Report on the transfer of the smart planets scenario to a science centre in Sweden, embedment into the astronomy scenario of COLDEX and educational ideas for the usage of RFID technology

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Summer workshop

13. – 18. June 2005

The idea for our visit in Växjö is to show the use and application of the RFID technology. This includes two parts:

We will elaborate the concept for workshops with students for the astronomy scenario, embedding the smart planets plug-in for Cool Modes [Jansen, 2005]. The transfer includes the following:

- Setup and installation in the science centre
- Discussion of the concept to integrate not only the smart objects, but also the CRATER simulation in the astronomy scenario
- Invited users can work on the astronomy scenario at the end of the week

Setup

The smart planets scenario has been developed in a university project in the Applied Computer Science [Eisen, 2004]; its setup in the Xperiment Huset in Växjö has been done in the following manner. First we installed the software, a *smart planets board application* (former called the *PadPC* in the project report) and a *smart planets version of Cool Modes*. The smart planets board application makes use of the RFID tag scanner in order to either identify or determine the parameters of a physical model of a planet. These physical objects, so far implemented as polystyrene (styrofoam) balls, are meant to be light-weight enough not to cause events permanently, but weight-focussed enough to cause a sharp position of the polystyrene planet.

The Cool Modes version with the smart planets plugin is needed to run the simulation of the planets' movements – heliocentric, geocentric or dealing with the (simplified) three-body problem [Wikipedia, 2005].

Figure 1 Polystyrene balls: our minimum size and the base for a stable stand

At the same time as the software installations, we constructed the polystyrene balls, i.e. we got four balls with a diameter of 11 cm, cutted them into two halves, removed somewhat of the polystyrene in order to get space for the RFID tags, put a tag in each ball and again stuck together the halves. Make sure that the tag you put inside is a working one, not all in the RFID kit will work. Attention: the tags must not be folded – in no case!

To get a stable stand, we added a base of packaging material; we also tested it with a base made of the bottom of a paper cup which works fine. After the preparation of the physical planet models made of polystyrene we connected the board to a computer. This is necessary for the transfer of the positions to the software simulation.

Figure 2 RFID tag inside

How to start

First, unzip the Smart Planets.zip which contains two .bat files, i.e. Smart-Planets CoolModes.bat and Smart-Planets BoardApplication.bat.

- double click `Smart-Planets CoolModes.bat` (the default folder is C:\Program\smart planets\collide.coolmodes\)
- open a workspace
- add the smart planets plug-in
- start the server (menu "Cooperation" > "New Session")
- start the `Smart-Planets BoardApplication.bat` in the same folder

In the dialogue box you can fill in the following parameters:

IP of the server (`localhost`[1])

Board [ ]

RFID [x]

Attention, the *Board* option is not usable, and to save the settings here is not working in this version. Just choose `OK` or `Cancel` in the dialogue.

Scan the planets (polystyrene balls) and detect in the BoardApplication which planets you have scanned. In case a planet is not defined, you are asked to do it (it is possible to reset the once defined planets). Re-naming of planets can be done using the Cool Modes application (Button "Write to tag").

Place the scanned ball on the board, now the planet appears in the simulation (PadPC – Smart-Planets BoardApplication), you can move the planet by dragging it (don't leave the board). If you put the ball off the board, the planet in the application disappears.
If something does not work properly, try to start the session again. Or, try to start the two applications again.

Programmers' session

Participants: Fredrik Alserin, Björn Eisen, Jonas Gustafsson, Marcelo Milrad, Maria Oelinger, Astrid Wichmann
Björn Eisen explains the RFID technology to the participants: Basic hardware and software coming with the RFID kit; new features implemented by himself. The RFID tags are writable, but the space for the text written on a tag is limited to 96 (97) characters. Ogata [Ogata, 2003] uses another type of tags, and Sugimoto [Sugimoto, 2000] works on the approach of a grid determined by little RFID

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[1] or `Andromeda` or whatever the name of the computer is on which you started the cooperation resp. session

