

UNIVERSITY OF SARAJEVO, BOSNIA HERZEGOVINA

FACULTY OF ELECTRICAL ENGINEERING

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ANNUAL REPORT ON THE PROJECT

**The application of HP mobile tablet PC technology in the design of
Interactive laboratory experiments in physical and virtual labs**

DECEMBER 2008- DECEMBER 2009

- **Project Webpage URL:**

<http://hp.etf.unsa.ba/>

- **Institution Name**

FACULTY OF ELECTRICAL ENGINEERING, UNIVERSITY OF SARAJEVO
BOSNIA HERZEGOVINA

- **Institution Location (City, State/Province, Country)**

SARAJEVO, BOSNIA HERZEGOVINA

- **Project Name (short title)**

The application of HP mobile tablet PC technology in the design of Interactive
laboratory experiments in physical and virtual labs

Project implementation members:

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Professor on Modeling and Simulation and CAD/CAM Engineering courses
2. Dr Selma Rizvić, project implementator
Assistant Professor on Numeric Graphics and animation
4. Aida Sadžak, BScEE, project implementator
Teaching Assistant on Numeric Graphics courses
5. Mr Ingmar Bešić, project implementator
Teaching Assistant on CAD/CAM Engineering course
6. Omer Tanović, BScEE, project implementator
Teaching Assistant on Modelling and Simulation course

1. PROJECT DESCRIPTION

Faculty of Electrical Engineering was recipient of HP Technology for teaching grant for 2008 year, and equipment was supplied in November of 2008.

The HP grant was awarded as implementation of the project under the title : " The application of HP mobile tablet PC technology in the design of interactive laboratory experiments in physical and virtual labs" .

Faculty is planning to utilize HP grant to upgrade and modernize its three courses from the recently adopted new study program that had been revised according to Bologna principles to bring its standards and quality in higher education to European levels of educational excellence and recognition.

The three courses are:

1. Course in Modelling and simulation that is taught on the second year of the undergraduate study at Automatic control and Electronics Department.
2. Course in CAD/CAM Engineering that is taught on the second year of the undergraduate study at Computing and Informatics Department.
3. Course in Numeric Graphics and Animation, taught on the first year of Masters Study at Computing and Informatics Department.

The implementation results achieved on these three courses and skills gained with new technology are outlined in the continuation of the report for each specific course and than in the summary as resume of the overall achievements and experience.

The web site for the project was created in the early phase of project implementation and was gradually refreshed as the implementation of the project progressed. The URL address of this web site is: <http://hp.etf.unsa.ba/>

2. General data on HP Lab facility

Faculty of Electrical engineering University of Sarajevo, was one of the recipients of HP Technology for Teaching for higher education grant for 2008 year, in group of EMEA countries.

The HP grant was obtained for the project submitted under title: " The application of HP mobile tablet PC technology in the design of interactive laboratory experiments in physical and virtual labs",

The grant included the following equipment:

- 21 Hewlett Packard Compaq 2710p U7600 12.1 1024/80
- 21 HP 2710p Ultra-slim Expansion Base with DVD drive
- 21 HP USB Optical Travel Mouse
- 1 Executive leather case
- 3 HP iPAQ 214
- 1 HP Designjet 130gp with printer stand
- 1 Mobile Net Education Center for 24 Notebooks(mobile Cart)
- 1 Digital Projector
- 1 HP Wireless Access Point installed into Mobile cart
- 1 HP ProCurve Switch 408 installed into Mobile cart

Part of the cash portion of the grant was utilized to purchase and install new advanced HP server type ML350 with 2 quad-core Intel Xeon processors, 32 GB of RAM memory and 1.5 TB of hard disk space. This server was used with Microsoft Windows server 2008 and Hyper-V to create about 10 Virtual machines with myriad of operating systems and application software packages and software development tools used on the three courses mentioned above. These courses were selected in the grant application phase, to modernize and bring them to the most advanced teaching and lecture design standards.

The view of the HP lab (that was named after the Donor), is shown in the following figure 2.1 which displays how the HP tablets are distributed on the tables. In the rear of the Lab HP Designjet 130gp printer/plotter was installed together with the mobile cart in which the tablets are held while not used. This mobile cart unit houses ethernet switch and HP wireless access point so that all tablet PCs have wireless connections to Internet and mentioned HP Server with virtual machines for cloud computing and access to large application programs and programming tools that have not been installed on tablet PCs themselves, due to the heavy demand on memory size and processing speed.

