

# M-Learning with Remotely Operated Laboratories

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## Abstract

*Mobile devices such as notebooks and PDA's are very interesting tools for web-based teaching and distant teaching today. By the development of wireless communication networks like portable mobile phone networks (GSM, GPRS, UMTS) and local wireless networks (WLAN), electronic teaching material can be accessed from any location. Providing students with html, pdf or WAP static text based learning material for mobile learning (m-learning) is state of the art. Solutions like PDF viewers and browsers like PocketIE, Opera, Netfront and Minimo are able to render text in a useful way on the limited screen sizes of today's PDA and smartphones. To support active, non static, multimedia, Virtual Reality or streaming content much more effort is necessary. web based remote laboratory environments have been adapted to mobile devices like PDAs and smartphones.*

## 1. Introduction

Mobile devices such as notebooks and PDA's are very interesting tools for web-based teaching and distant teaching today. By the development of wireless communication networks like portable mobile phone networks (GSM, GPRS, UMTS) and local wireless networks (WLAN), electronic teaching material can be accessed from any location.

Since the typical students of distant teaching universities are professionals, mobile learning will give them the opportunity to effectively use also small amounts of spare time.

In particular the rising offer of campus WLAN's context based studying becomes 'on demand learning'. As an example a mobile user is able to do a quick search in an online encyclopedia to discover informations about a building. Beyond the university based teaching a need for lifelong learning exists. Today acquired skills must constantly be extended and updated. In this context mobile learning can point out a rational way.

Providing students with html, pdf or WAP static text based learning material for mobile learning (m-learning) is state of the art. Solutions like PDF viewers and browsers like PocketIE, Opera, Netfront and Minimo are able to render text in a useful way on the limited screen sizes of today's PDA and smartphones. To support active, non static, multimedia, Virtual Reality or streaming content much more effort is necessary.

## 2. Online experiments

To avoid travel cost and time for the students of the electrical engineering faculty of the distant teaching university in Hagen (Germany) various web based online experiments were developed since 1999.



Fig.1. Pioneer 3 AT robot controlled by smartphone

To provide our student with a mobile learning solution two web-based remote laboratory environments have

been adapted to mobile devices like PDAs and smartphones.

- An omnidirectional mobile robot platform:  
Students task is to adapt parameters off the underlying motor control. The complete AWT based experimentation GUI for PC environment can be reused on PDA's and smartphones. The mobile robot moves on preplanned paths (fig. 2)
- A web controlled Pioneer 3 AT mobile robot:  
A robot remote control application which demonstrate the features of the robot (fig. 1)



Fig.2. Omnidirectional mobile robot platform, GUI, experiment

Today's PDAs have displays with up to 640x480 pixels resolution, which is enough to monitor our experiments. To realize a remote control to our experiments active components in a web based environment are required. A Java based server system together with Java applets embedded in web pages on the client side are used. To convert the existing solution to PDA's and smartphones Java supported devices are deployed.

### 3. Java on mobile devices

The modified client Java applets are running on a 'Personaljava' virtual machine. 'Personaljava' is a Java runtime environment for mobile devices with limited resources. The newer and better known J2ME standard is divided in different profiles and configurations. The Mobile Information Device Profile (MIDP) in combination with the Connected Limited Device Configuration (CLDC) is implemented on most of today's mobile phones. The J2ME (CLDC) application environment (MIDlets) does not allow a seamless

integration of streaming clients with an MIDlet user interface (GUI).

Different to J2ME (CLDC) the J2ME Connected Device Configuration (CDC) and its predecessor 'Personaljava' are providing the full AWT (Abstract Window Toolkit) API.

Like on standard PC's 'Personaljava' allows an integration of a Java virtual machine into the web browser of a mobile device. Implementations of 'Personaljava' are available for Windows CE, Linux, Palm and Symbian OS

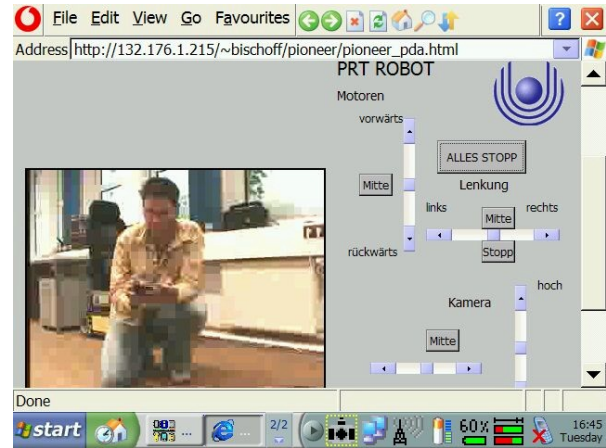


Fig. 3. Web and Java AWT based GUI on a smartphone (640x480 pixel)

based PDA and mobile phone platforms.

### 4. Video streaming on mobile devices

Our favorite streaming solution (SUN's Java Media Framework JMF) is not available on mobile platforms. As an alternative for mobile users a MPEG4 based video stream, generated by the Linux based ffmpeg/ffserver [1] solution is provided. The Microsoft ASF streaming format



Figure 4: MPEG4 video stream on a Windows Mobile 2003 smartphone

is used as container. ASF was natively supported by PocketPC variants (PocketPC 2002, Windows Mobile 2003, Windows CE NET). On Windows CE based PDA's and smartphones the ASF/MPEG4 stream is embedded in a web page with an ActiveX control.

Since not all implementations of PocketPC are supporting an ActiveX control integration to a web page and ActiveX is not available at all on other platforms an alternative solution was chosen.

On typical PDA's the Java virtual machine (JVM) is not fast enough to decode MPEG4 in real time. But with the help of the open source 'kuttpech' applet [2] it is possible to decode up to 3 frames of a MPEG1 video stream on a PDA (fig. 5). For Linux based PDA's the VideoLan player is an alternative to display MPEG4 content.



Figure 5: Pioneer robot remote control applet with kuttpech video stream on a PocketPC

## 5. Conclusion and future work

The computation power of today's PDA's and smartphones is high enough to realize a convenient web based environment for mobile online experimentation. Screen resolutions of 640x480 pixel are sufficient to integrate remote control applets and a video stream into a single webpage.

Future work will cover an evaluation of the introduces environment in everyday use.

## 6. References

[1] <http://ffmpeg.sourceforge.net/>

[2] Ron Breukelaar. Kuttpech MPEG-player Homepage. <http://kuttpech.sourceforge.net/>, 2002.

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