scanners. Multiple scanners (resp. a multiplexer) can be used in one setting in order to extend the range. The RFID scanners comes with a CD with drivers and software. The manufacturer [Winckel, http://www.winckel.de/] provides a software which can be re-compiled and adapted. The cost function of readers and the costs of RFID tags depending on the frequency is shown in the following chart.
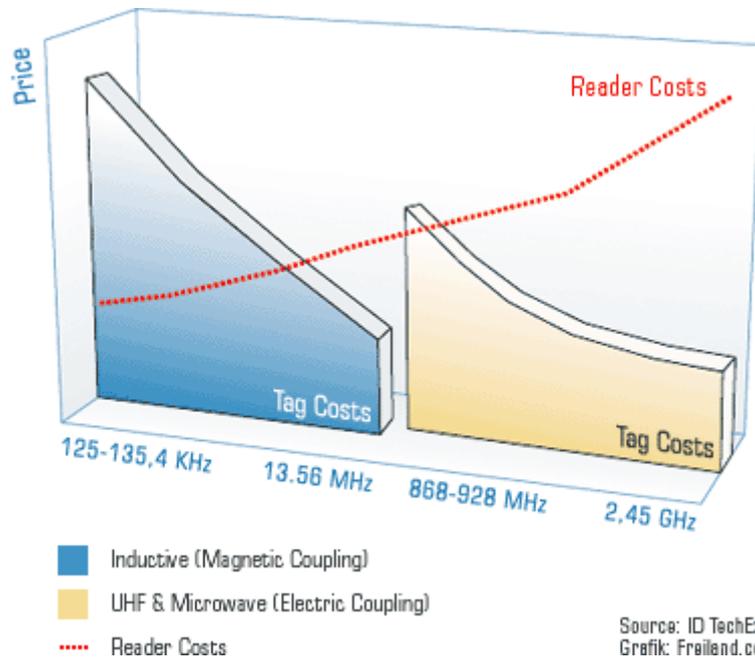

Figure 3 Costs of RFID hardware

Therefore, it is important to specify the concrete application before the hardware is bought. If you will need many tags, then a more expensive reader (RFID scanner) is feasable, and vice versa. It is not possible to protect particular RFID tags against reading and/or writing unless a special Crypto Tag, like the mifare-chip, is used. The Swedish programmers bring another idea for using RFID: IKEA is interested in letting customers build miniature kitchens in the stores, using blocks/bricks which represent refridgerator etc. Well, you have to identify the objects which can be done with RFID. However, for such an application – noticing the locations of many objects in a "room" – a lot of computers are required.

The smart planets scenario is presented to get the impression of the application. The code will be shown later. Cool Modes is explained to the programmers. The plug-in for the smart planets is opened. The connection between hands-on experience and computing is now exemplified with the two parts of the smart planets scenrio, on the one hand the physical polystyrene balls, on the other hand the simulation within Cool Modes. The physical part starts with an unknown object (a polystyrene ball with an RFID tag inside). The application notes this and gives feedback that is in unknown and the user can define it using Cool Modes as definition tool. Afterwards this planet can be identified by the scanner. The positioning on the board is transferred to Cool Modes. Input devices in this environment is on the one hand the scanner for identifying, the touch-sensitiv board for getting the position of the planet. It is possible to combine virtual planets defined and position within Cool Modes and new arising planets which are added using the physical touch on the board. The physical definition of an orbit can be given by hand gestures. There are also buttons marked on the board for physically control the simulation in the virtual environment. The PadPC is an application which can be connected via the MatchMaker to Cool Modes.

Educational ideas and astronomy scenario

Brainstorming

In this section, some possible applications of the RFID technology are listed. This is the result of discussions during the transfer stay in Sweden.

- Darts
- Students may take home their polystyrene spheres which they have used and designed during the workshop (works only if the spheres are empty and the tag can be removed easily)
- Students may wear RFID tags and enter the spaceship where a RFID scanner is installed at the entrance; thus the identity of each person can be seen not until she passes the entrance. Underlying idea: the functions of the students within the crew can not be determined, i.e. the captain can be a rather quiet and shy student which will not happen if they can choose their role themselves. Driving the space ship depends on having the right tag near (entrance / access control)
- Digital paper chase ("Schnitzeljagd")
- Emulate astronomical constellations: positioning of star models (again, polystyrene balls with tags) on the board, not only the pure positions, but the right stars in the correct locations in order to learn the names of the stars correctly; usage of the Cool Modes checker to get feedback if the constellation is correct (or where not)
- Role-playing: tags used as storage medium for life points etc.
- Access control for activating the space ship control: you need to have the right tag with you to start the control functionality
- Planet expedition: RFID scanners are used as in the science fiction programs (e.g. Star Trek scan devices), like hold the scanner near to a stone resp. mineral in order to identify if it is useful for the space ship (keyword: half-life period, consumption of resources)
- Warehouse management, e.g. for equipping the space ship
- FoodInSpace: information about the single plants, e.g. date of planting or sowing, species
- Extinguish fire: on a wall a fire is projected; a digital enriched fire extinguisher resp. water hose contains a scanner, the wall contains several RFID tags; if the scanner is near enough (and for a minimum duration) the fire is put out
- Collect the user's own experience collected during her visit in the museum and then uploading it to a web portal, using RFID technology and pocket PCs [Hsi, 2004]
- Connecting pocket PC applications: start of an application depending on the recognition of different RFID tags
- RFID tag as kind of entrance to contextual information, automatically connected to an upload mechanism to the LOR: upload of metadata enriched data of physical objects, added to images which are uploaded etc.

