Experimental and Virtual Laboratories in Information Systems Teaching

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ABSTRACT: *This paper is focused to the use of virtual laboratories in teaching in the area of information systems, closely connected to control systems. The Paper presents good experience with developing real laboratory tasks oriented on wireless communication systems, using a GSM controller. During their semester project in the subject „Database systems", students have developed these laboratory tasks and the web connection to these tasks. The completed projects put the problems of data measurement, control systems, database systems and other parts together and make demands on students to solve all these problems together. This has proved a useful way to understand the complexity of separately taught subjects.*

1 INTRODUCTION

Four years ago our Faculty of Mechanical Engineering has changed all study plans to the serial study system, according to the Bologna Declaration, because of the accreditation process, which motivated us to change the study plans completely. Now our students are in the third year of a three-year Bachelor study and we have started study specialisation. The study branch subject starts in the fourth semester of Bachelor study, the Master study has only a few connected subjects. This is a huge change in study plans, because previously the study system had been parallel and only a small number of bachelor students continued to the master study through a special year of study, including background subjects like Mathematics, Physics, and Mechanics, etc. Now we have much more space for the study branch subjects than before, but we have differed the subjects for bachelor and master study, because previously the subject contents had been similar from 20% to 50%. The second problem is to fill in the study branch subjects. We have now much more space for specialisation, so that we have prepared three specialisations in our study branch called "Engineering Computer Science and Control" in the bachelor study plan. They are:

- *Control Systems* – focused on basic knowledge of control systems, instrumentation, sensors etc.
- *Application of Computer Science* – focused to computer hardware and software, database systems etc.
- *Technical Management* – information systems, engineering management etc.

Thanks to the study plan changes, we have obtained the possibility to completely change the subject content. At first, we changed the content of subject "*Databases and Internet*", which is the fundamental subject in the specialisation Application of Computer Science. Previous subject content was oriented on database system development only and laboratory tasks were focused on database system problems, Internet connectivity etc. It is clear that we cannot change the full subject content, the main database problems have to be included in the lectures. Then we changed the principles of exercises taught to show how databases and information systems are connected to other control systems parts. They are many different problems and systems using databases or other ways to store data for their processing, like visualisation and supervisory systems [LANDRYOVÁ, ŠKUTA & BABIUCH], measurement systems [KOČÍ, TŮMA], instrumentation systems [SMUTNÝ] etc.

As a first step to connect database problems with other parts of study, we found some problems taught in other subjects and included them in the exercises:

- Measured data storing and processing (Instrumentation, Sensor Systems).
- Control system analysis and further data processing (Control System Theory).
- Technological process data storing and analysis (Process Visualisation).
- Production data analysis (Management systems).

This strategy helped students to develop their semester work, bachelor and diploma thesis from these fields of interest. Unfortunately, it was very complicated to take data and databases from so many different fields of interest, because every part of the problems had been solved in different laboratories with different equipment. This way is also good for completing a bachelor or diploma thesis, but very complicated for standard teaching. Upon this ascertainment, we started to build a special laboratory for database and information system completion, including:

- Database server (Microsoft SQL 2000 Server).
- Application server (web server with ASP technology support).
- Client program developing systems (PowerBuilder, Microsoft Access database).
- Data acquisition systems, measurement systems.
- Supervisory control systems, remote control systems.
- Control system developing software.

2 INFORMATION SYSTEMS LABORATORY

Figure 1 shows the basic structure of a built laboratory. The main part is a server farm located in a special computer room together with network hardware. All servers are remotely operated using the network. The computer laboratory has been equipped with software for client tools development. Most important is a specialised laboratory, which is built now. The first equipment installed in this laboratory is shown in Figure 2:

- Bar code readers – enables the development of typical warehouse and sales information systems with online data input,
- Simple input carts – enables the development of data measurement and data processing systems, connected to existing laboratory tasks used in other subjects from the area of control systems and instrumentation,
- Special GSM controller – enables the development of simple measurement, data storing and remote control systems with the use of knowledge acquired in subjects from the area of control systems theory, sensor systems and data processing systems,
- SCADA/HMI software connected to the laboratory tasks for system visualization and control.