Also, while in the mobile cart, all tablets are connected to power supply, so when taken out for lab exercises, they are fully charged and ready for 3 hours autonomous operation.



Figure 2.1 View on HP Lab with PC tablets and mobile cart

Tablet PCs in HP lab are complemented with 80" Smart interactive whiteboard which is touch sensitive and allows for hand writing as well. Smart interactive board is used for presentations and lecturing or tutorials accompanying lab exercises and is mimicking on the large scale those interactive capabilities of HP Tablet PCs. The view over the smart board is shown in the following figure 2.2



Figure 2.2 Touch sensitive and interactive Smart board in HP Lab

The original operating system on the tablet PCs as delivered, was tablet version of Microsoft Windows XP professional, but recently, with release of the Windows 7, was replaced with the tablet version of this latest operating system, that proved to be beneficial.

Since the HP Tablet PCs model 2710p delivered to us as part of the HP grant, were equipped with only 1 GB of RAM memory, we have increased memory capacity to 3 GB adding one more memory stick of 2 GB. This was necessary since many programs installed for the lab exercises were quite heavy (like Matlab suite for Modelling and Simulation course, AutoCAD and Pro Engineer for CAD/CAM engineering, 3D Studio Max for course in Numeric Graphics and animation).

When even this has not prove efficient, we decided to add to the HP Lab above mentioned powerful HP Server with Hyper-V virtual engine and have created about

dozen virtual machines hosting all these heavy application programs used for lab exercises and project and seminars on the three courses. The migration to "cloud computing" has proved to be very efficient way of solving the limited computing capabilities of the HP Tablet PCs, and in many cases the issues of the number of licenses available for many application programs used in lab exercises and project and seminar design assignments, since we replaced license "per seat" model with "per server" model which was much cheaper to implement.

Finally, although not part of the HP grant or the additional equipment bought for the cash part of the grant, we have to mention the implementation and utilization of Wimba classroom Ver. 6 collaboration software which has proved to be perfect companion to HP Lab and its Tablet PCs.

Interactivity and mobility of the Tablet PCs accompanied by the interactivity of Smart interactive 80" board and Wimba collaborative and learning software, produced incredible synergy effects and made the lectures and lab exercises truly joyful experience both for in-classroom and distance learners attending the three courses.

The organization of the work in HP Lab was done in such way that each student attending the lab exercise was always issued with the same serial number of the Tablet PC, assuring on this way that they could get to the same programming and files organization environment, as well as keeping track on the tablet status.

The students were holding all their projects and personal files, for each application they used on tablet PC, on the Faculty file server where they had their folders linked as local drives to the tablet PCs.

In this way we have assured that their personal files were protected from accidental delete or change, as well as enabling them to access these personal folders on File Server from anywhere and anyplace when working on the projects and assignments outside HP Lab.

3. Course in Modelling and simulation

Course under this title existed in the ante Bologna curriculum and was revised and included in Bachelor study program at the Department of Automatic control and electronics.

Course code is ETF AEO MS 2460 and teaches mathematical methods based on physical phenomena and laws in order to derive mathematical models that describe modeled system behavior. Simulation part than includes the utilization of the derived models on various computer simulation packages like Matlab Simulink to analyze dynamical characteristics of the modeled system and than for synthesis of control system superimposed on the model.

Number of Students: 52 Students enrolled

Staff Contact:

Full time Professor: Adnan Salihbegovic, PhD
Teaching assistant: Omer Tanovic, BscEE

Implementation

Modeling and simulation course is very intensive in making use of computers especially in the part of simulation, since it is nowadays always done on some of digital computer based simulation programs like Matlab Simulink being the most popular one.

So, this course is no exception and all of the lab exercises were organized in the HP lab with HP tablets having Matlab and Simulink installed.

Due to CPU processing speed and memory capacity limitations, we have also installed Matlab suite with Simulink program on one of the virtual machines on HP Server, so the students in HP lab used Tablet PCs in the role of remote terminal to access and control Simulink program execution running in the cloud on virtual machine.

The interactivity of the tablet PC was beneficial and appreciated by the students, since most of them learned very quickly to use pen instead of mouse for command and data entry, and were running and analyzing their simulations with ease.