Educators' session

Participants: Björn Eisen, Katrin Lindwal l, Helene Öberg, Maria Oelinger, Jan Sjokvist

After explaining the hardware (i.e. the back-projective SmartBoard), the RFID demo software and the smart planets applications are introduced (see also the section how to start). There are three animation modes so far: geocentric, heliocentric, three-body-problem. The three-body-problem has to be elaborated if students should use it.

To work with the smart planets, you need computers connected via a network if you want to use them together in a MatchMaker session. If you just want to use one computer (e.g. a big projection on the wall like a common blackboard), you can use a single computer and the localhost for the MatchMaker server.

More brainstorming

- Tag a visitor and track what she is doing: give her a problem to solve and let her discover things in the exhibition, maybe also writing on the RFID tags with "collected" parameters
- Different levels of exhibition explanations depending on the previous knowledge, e.g. for different school grades
- Visitors leaving feedback at the exhibition; maybe answering a questions, maybe assess the exhibit
- Compare my experience in the exhibition with the experience of former visitors; collect the visitors' answers (depending also on age, previous knowledge etc.) in order to analyse and enhance the given exhibits. Visitors should get back a paper sheet with their results, also compared with the other visitors' results to take that paper sheet home

Parts of the astronomy scenario

Within the astronomy scenario of the COLDEX project, different parts are integrated. The following sections describe these scenarios.

Crater

Using the CRATER simulation – a web-based tool (www.geosim.org) enriched with VRML functionality – they have the possibility to set several parameters of the meteorite and the target ground, including the size, density and speed of the meteorite.

Figure 4 CRATER scenario
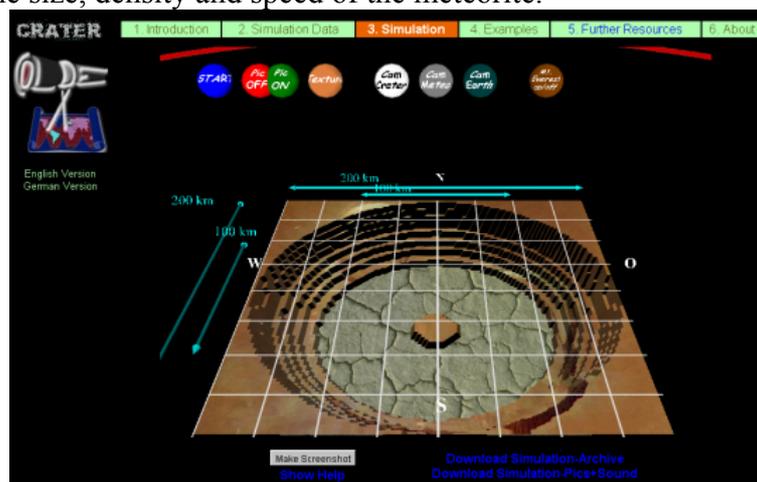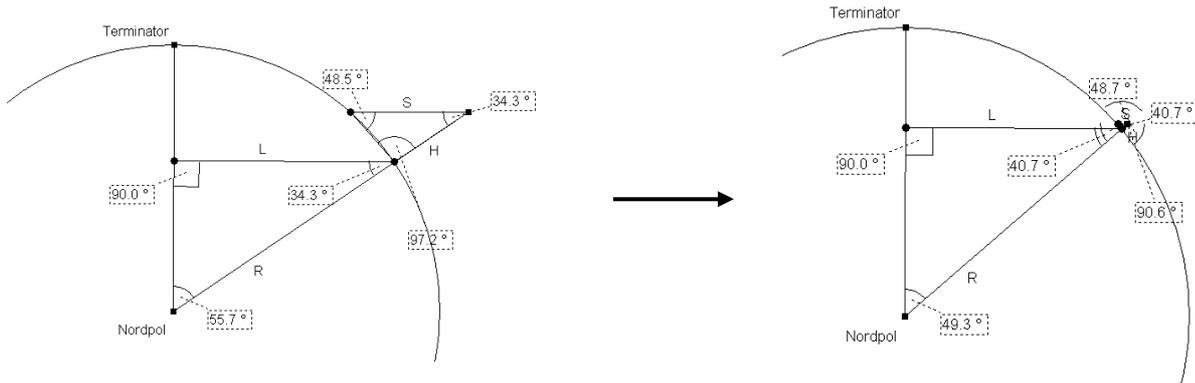
Meteorite impacts can not only occur on earth. Consequently, the simulation also allows simulations for other cosmic bodies and thus allows, for example, to see what happens if a meteorite collides with the moon and then to compare it with impacts on earth or planet Mars. The system dynamics plug-in of Cool Modes, finally, can be used to simulate the energy flow in a water rocket experiment.

