

## **An Approach for Development of Remote Access to a Real Laboratory on Embedded Systems Course**

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**Abstract:** *This paper focuses on the process of building an universal system for a remote access to devices for educational purposes. The aim of the project is to find a solution for remote access to development training boards, based on MCS51, AVR, PIC, ARM, and other embedded microcontrollers from anywhere and anytime.*

**Key words:** *Computer Systems and Technologies, Remote access, e-Learning, Embedded systems, Microcontrollers.*

### **INTRODUCTION**

The term “e-Learning” nowadays is being heard more and more frequently. The reason for this is the dynamic of the life and the new demands for the modern human. Laboratory experiments are a vital part of engineering education, which have been considered for a long time as impractical for distance and e-learning learning. However, recent advances in Internet/web technologies and computer-controlled instrumentation presently permit net-based techniques to be utilized for setting up remote laboratory access [1]. The trends for development of the modern technologies require more flexible and continuous learning. This is a process that starts with the human birth and it is a lifelong. Thus we talk often about life-long learning. The both phenomenon – e-learning and life-long learning are demanding new approaches and technologies for conducting and supporting the learning process. This process should be adapted for the daily round tasks and it should not disturb the routine business and personal engagements. That’s why the requirements for this process are quite complex. The modern learning technology should allow usage, independent from the place and time. The instruments providing it should be flexible, scalable, intuitive and able to give a “touch” to modern and expensive equipment.

### **THE PROBLEM**

To provide the “touch” to learning equipment for the “Embedded Systems” course, in the Department of computing in the University of Ruse, we decided to use a system for remote access and control. Such systems exist and are used from a couple of years. One of the popular is Nokia’s RDA (Remote device access) [2], which allows access to their symbian based phones to programmers, testers, enthusiasts, or just curious buyers, who would like to play with the device and to evaluate it before buying. This approach is quite useful, since for a software developer it will be quite expensive, if he has to own all of the devices that could run his application and to test it.

Another solution for remote access is the LabView suite from National Instruments [3]. It provides remote access to National’s products and is quite popular for internet access to the labs [4].

On one hand there are existing systems that allow remote access, but there are two main problems for their usage:

- The first one is the price – since we talk about department of “Computer Systems and Technologies”, it is more appropriate such system to be developed by its staff and students, rather than spending funds for it;
- The second factor is the universality – usually these systems are quite specific and they work only for a given scenario and hardware equipment. In this meaning they are “custom” systems and the cost of ownership includes also a kind of a customization, which can vary from just a slight cosmetic adaptation to re-engineering of the product

## THE SCENARIO

For the course “Embedded Systems”, we are using hardware development/evaluation boards, based on MCS-51 MCUs. The students can access them only during the normal classes. This way they can not experiment their own projects, ideas, or just experimental analyze the details of the microprocessor family. On another hand, the teachers could not place assignments, related with the development boards without such a system. Besides it should allow access control and priorities for the different groups of students. Obviously the students that have assignments should be in the highest priority list. The ones that attend the course are in the lower and the rest of them are in the lowest priority list.

The next question we have to answer is the technology of access and feedback. The two possible variants for our case are:

- Feedback via software kernel, which allows program execution, using time division and communication via RS232. This could be a nice solution if we had only one kind development boards. Having different boards, with different MCUs require different versions of the software kernel, which is quite time consuming, expensive and not so flexible.
- Using video feedback is a much simpler solution, which allows the usage of different development boards and peripheral devises with minimal costs and efforts. The system is web based and could be easily integrated with the existing e-Learning platform. Actually, it could be built as a plug-in module for the e-Learning system. The additional software, needed in this case is a program loader (usually free, downloaded from the manufacturer) and a video streamer and client (in our case Adobe Flash based, which is also free and open source)

Figures 1 and 2 represent the main stages of the process of scenario development and application building.

