IQube: a cube for learning

Nume Inventie: IQube: a cube for learning

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Microsoft Imagine Cup 2011, Embedded Development - calificare in semifinala

Scurta descriere a invenției:

We have conceived the IQube, to be a low cost and flexible hardware/software edutainment platform. Its flexible structure allows it to be reutilized for many years, decreasing the overall cost of implementing the solution. Also another crucial aspect is the user interface, our team concluded after research that the children must interact naturally with the educational device, without any forehand training. So we excluded classical PC interfaces such as mouse, keyboard, etc. and came up with the idea of creating cube shaped devices.

There is no need for instructions how to use it. There are no special rules for how to play with it. It is simple, colored, plays different sounds and vibrates.

Hardware architecture

The IQube platform is based on a low-power microcontroller with wireless and infrared communication capabilities and several built-in sensors and actuators (e.g., an accelerometer and a vibrating motor). The hardware architecture of a single IQube has a 1.6' LCD on each side of the cube which is its defining feature, a buzzer for emitting sounds, a small vibrating motor and a RGB status led for indicating the status of that cube and position (relative to other cubes).

The user interacts with the cube by means of an accelerometer sensor. Each tilt and rotation of the IQube corresponds to a certain change in its state. Also, the position relative to other cubes is constantly monitored using internal infrared sensors. The cube's state and position is sent to an embedded central node (C.E.N.) via wireless communication. The central node then processes the information received and, depending on the displayed images and the cube's position, it will send other images, change the color of the cube, announce a game completion or failure, depending on the running app.

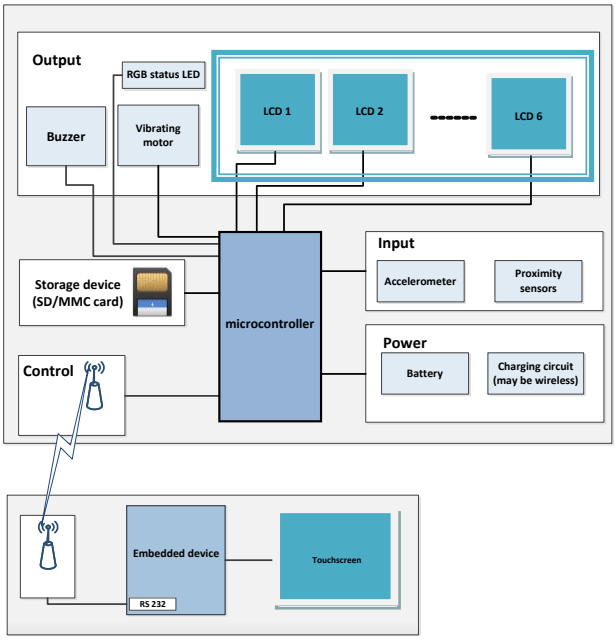

Figure 1: Hardware architecture

Transmission and reception of information is done using a wireless connection between the IQube and the C.E.N. One way of accomplishing this is by using an XBee wireless communication module. At the heart of the device lies a microcontroller which controls all above mentioned components. In addition, a storage component is added to store the received information and media (picture, sounds or animations) from the C.E.N. The power supply consists of a rechargeable battery which is recharged wireless using inductive coupling.

As mentioned above, all the cubes communicate to one another as an ad-hoc network communication, as well as with the C.E.N. The next figure (fig.2) shows one possibility of how this could be done.

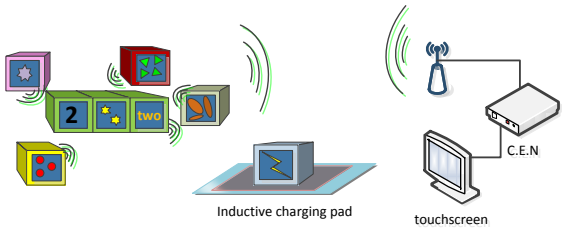

Figure 2: IQube operations

Software architecture

At the highest level of abstraction, the software system is divided into three major components:

A. The web component runs in Windows Azure and provides two features: (a) User Statistics and Game Development Kit is the web application where users can see the statistics about the progress of children – information like: the games they played, the results, the time spent on each game, etc. It also provides an easy way to use game development kit: a Silverlight application that allows users to create and publish games in the Games Store. (b) The online Game Store is an application where customers can buy/rent games that can be installed on the IQube.

B. CEN application allows teachers to create teaching programs by choosing the games that children are going to play.

C. IQube framework environment - each cube provides a game environment and allows loading different games on it. It uses a local storage system to store images and game logic.

IQUBE GAMES **GAME : NUMBERS, OBJECTS AND WORDS**

Goal: Match the numbers with words and pictures

Number of IQubes: 3

Description: The child must match correctly a mathematical number and certain images that contain the same number of objects and with the word that spells that particular number. If you rotate the first IQube forward or backwards the number increases or decreases. (Number are shown as a mathematical symbol from 1-10). If you rotate the second IQube in any direction images appear with random number of objects (From 1 to 10 objects per image). If you rotate the third IQube in any direction a word will appear that spell a specific number (From 1 to 10). After obtaining the matching number-image-word on the three IQubes the child must then join them for verifying the result. If ok – the cube turns green. If not ok – the cube turns red.

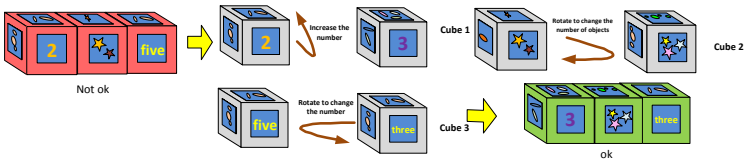

Figure 3 Game example

Team games:

Every child has an IQube. Each of them is able to modify a certain characteristic of an animal; the first child can modify the head, the second - torso, the third – legs, fourth – color, etc. After joining all the cubes, final result is sent back to the eBox and the teacher evaluates the result on the screen. Other team games may include puzzle games.

Current Implementation

Currently, this project is a work in progress. We have achieved much but there is still a lot of work to be done. We succeeded in building one cube with some of the desired features: It has all the LCD screens functional, capable of displaying images and videos, wireless communication and data transfer, and a LED-colored plastic case.

Figure 4: current hardware status

Because it is difficult to work with small electronic components inside the cube, we made a test-bench in order to help us advance faster with the work. In this way, we managed to work with an SD card to make image displaying on the screens faster and easier (rather than sending one image at a time through wireless communication). Also, we started working with an accelerometer sensor. The test bench allows us to experiment with different types of hardware in order to maximize the efficiency of the overall embedded system keeping it all at lower costs.

For the power supply, we used a small 3.7V battery which can currently keep functional the cube for about 3 hours. Also we experimented with inductive electricity transfer and managed to light a LED wirelessly at a distance of about 3cm using two simple LC circuits. Inductive energy transfer will be integrated into the cube in order to charge its battery. This way the cube is symmetrical on all of its sides, not requiring any power sockets, making it more appealing for children.