Since on the course students learn Matlab and Simulink program for the first time, touch screen interactive 80" Smart board was of great advantage. Working in Simulink students build models by dragging and dropping blocks from the library browser onto the graphical editor and connecting them with lines that establish mathematical relationships between the blocks. This is completely new approach for the majority of

the students, since majority of them haven't used any of these kinds of programs in the past. With the above mentioned smart board, teacher was able to demonstrate on the smart board drag and drop way of graphical programming they have replicate on Tablet PCs with pen, without moving to each student and demonstrating it on their Tablet PC. Hence, important advantage of pen over mouse for the Simulink drag and drop block modeling was demonstrated with ease.

The true value and strength of the Tablet PC capabilities shines when used for running and controlling online physical laboratories built as small pilot plants controlled by computer programs and monitored with web enabled human-machine interface software.

These Internet and intranet based and accessible online laboratories, are used as physical equivalent of the model of the plant in order to analyze the quality of the derived mathematical models comparing the output data from the model with the ones acquired from the pilot plant.

Furthermore, these online labs are also excellent testing site for the students to get the feeling and sense of the dynamics and system behavior when various input commands and changes in parameter values are applied on the plant model.

The following figure 3.1 illustrates such an exercise where the students are with Tablet PCs monitoring and controlling one such pilot plant, and observing its responses and plant dynamics behavior.

It is obvious that this setup can be used not only in course teaching modeling and simulation but in plethora of other software related courses on human-machine interface design, web based applications and many more.



Figure 3.1 Students with Tablet PCs are controlling Internet and Intranet enabled pilot plant

From the student quiz replies the impact on student learning with new technology was assessed with the mark 3 , while impact on teaching was assessed with 3 as well.

4. Course in CAD/CAM Engineering

The course was introduced for the first time on the second year of Bachelor Study program at Computing and Informatics Department , so it was from the very beginning relying on the HP tablet PC technology to define the curriculum structure including lectures and lab training exercises

Course code is ETF RII CCI 2445 and the goal of this module is to provide basic knowledge and skills in methods, techniques and software tools for computer supported drawing, designing and production. Presented are software suites like AUTOCAD, SOLIDWORKS, PRO ENGINEER as representative in software family for CAD/CAM/CAE design chain activities in modern industrial production. The focal point of the course is on programming languages behind all these software packages from the point of view of software engineer who is helping to develop all these software tools

Number of Students: 16 Students enrolled

Staff Contact:

Full time Professor: Adnan Salihbegovic, PhD

Teaching assistant: Ingmar Besic, BscEE, MsEE

Implementation

As in case of Modeling and Simulation course, the course on CAD/CAM engineering is also very intensive in making use of computers, since all is about computer based design and manufacturing including drawing, conceptual design, virtual prototyping and virtual engineering and production modeling.

Here again, due to HP Tablet PCs CPU processing speed and memory capacity limitations, apart from AUTOCAD and AUTOSKETCH which were installed on each Tablet PC, we have installed all other software programs used on the course on one of virtual machines on HP Server. To access and work with these programs the students in HP lab used Tablet PCs in the role of remote terminals controlling program execution running in the cloud on virtual machine.

The main requirements on PCs used in connection with CAD/CAM software when working with these software packages, are on their graphic engine, the size of the screen and interactivity and capabilities of the input devices.

Although tablet PCs do not excel in respect of resolution and speed of graphic controller, neither in the size of the screen, the pen and handwriting and sketching capabilities are of the utmost importance and advantage when working with these software packages, as is seen on the following figure 4.1



Figure 4.1 : Student working with tablet PC with one of graphic design package

This is particularly advantageous when working with Autodesk AutoSketch software package as well as myriad of 3D viewers like Corona for VRML programs, AUTOCAD viewer and universal SOLIDWORKS eDrawings 3D viewer.

The navigation and animation capabilities with 3D objects on the scene can only be fully exploited and utilized when working with interactive input device like pen of Tablet PC, and only new generation of 3D mice can match that experience.

In the context of this interactivity and manoeuvrability of pen as input device so important with 3D viewers mentioned above, the touch screen interactive 80" Smart board proved invaluable demonstration tool, since the teacher could demonstrate to students how to navigate and manipulate with 3D objects on the scene without going to individual student and demonstrating them on their Tablet PCs.

From the student quiz replies the impact on student learning with new technology was assessed with the mark 4, while impact on teaching was assessed with 4 as well.

5. Course in Numeric Graphics and Animation

This course was introduced for the first time on the first year of Masters Study at Computing and Informatics Department , so it was from the very beginning relying on the HP tablet PC technology to define the curriculum structure including lectures, lab training exercises and field work.

Course code is ETF RII NGA 4855 and teaches advanced computer graphics, such as OpenGL programming, advanced techniques of 3D modeling, illuminations, mapping and 3D animation, laser scanning techniques and visual perception.