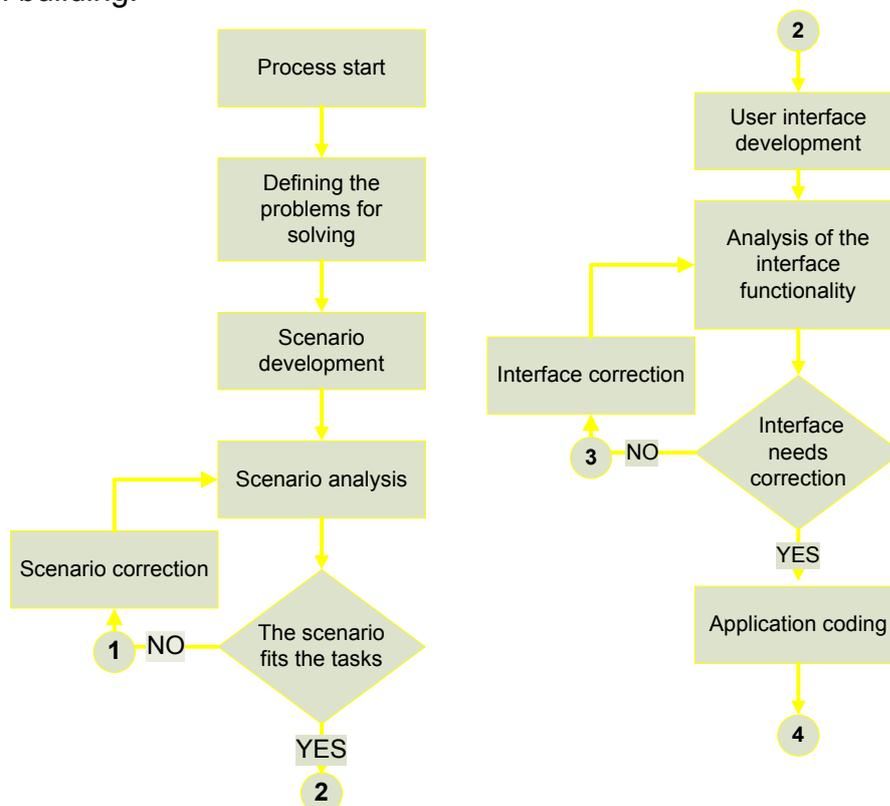


Fig.1

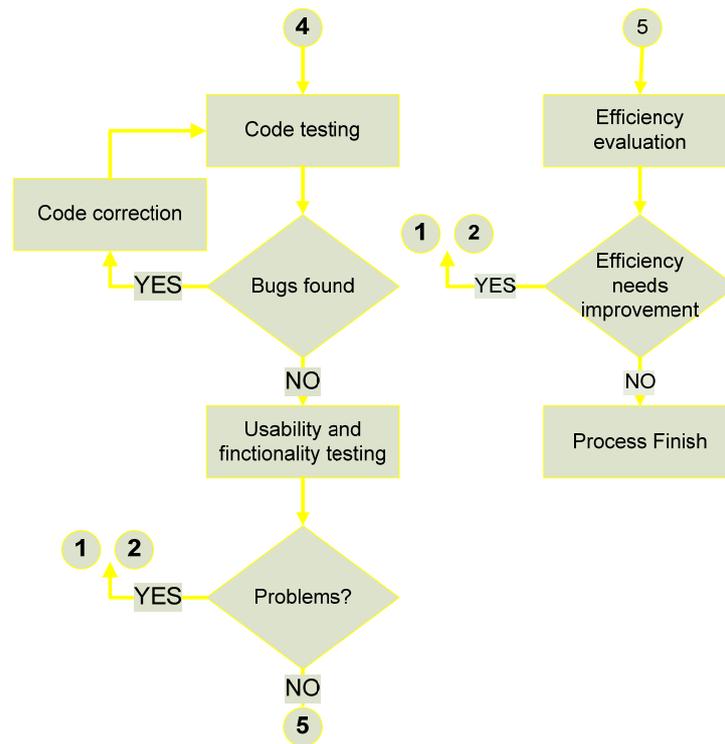


Fig.2

### THE ALGORITHM

The aim for the algorithm realization was to keep it as simple as possible. The stages are:

- Authentication – here the user identifies him to the system. We use the login database from the existing e-Learning Shell, which saves time and it is not necessary to create new users;
- Checking for an available device – since the devices are limited, and the students are generally more than the available development boards. It is possible a student to attempt access, when all boards are busy;
- Suggest a time slot – if all boards are busy, then suggest a time, after which the student will get access to the device;
- Slot reservation – the user may accept, or deny the use of the suggested slot. This may happen if the waiting time is too big. In case of deny – the system finalizes the session;
- Grant access to the device – at this stage is the real work of the student with the board;
- Free the device after slot expiration – after given amount of time, the device access should be granted to another user

The described stages are illustrated on figure 3.