Laboratory tasks are used during the exercises for example for data source connection, data storing and on-line data processing. Some of them need knowledge from special subjects like real-time system programming [FOJTÍK], non-linear control theory [WAGNEROVÁ] or special data processing methods [TŮMA]. An important use of this equipment is also in completing semester work, which is an integral part of completing a subject.

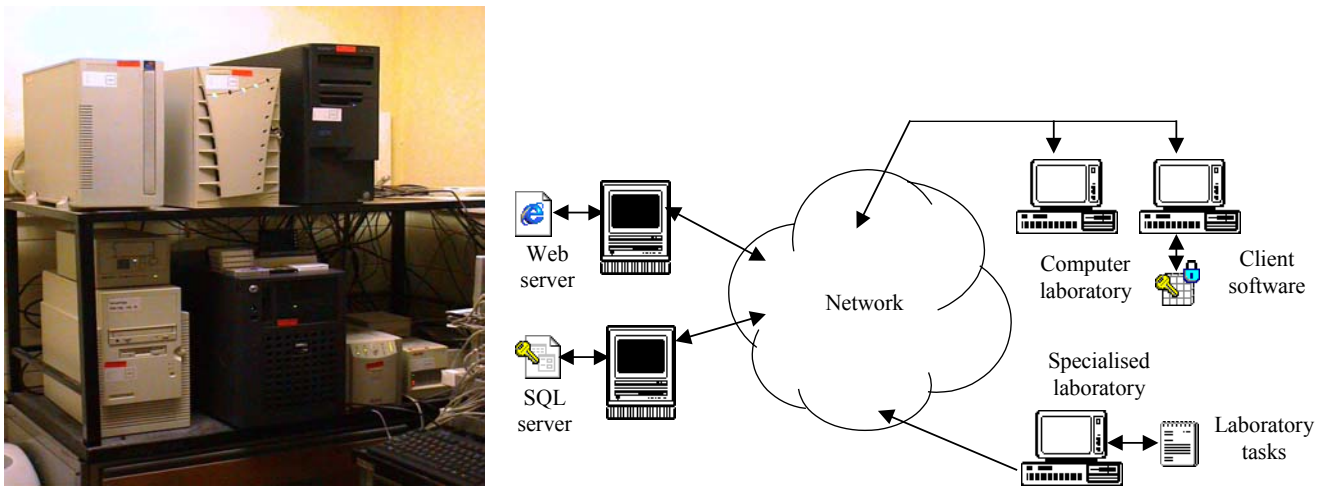

Figure 1 – Information Systems Laboratory – Server Farm and Computer Connection

Figure 2 – Specialised Laboratory Equipment

Semester works are oriented on solving complex problems, including the problems of system analysis, control system synthesis, data collection (sometimes including data compression), data processing and presentation. A typical problem, solved with the help of the GSM controller, is shown in Figure 3. GSM automat is used as a data measurement system, which puts data in the database for further data processing and visualization.

