

The Sensitive Sample

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Abstract

This paper describes Sensitive Samples - everyday artifacts turned into tangible user interfaces, while preserving their original look. The solution presented is inexpensive and is built on fairly simple technology. The system supports multiple samples simultaneously. Sensitive Samples were tested at the Academy of Fine Arts in Vienna. Various objects, ranging from a simple paper cube up to complex architecture models were turned into sensitive samples. The technical realization and two application examples - The Control Cube and Materialkammer - are described in the paper. The Control Cube can be used to trigger six different actions. Materialkammer describes an inspirational learning environment where architecture students can get familiar with materials in an unconventional way.

1. Introduction

In the scope of the Atelier project [1] we collaborate with architects and architecture students. The main task of the project is to develop an inspiring learning environment for architecture and interaction design students. As part of the "Disappearing Computer Initiative" [4] the Atelier project develops alternative user interfaces. One of these developments is the *Sensitive Sample*. A Sensitive Sample is any object enriched with various sensors, that can sense the environment. Sensors are completely hidden inside the object, and the actual sensitive artifacts do not appear to be different from their non sensitive counterparts. We have experimented with various samples ranging from a simple paper cube to architecture models. The use of Sensitive Samples instead of traditional user interfaces was a new experience for the architecture students. We have developed an electronic device which supports various sensors. Tilt switches and touch sensors were mostly used. The idea of making a small device, which can be incorporated into real objects in order to make them a part of interface is not new. The SoapBox [9], SmartIts [5, 8], and Navigational Blocks [3]

are some well known examples. This paper describes a low-cost alternative, which supports arbitrary sensors and multiple samples simultaneously. Two application examples, "Control Cube" and "MaterialKammer" are described in this paper.

2. Fundamental Concepts

Tangible user interfaces are becoming more and more popular and important. Our experience shows that non-expert users, who are sometimes afraid of technology, find tangible interfaces less complicated and more user friendly. Descriptions of experiments with the students conducted during the Atelier project are described in [6] and are out of the scope of this paper. The main idea behind the Sensitive Samples is to make common artifacts, found in architecture studios or the office, become part of a computer interface. In order to fulfill this requirement, the electronic device has to be small enough to fit inside objects of various sizes. The electronic device should also support a wide range of sensors and simultaneous use of more than one device. The communication with the computer system has to be wireless, and in our case the device had to be inexpensive even in small production runs. Once the device is installed the artifacts can be used as input devices. Figure 1 illustrates a typical configuration.

2.1. Hardware

After roughly specifying the requirements and with a relatively small budget a micro-controller solution was chosen. The Atmel [2] micro-controllers were used. The printed circuit board is designed so that it has only the necessary electronics needed for the controller to function. There are connectors to all I/O ports of the micro-controller and a reset button. All additional sensors or signal LEDs are realized on separate modules and can be connected to the main board. The micro-controller can be easily programmed, and can communicate with a PC via a serial port. After successfully finishing the first board, various sensors were added.

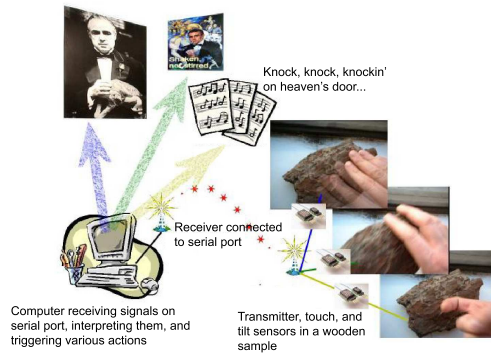


Figure 1. A typical configuration of the system using sensitive samples.

Tilt switches and touch sensors were the mostly often used kinds of sensors. Tilt switches are a very simple piece of hardware that connects two wires depending on the inclination of the switch. This sensors can be used to estimate which side of the object is facing up, or to detect shaking of the object. Touch sensors provided by Quantum Research [7] have also been investigated and deployed in the samples. These sensors have to be mounted beneath an insulator and can sense if the object is being touched at the certain place. They can be built in various sizes, and can cover various areas of an object, and they are not visible from the outside, which makes them popular among the students, because the look of their model is not changed. Incorporating such sensors in the architecture model, and triggering various multimedia files during a presentation, just by touching the model, was a great fun for students and teachers. Figure 2 shows a model and touch sensors mounted underneath the model. Once the main board and the sensors are installed the communication between the sample and the PC has to be solved. A wireless communication was required, and support for more than one sensor simultaneously. A communication protocol on a time sharing principle was developed. There is a special module attached to a PC which is called server. Each sensitive sample has an unique ID, and acts as a client in the system. All clients and the server are equipped with radio transceivers. This is a device which can transmit and receives radio signals. Figure 3 shows the main board with the transceiver connected. The following protocol was defined:

