining various possibilities for the implementation of such a system, the proposers have reached two different approaches. The first approach is to develop a new platform which would be used as a connection between the computer, sensor and process actuator, while within the second approach one would consider some of the commercially available acquisition cards, such as NI USB-6001.

A new platform

This solution is based on the NUCLEO F411RE development board which is programmed to enable the acquisition and installation of digital and analogue signals from a specially developed application on a PC. A microcontroller is programmed to function as a slave, i.e. to react to the commands obtained from a PC application via serial port. The setting of an electric motor reference speed value has been enabled, as well as that of the PID controller parameters via the application programmed in the MATLAB. The application was developed in MATLAB GUI so that one can enable easier data processing in the course of work. One of the suggestions was to develop application in Python, so as to reduce software cost.

From the beginning the good sides of creating an acquisition board are a great input and output organisation flexibility, a larger number of inputs/outputs, as well as the price (the material for the realisation of one platform cca 100 e + energy electronics + apparatus). Likewise, the possibility of further system upgrade is large, but it implies a vast knowledge of embedded programming, of electronic board development, as well as of programming and working with MATLAB software. The bad sides of this approach are reflected in the time and cost necessary to develop MATLAB software (unless one uses Python). Also, the speed, as well as the precision of a signal acquisition would be smaller than using commercial solutions specialised for this purpose.

The use of commercial acquisition card

The presented solution is based on the NI USB-6008 acquisition card (which was available at the time). One of the remarks was that the card is out of date and that one should use the more recent NI USB-6001 card, which is cheaper and has better performance. The card enables the acquisition and installation of digital and analogue signals from a specially developed application at a PC. The application is developed in the LabVIEW software. A card is simply attached to a computer and other peripherals. The setting of an electric motor reference speed value has been enabled, as well as that of the PID controller parameters via the application programmed in LabVIEW.

The good sides of this approach are reflected in a shorter time necessary for its development, so one can dedicate more time to develop different apparatus. The possibilities of a further system upgrade are greater than with the previously described solution, since one does not need the knowledge of embedded programming, and the software is more intuitive for the beginners. The bad sides are the price (card cca 250e + energy electronics + apparatus), fewer inputs/outputs, as well as the price of the LabVIEW package.

Laboratory equipment integrated with the course software and hardware

1. The general requirement for the entire laboratory measurement equipment, which has the possibility of communicating with personal computers, is that laboratory device which is connected via some of the suitable communication ports (rs232, USB, etc.) be tested and verified by the provider who is to confirm that the course equipment is mutually compatible and that there are no interferences between a PC and the lab equipment.
2. The teaching process management software and laboratory equipment management software need to be in compliance and capable of demonstrating any exercise to the students through the network on their computers.
3. The very preparation of measurement samples and application of various procedures need to enable live transmission to students via webcam to their computers.
4. It needs to be possible to distribute the measurement results to students in the form of files, so that students can do the analysis on themselves based on the material distributed in the form of a file, which contains the measurement results.

By implementing this integrated system, which would encompass all of the abovementioned elements, students would have an effective system at their disposal which would enable the application of a modern approach in engineering education. Thus, conditions would be created for students to ultimately obtain the competences necessary to comply with the requirements of a modern market in the waste management field.

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