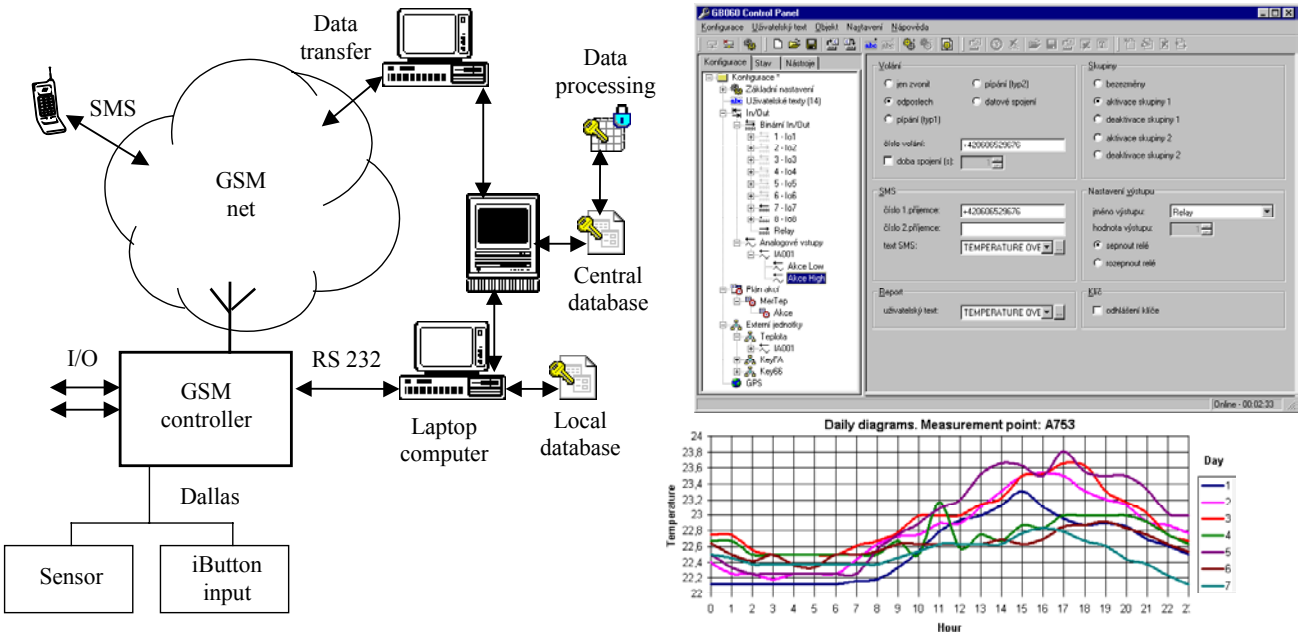

Figure 3 – Typical laboratory task with use of GSM controller

3 VIRTUAL LABORATORY CONNECTION

The next logical step was to change focus to remote laboratory tasks connections. We have very good experience with SCADA systems InTouch and Control Web 2000 [LANDRYOVÁ, ŠKUTA & BABIUCH]. Both of them give us the possibility for creating client applications connected to real laboratory tasks by Internet, and also includes standard programming interfaces like ODBC, which can be used for developing a data source component. Thanks to this standard interface we can use the SCADA client program as a data source and store the acquired data in the database for developing database client systems. Students appreciate the real system behavior, which they have analyzed during studying previous courses from the area of control systems theory, identification and modeling. A typical user's interface of the robot control system is shown in Figure 4.

In the last year the control systems laboratory has been extended by a special supervisory system equipped by the web camera, which can be focused to a real laboratory task, with the help of specialized web oriented control task [ŠKUTA], see Figure 5. Projects, based on this laboratory task are very popular in spite of the fact they are very complex and the knowledge from more different courses is needed.