- the server is in transmit mode and all clients are in receive mode
- the server sends the message "send status"
- the server switches to receive mode for a certain time
- the clients analyze the message, prepare the status, and then send an answer with a time-offset depending on ID, and

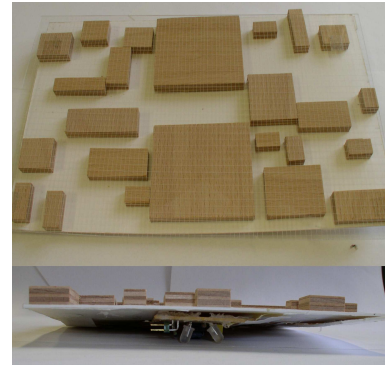


Figure 2. Architecture model with touch-sensors mounted underneath.

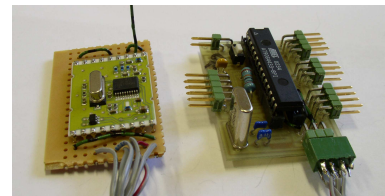


Figure 3. The main board with micro-controller and transceiver board connected.

switch back to receive mode

- the server collects all the stati and then sends them to the PC
- the server switches to transmit mode

This list is performed 20 times a second, this allows to support up to 10 clients simultaneously. The advantage of such protocol is that only one frequency can be used, and since every client has its own time slot depending on the ID, a collision can never occur. The server also knows which clients are active, and if some message did not reach the server, they will be sent again in the next cycle.

2.2. Applications

Two example applications - the ControlCube and Materialkammer - will be described in following section. The ControlCube is already realized, and has been used in experiments, Materialkammer is still under development.

ControlCube. The Control Cube is a simple cube, which can detect which side of the cube is facing up. Furthermore, the cube can be equipped with touch sensors and a RFID tag. The goal was to develop a tool, which can be used by students to trigger media playback, because the students often need to play various videos or still images during a presentation. As an alternative to powerpoint presentations, we have offered them to use the ControlCube. A

video or a still image is assigned to each cube side, and if the student turns the cube, the file which corresponds to the side facing up will be played. Since they wanted to use more than six videos in their presentations, we added RFID tags to each ControlCube. A tag reader is placed on the table (or even more readers, one for each projector), and the user can start a video simply by placing the cube to the specific tag-reader, with the desired cube side facing up. Such a way of triggering multimedia files is much more collaborative, and can be used in a multiuser setup easier than traditional interface. Figure 4 shows an example of a ControlCube made by the students.

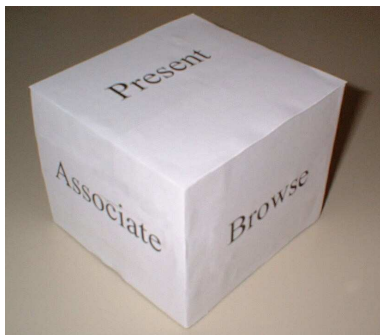


Figure 4. The ControlCube made by the students.

Sometimes students wanted to browse through their images and then select a certain image. For such a purpose we have build a cube with two touch sensors on one side. If the side with the sensors is facing up, the user can browse through the images by touching the places which correspond to previous and next. Once the user has found the image he/she wanted, the ControlCube is turned up-side down, the image can then be used by other applications in the system.

The ControlCube was realized using the board with the micro-controller described above and 3 tilt switches. The three switches are connected orthogonally, and placed inside the cube so that axis of the switches do not correspond to the cube axis. When a particular cube side is facing up, the three tilt switches will have a unique state.

MaterialKammer. The Materialkammer is work in progress where goals, concepts and technical issues are already solved. Since materials play a crucial role in architecture, it is very important for the students to explore and to get familiar with various materials and their qualities. Materialkammer is a room filled with material samples, which is supposed to be an inspiring and learning environment. Material samples are of various sizes and shapes. A concrete block has to be big and heavy, it's not something the user can take in his/her hands to play with it. On the other

hand a brick can be easily picked up and explored in a different manner. All samples are sensitive, and can sense various user actions. To enable the material samples to detect various actions, tilt and touch sensors are being installed inside the objects. Tilt switches are needed to detect user actions like shaking hard, shaking gentle and turning upside down. Touch sensors are used to recognize user actions like touching the object, stroking the object (more sensors are used here and responses from them can be interpreted as stroking in various directions and speeds) and knocking on the object. Figure 5 illustrates the actions that can be easily recognized by the Sensitive Sample.