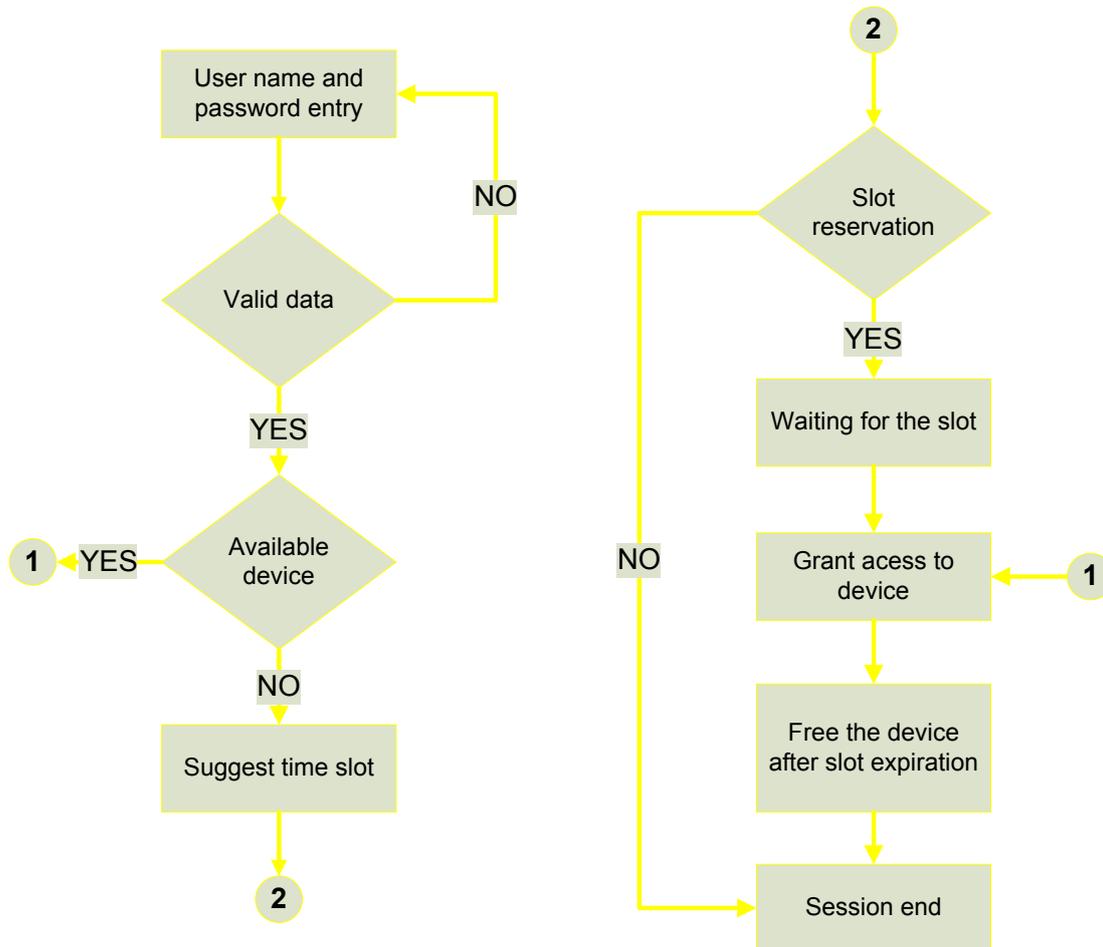


Fig.3.

### CONCLUSIONS AND FUTURE WORK

The realization of the remote access system should improve the usability of the laboratory devices and should motivate the student of hardware course to spend more time on development and research. This technology should ease their access to development equipment.

Next step on this project is to test the system in real conditions and to define the length of the time slot. It should be not too long in order to keep the time for waiting as short as possible. After this step is done, the system should be integrated with the e-Learning Shell system as a module and priority queues should be organized, for at least three levels:

- First level priority – the priority level for students with assignments;
- Second level priority – for students, currently attending the course;
- Third level priority – for all other users of the system.

In parallel with the prioritization, we should develop also a user interface for the teachers to manage student accounts in these 3 priority groups.

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