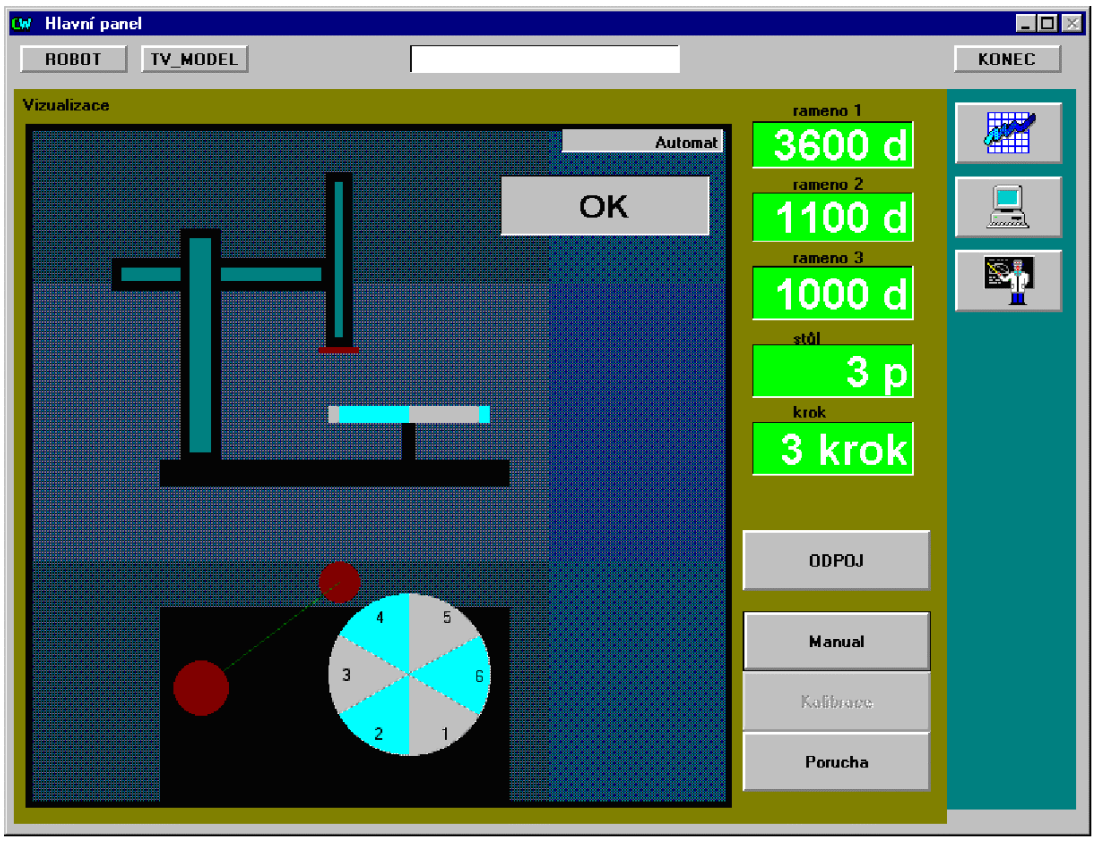

Figure 4 – Robot control system user's interface

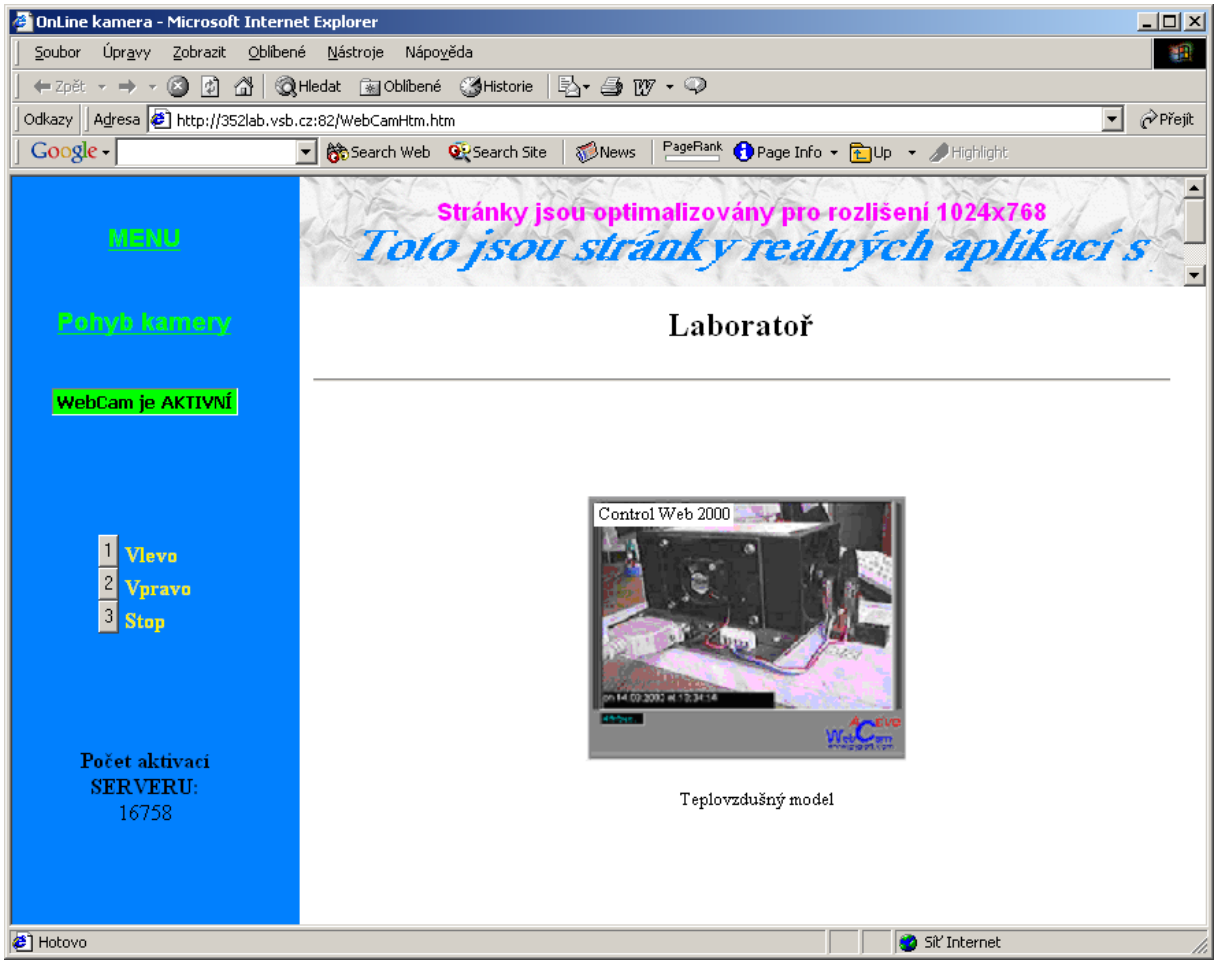

Figure 5 – Web oriented supervisory system output

Another way we can use a connection with real laboratory tasks is a wireless connection based on WiFi or GSM standards. The main goal of his projects is to develop the data source connection system, take, analyse and store information sent in standard SMS format. Figure 6 shows the main form of the data collection system including the typical SMS message pattern and the SMS read algorithm. This system has been also used to measure the time delay between sending and receiving information by SMS. The analysis based on this measurement has shown us the usability of this communication systems for data collecting, supervisory and/or control systems.

The main problem of these projects is to analyze the text messages and to process acquired data, especially with the use of different graphical representations, as shown in Figure 7.