Figure 5 Moon cartography tool

Via the LOR (Learning Object Repository) users can exchange different models like maze or moon models, simulations as compressed VRML archives or pictures (e.g. screen dumps of simulations, moon pictures) to explore different kinds of the astronomy scenario, e.g. meteorite impacts.

Smart Planets

The Cool Modes plug-in for the smart planets is another part of the astronomy scenario, like it is described in the first part of this report.

Moon cartography

This section explains how the moon cartography works. The moon cartography plug-in (containing lunar heights and general measuring of distances in images) is combined with the Calcad plug-in, a graphical representation of simple formulas, i.e. calculation nets. Here, the input of data is needed, an image, in the case of moon cartography one of the moon with visible terminator. You can also use it for measuring other lengths, e.g. the length of a leaf.

The moon plugin only has one type of node; the image node. A picture can be loaded into the node by pressing the browse button.

Once a picture has been loaded into the node it is resized adequately and shown within the node. Left-klicking into the picture produces a new layer with a new zoomed-in picture centered according to the pointer position. It is possible to switch between layers.

The Measure button is activated after a picture is loaded into the node. Once pressed the measurement procedure is started and will produce an calcad input node with the measured value (in pixel according to the original image).

Modelling process

Create an image node. Load a moon picture into it. Measure important distances for moon height calculation. Use the produced input nodes within calcad to calculate moon crater height.

Measure within the moon photo (in pixel)

D: Diameter of the moon => R: Radius of the moon (get R by dividing D by 2)

L: Distance crater edge to terminator

S: Shadow length of the crater

How to get the formula


It holds (almost):

$$\frac{L}{R} = \frac{H}{S}$$

Tasks

Simulation

1. Measure of values (using a moon picture):

   – S: Shadow length of the crater Eudoxus (see image file "mond2mitlabels.jpg")

   – L: Distance crater edge to terminator

   – D: Diameter of the moon => R: Radius of the moon (calculate R from D)

2. Connect the values to a calculation net to get the height of the crater.

3. Calculate the heights of Eudoxus, Aristoteles Plinius and Aristillus.

Moon view side- and upwards
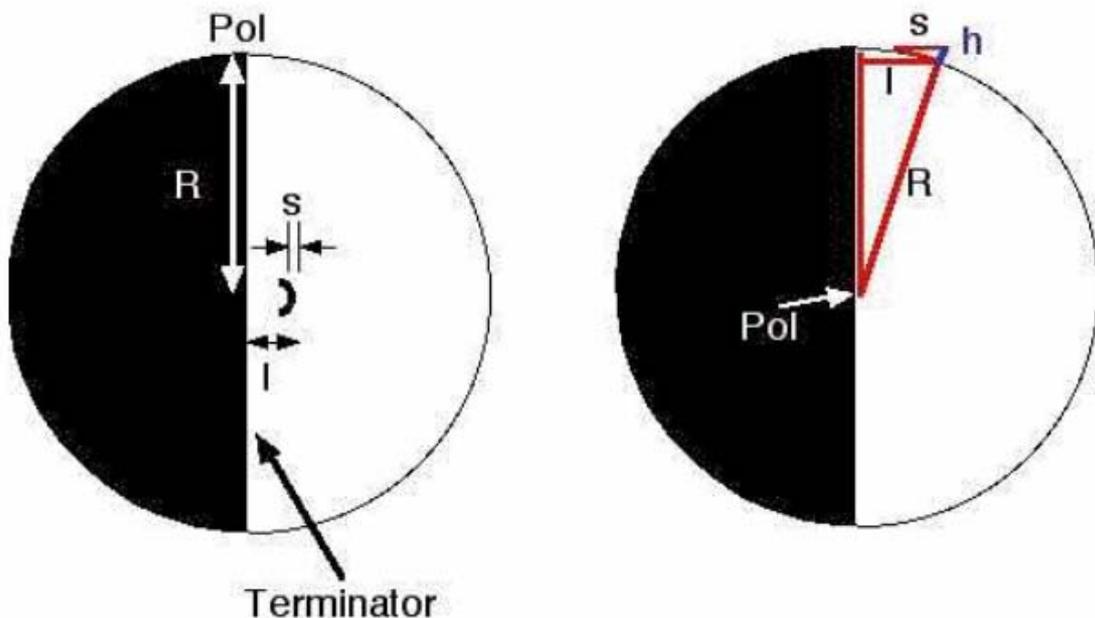
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