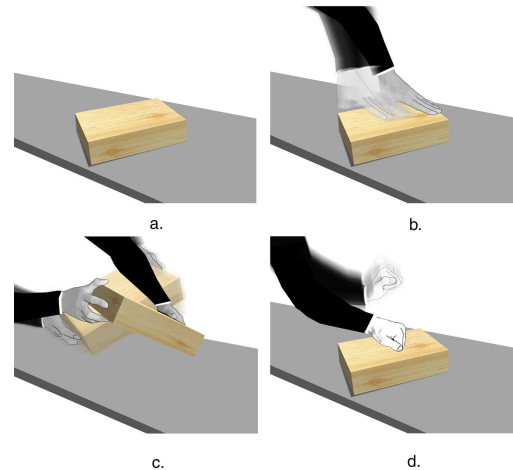


Figure 5. Some of the actions that can be sensed by sensitive sample.

The room is equipped with projectors, sound devices, fans, lighting equipment... The users enter the room and start exploring the materials. Depending on the way how the users interact with the samples, an atmosphere in the room is created. If someone plays with the wooden samples, and does it in a quite gentle and smooth way, an atmosphere of a wood in spring could be created. Another user shaking the wood samples more erratic can trigger a saw-mill like atmosphere. If the users play with different kinds of samples, like wood, bricks, glass,... completely different moods will be created. In order to make the whole room inspirational, and not predictable, a lot of parameters influence the choice of the presented materials. Videos, sounds, still images, but also wind coming from the fans and controlled lighting are used as output devices. Such a setup represents an unconventional way to explore materials. The connection between materials, actions and presented materials is not always clear to the users, and the surprising element that emerges plays an important role in the inspirational process. So, when users are interacting with the Sensitive Samples, the signals are sent to the main computer.

Actions are being interpreted there, and highlevel messages such as: shaking wood hard, or knocking on glass are being sent to a multimedia content selector. The multimedia content selector selects a media (in broader sense, where light and wind are media as well) depending on randomness level (surprise factor) and the users current and previous actions. Figure 6 illustrates the MaterialKammer components.

By interacting with the real material, feeling, smelling and seeing it, and getting additional inspiration from the medias presented by the system, the students are encouraged to reflect about the meaning of a specific material. This helps them to understand how the usage of this material influences their project.

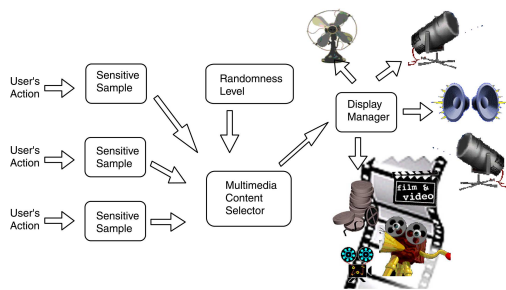


Figure 6. MaterialKammer components.

Another more conventional use of the samples would be to use them for texture selection. For example a wooden board can be used for wood texture selection. When a user takes the board a wooden texture is displayed. Now simple by touching the board on the right or left side the textures can be browsed. When the desired texture is found, the user knocks in the middle, and the texture is being exported to another application. In a scenario like this a stone would be used to select stone textures, a brick for brick textures, etc.

3. Future Work

As stated above the Materialkammer is not completely finished yet. For the setup to provide the above described functionality, two parts are crucial. First enough media must be collected and indexed to specify to which material the media is connected to. For example a picture of a saw-mill is connected to wood and steel. And second the multimedia content selector must be implemented so that the resulting medias are connected to the users actions in a meaningful way. The media displayed should not be totally random (which is quite easy to implement), but be related to the actions of the users. But on the other hand there should be a surprising element that encourage the users inspiration and reflection on the media that is being displayed.

Now, after the technical issues are solved, this is the biggest challenge. Our research will focus on the meaning

of user's actions. What does it mean when someone strokes a sample, or when someone knocks on it. Many social and cultural issues will certainly influence the meaning, and all of these should be taken into account.

4. Conclusion

This paper shows an alternative and inexpensive way of creating sensitive samples, i.e. real objects that can sense the environment. The design of the samples is modular, so that practically any kind of sensor can be attached to the main board. We have only experimented with two kind of sensors: tilt sensors and touch sensors. Even with such a reduced set of sensors, the ControlCube and the complex MaterialKammer application can be implemented. The ControlCube has been extensively used by the students to start various videos during the presentations, and MaterialKammer is still work in progress. But first mockups that were tested by the students, using a very simple media content selector and just one material sample, proved that the fundamental concept is highly appreciated.

5. Acknowledgements

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