Number of Students: 38 Students enrolled

Staff Contact:

Assistant Professor: Selma Rizvić, PhD
Teaching assistant: Aida Sadžak, BscEE
Student helper: Goran Radošević

Implementation

At the beginning of the semester each of the students in the Numeric Graphics and Animation course was allocated with specific HP Tablet PC tied to its serial number, within the HP tablet PC lab that was equipped with donated equipment.

In order to introduce the students to Tablet PCs, one day training devoted to using of the Tablet PCs for drawing, painting, taking the notes and generally working with the pen was organized. Students took notes for the class on a Tablet PC using *Windows Journal*. They were also allowed to play the Tablet-PC-specific games since learning through games was seen as very efficient form of practicing with using a pen.

At the end of this one-day training, students reported that using of the pen was “time-saving”, since it makes taking the notes faster and documents and information more accessible. Without exception, students felt enjoyable and comfortable using the Tablet PCs. During the rest of the course students were supported to complete the vast majority of the semester classroom work on it.

Students generally felt that it was better to learn with Tablet PCs than to learn without them. For them learning with Tablet PCs was more fun. They felt that they worked faster and that the quality of their work was better when using Tablet PCs. They also appreciated having a wireless access to Internet, provided within the HP lab with donated WAP router installed in metal cabinet housing the tablets

The two main examples of how we have integrated Tablet PCs classroom throughout the course curriculum are described in the two following projects:

5.1 Image based modeling using Photomodeler software

Photogrammetry or image based modeling is creating 3D models out of digital photographs using specific software tools. It differs from traditional graphics in that both the geometry and appearance of the scene are derived from real photographs by only referencing them. This modeling technique offers shorter modeling time, faster rendering speed, and significant level of photorealism.

To perform this process a third-party application is needed. Although various software packages are available we gave preference to PhotoModeler software package available from the Eos Systems Inc. group (<http://www.photomodeler.com>).

Students were demanded to create 3D models of Stecaks (Bosnian gravestones), which are now located in the National Museum of Bosnia and Herzegovina, by using image based modeling. Project consisted of the following phases:

- Photographing the real-world Stecaks from multiple angles
- Importing and balancing the digital photos using Photomodeler software
- Calibrating the images
- Building geometric shapes based on the imported images
- Applying the digital images as textures
- Exporting the model of Stecak to 3D Studio Max for further adjusting of model

PhotoModeler's result depends heavily on the nature and quality of the photography used for measurement. However, the process of measurement is never perfect. If PhotoModeler has incorrect data on camera positions or orientations, it will generate an incorrect position for the 3D point. This means that process of taking the photographs may have to be repeated if the measurement was not accurate.

With previous desktop or standard laptop PCs in the computer labs, field visits with the computer equipment were not possible while teaching the image based modeling techniques. The students in the courses like this one have always been working in the field carrying various on spot activities like taking measures, photos and visuals and then bringing them to the lab to continue working with various photo and image modeling tools. The Tablet mobility has enabled students to work with their models directly comparing digital model of Stecak to the same real-world Stecak. This was extremely time-saving since when using HP Tablet PCs for this purpose, they were able

to improve their work by adjusting of the 3D model according to the original object in the field (see Figure 5.1). They were able to calibrate taken photographs on the spot, correct the measurements and take new photographs if it was needed, right “on site”.

Final result of this project was an interactive digital catalogue of Stecaks in the form of schematic description of the exhibitions. Figure 5.2 shows an example of modeled 3D Stecak.



Figure 5.1 Students are comparing the 3D model on the HP Tablet PC with the original object on the site



Figure 5.2 3D model of Stecak modelled by one of the student. It can be explored in 3D space by using the adequate player

The field visits as part of course assignments, aimed to improve the teaching and learning methods in the Numeric Graphics and Animation Course, using HP Tablet PCs and mobility associated with them, made the process of heritage digitalization on the original sites possible and very efficient way of visual data acquisition and collection.

5.2. Creating the storyboard for computer animation project

Storyboarding is one of the most important phases in the process of creating computer animation. Storyboard is a set of sketches of the key moments in the animation sequence. In this project students were asked to create a storyboard for their final animation project using Autodesk Sketchbook Pro software, which is itself designed for use with tablet PCs or digitized pen tablets.

Advantage of using HP Tablet PCs in this project was obvious from the very start, as the project would be very difficult to accomplish using standard input device like mouse.