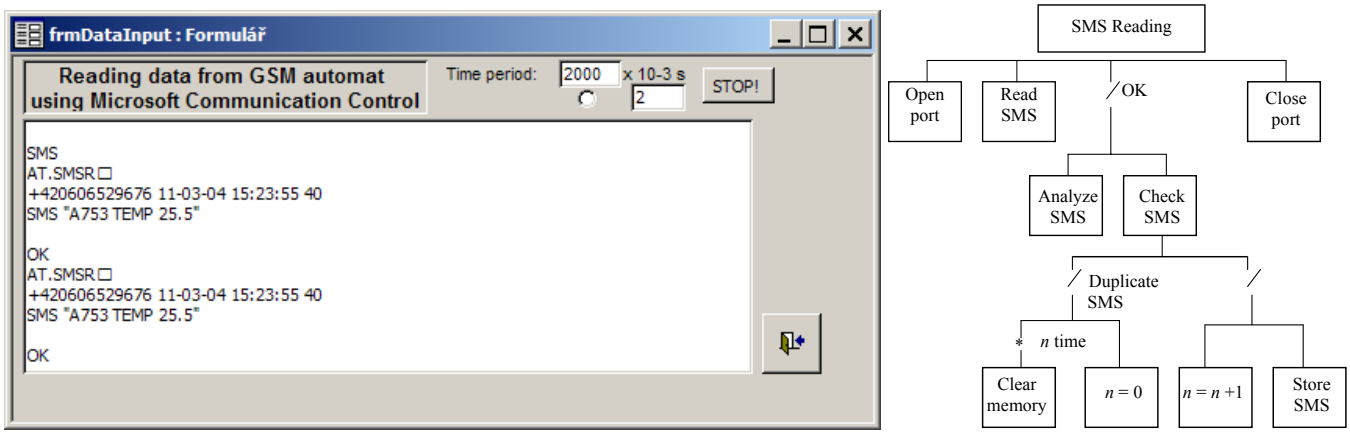

Figure 6 – SMS oriented data collection system

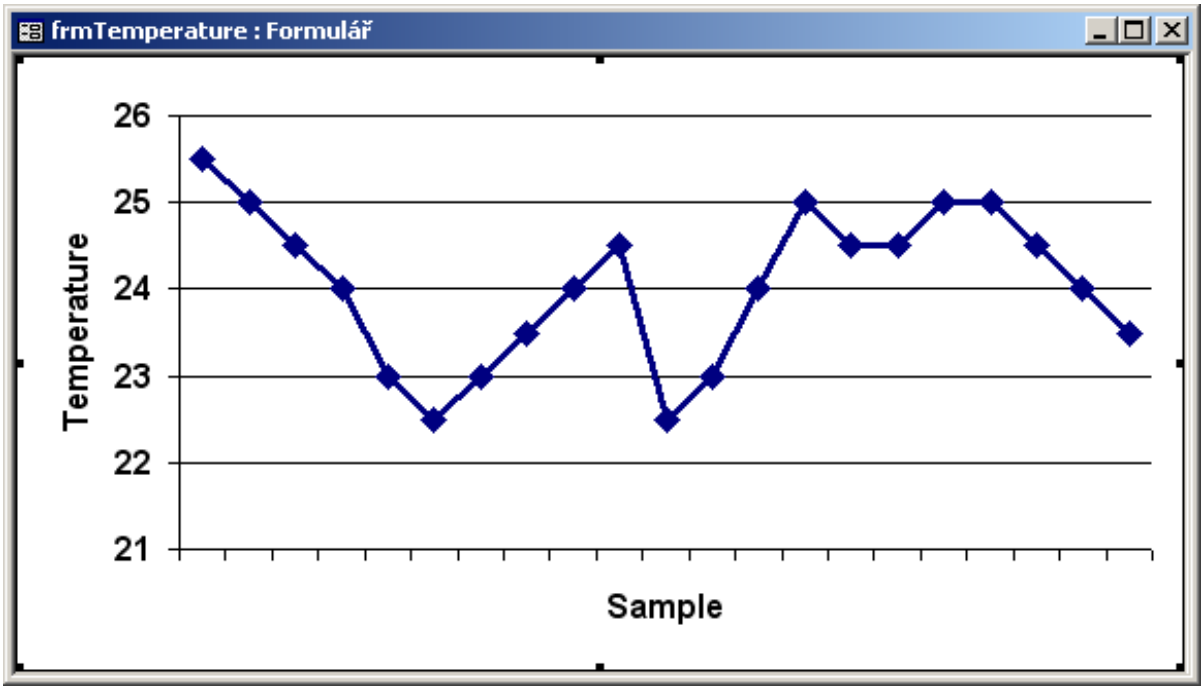

Figure 7 – Processed data chart

The logical last step used of this developing process is the orientation to virtual laboratory tasks. Both supervisory programs include also the simulation systems based on defined mathematical models. The difference between real and simulated data is only given by the simplification of the mathematical model, ignorance of non-linearity and noise. But for solving the database project this influences are negligible, when the fundamental problems are from the area of data collection, data storing, searching and processing.

4 CONCLUSIONS

We have now only the first experience with solving so complicated and complex problems in the teaching process, and they have showed us that it is very complicated to prepare suitable laboratory tasks, but students are achieving very good results and these problems are very popular, especially among good students, because they can synthetize their knowledge from different study courses.

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