Before HP tablets were available the students were drawing storyboards using classic technique of pen and paper. Storyboarding with Tablet PCs has gone a significant step further over traditional storyboarding using the paper.

Like in the case with traditional storyboarding, with HP tablet PC and Sketchbook pro software package is still possible to change the pen into different brushes for drawing, pencils, paintbrushes, and markers.

Furthermore, pen can be an airbrush tool, pens and felt tip markers, and a chisel tip pen. All brushes can draw in any colour, and the sizes of the tips are adjustable.

Advantages of storyboarding with tablet PCs are numerous. Today storyboard has become digital document with multimedia content and experience – it may be accompanied with the sounds, images, text, videos. There is also possibility to sketch in layers which enable designer to explore design iterations with layer after layer just like on translucent paper, but without unnecessary repeating drawing with previous layer's elements. One more advantage over the traditional storyboarding is dynamic symmetric drawing, the technique which has capability of mirroring strokes on a horizontal, vertical or simultaneous horizontal-vertical axis.

Students generally enjoyed using HP Tablet PCs for drawing and painting while preparing they storyboard projects. Using the pressure-sensitive pen helped them improve their artwork, and some reported that they felt that their handwriting and drawing skills had improved as result of using pen, and open their mind to new artistic possibilities.

Storyboard for A. Pehratović's final animation, page 1

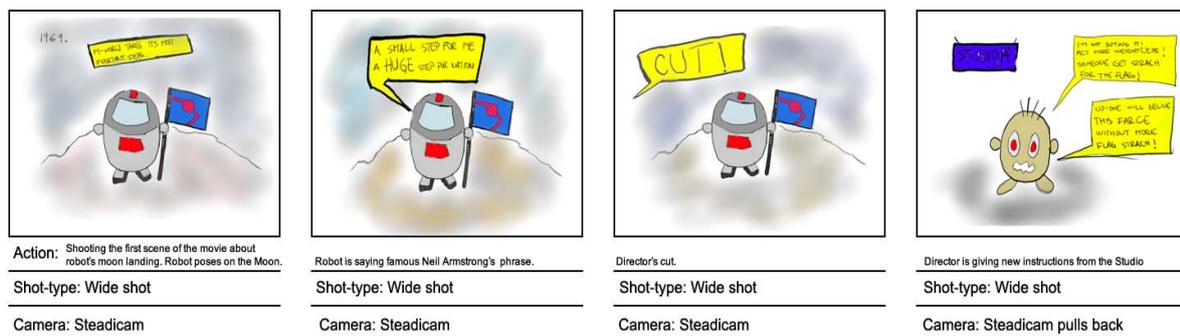


Figure 5.3: An example of storyboard's page made by one of the students

From the students quiz replies the impact on student learning with new technology was assesed with the mark 3 , while impact on teaching was assesed with 4.

6. Summary

In the three courses implemented in one semester since HP Tablet PC technology was introduced in their syllabi , it has proved its superiority over standard desktop and laptop environment used to organize and deliver the lectures and lab exercises and projects assignments.

In the Modelling and Simulation course, the most remarkable advantage was achieved in using HP Tablet PCs mobility and pen writing and selecting capabilities for on the site monitoring and control of the pilot plants and test stands connected to Intranet and Internet as interactive labs.

In the course of CAD/CAM engineering, it was its pen input device enabling easy navigation and manipulation with 3D objects as well as hand sketching of the objects that are converted into geometric shapes by the rapid design software routines, enhancing and speeding drawing and designing work.

The third course Numeric graphics and animation in which HP Tablet PCs were introduced, although to some extent lacking resolution and the size of the screen, was great in the field exercises when students took tablets to the location of the historic sites where they had the objects assigned to them to model and catalogue them as part of cultural heritage acquisition and presentation project.

Second to this was the case with storyboarding, when HP tablet PC and Sketchbook pro software package were used for storyboard creation and animation projects. Students preferred tablet PC with pen, to desktop PC with mouse, when using various tools like pencils, paintbrushes, markers and erasers when creating and animating their stories.

The experience gained so far, after using HP Tablet PCs complemented with other technologies introduced in HP Lab like HP Server for heavy applications to be accessed and used in cloud connected over wireless network and large 80" Smart interactive board mimicking tablet PC capabilities as touch screen device, shall be used to further advance the level of this technology penetration in the three courses devising new lab works and exercises that shall make use of this technology further, and spread it to other courses that are waiting on these results before start to use the same technology in their classroom implementation.