An Efficient User Interface for Education and Rural Development: The Featherweight Electronic Book

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Abstract

In this paper the work presented is a demonstration of innovation in technology for emerging trends in market. Here design and fundamental concepts behind development and deployment of smart electronic accessories is illustrated with an example of “smart electronic book”. The motivation and idea behind the approach is to create a new capability in the object without changing basic overall look and architecture with optimum computing. An eventual prototype of “featherweight electronic book” is developed at the end. The interaction with prototype is flexible in terms of content and the information which it can contain. Also the device is user friendly to illiterate adults and children who have very less knowledge and awareness about technology of modern age.

Invention of new technologies and techniques, making suggestions on policy are the central ideas here which lead the growth in emerging market and also to socio-economic development of poor and incapable communities worldwide.

1. Introduction

Today as the focus is on the welfare of worldwide community it’s very necessary to take the backward communities into account as well. Presently the vision of most of the developing countries is to become developed country by the end of this or next decade. One important reason behind the new trends and business opportunities in market is being the innovation in technology which drives the need of development and creates the healthy social environment. Development of smart devices and their deployment in fields has an important part in lifting the life levels. Also showing strong interest in improving quality of life through increased literacy and information is another good reason for following the world of digital manipulative.

Smart toys combine the better of the two worlds – traditional toys and the power of computers and electronic chips. Experts predict that almost every toy will be powered by interactive technology in near future [1]. Electronic Book is the one among few devices which can play an important role to surge the goal of rural education and development rapidly which is crucial for developing countries. The intuition and motivation behind developing such products like “Featherweight Electronics Book” is to provide a particular kind of awareness to the particular age group people. Cost effectiveness, High reliability and Easy availability are some of the Secondary goals which can assist this device to become a global accessory. Same time it should be also user friendly and should require a very less knowledge about how to operate such devices. As these products aims to the backward communities, children and illiterate adults who have a very little awareness about the external world. Less complexity in understating the interaction will provide an ample opportunity in success and popularity. There are numerous alternatives by which the same goal can be achieved. At the end we attempted to prototype an Electronic Book using embedded system techniques.

The main work done is to create the flexible content and technique by which it can be loaded to device over time so that after some point of time as user grows still it should be able to provide him some knowledge which is relevant for him. Section 2 speaks target users and potential customers whereas section 3 point out the differences between a general purpose computer and the smart devices. Section 4 explores the possibilities at block diagram level. In section 5 describes the eventual prototype developed and finally section 6 concludes the work with future directions and possible enhancements.
2. Application and target users

Researchers are now exploring ways of adding computational capabilities to everyday objects ranging from notepads and desktops to eyeglasses and shoes [2]. Two educational toy companies in the United States (LeapFrog and Fisher-Price) have electronic books on the market in which a paper book provides the visible interface and a pen or finger interface allows children to hear audio feedback from the book.

These devices fit some criteria for a rural education device perfectly – they don’t require literacy to use, they have extremely simple interfaces, they’re physically robust, and they’re inexpensive. They are very specifically for a particular age group of learners. Once the content embedded in book there is a very small authority to users to change it. This design is also an attempt to incorporate the possibility of changing and adding new content to the existing book through some external device like or a computer.

In a developing country where the average income level is very low, it’s hardly possible for a person to afford a general purpose computer. A user needs a lot of technical information to operate a General purpose computer. Complex user interaction is another problem to obtain a good familiarity and in use. Our goal in designing new “digital manipulative” is to make a new set of concepts salient for children. Our basic strategy is to embed computational and communications capabilities in traditional children’s toys.

3. Functional description and modeling

Electronic book is a device looking very similar to a regular book but equipped with some excellent capabilities also. Generally a typical Electronic book provides a simple text UI (user interface) to users which may contain awareness oriented information for a particular age group. For example alphabets, poems and stories for kids, health awareness for adults and women etc. Just below the text a efficient sensing mechanism is installed in such a way so that whenever users interact with the book (Interaction means touches the text written on Pad with fingers or some conducting device i.e. stylus based on Magnetic effect or capacitance changing) a signal goes to central Controlling unit (in this case microcontroller) which will determine the correct address of audio information stored related with the text in memory device attached with it with the help of data which was sent from sensing element array (generally touch pad but 4x4 keypad in this case).

4. Block diagram and components

The complete circuit of the design is as following.

Microcontroller:

Unlike a general-purpose computer, which also includes all of these components, a microcontroller is designed for a very specific task – to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production costs. A microcontroller is a computer-on-a-chip optimized to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor, the kind used in a PC. A typical microcontroller contains all the memory and I/O interfaces needed.
Multimedia Memory Card:

Multimedia Cards are one of the smallest Flash cards available, about the size of a postage stamp. A Multimedia Card (MMC) is a tiny memory card that uses flash memory to make storage portable among various devices. Multimedia Cards are much more rugged than traditional storage media. MMC features encryption capabilities for protected content, to ensure secure distribution of copyrighted material. High Speed SD and miniSD cards offer a combination of high storage capacity, great flexibility and security.

Touch panel:

Infrared touch panels are designed to fit most flat panel display technologies. The touch panels are a matrix of infrared diodes and detectors, scanning electronics, micro-processor controller, bezel/optical filter assembly and hardware to mount the touch panel and controller to the flat panel display. They have RS-232 interface through which it can send the coordinates as in where it is touched.

In the present design a touch sensitive panel has been replaced by a 4x4 keypad. This particular keypad is easily available and far cheaper than touch sensitive pad. It is also fruitful to learn the decoding techniques of mechanical switches by the use of microcontrollers. These kind of simple keypad consist of n by n keys with n column and n row connections. The popular ones are 4x4 and 8x8.

Audio Generation:

A sampled sound system may require low-pass filtering to remove the harsh, hissing sound of high-frequency switching transients caused by the transition from one sample to the next. As with a PWM output, a high sample rate makes filtering easier.

A simple RC circuit, fourth-order low pass filter and audio amplifier are used to convert the PWM signal into audio signal. The output sound quality is as good as an AM radio. The audio generation circuit consists of a RC circuit, four-order low pass filter, audio amplifier and speaker. The RC circuit and Low Pass Filter is used for harmonics and carrier frequency generated by PWM signals.

Figure 3: Schematic of complete system
5. Implementation: An Eventual Prototype

After considering a number of possibilities finally we decided the following components which are more advantageous than others in because of these reasons.

- Cheap
- Easily available
- Easy interfacing
- Easy programming for configuration

The constrained features of conventionally implementation Electronic Book by LeapFrog and Fisher-Price were one time programmability, fixed components, less and non accessible Memory for users, and difficulties and limited scope with new Content update. This simple and cost effective implementation of Featherweight Electronic Book is addressing and incorporating the solutions of various potential problems which have been noticed in similar products.

<table>
<thead>
<tr>
<th>Functional Block</th>
<th>Component/Part used</th>
<th>Cost / Part</th>
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<tbody>
<tr>
<td>Central controller</td>
<td>8-Bit RISC MCU</td>
<td>50/-</td>
</tr>
<tr>
<td>Storage Device</td>
<td>MMC Card (16MB)</td>
<td>150/-</td>
</tr>
<tr>
<td>Audio Generation</td>
<td>LP Op-Amp, R,C</td>
<td>20/-</td>
</tr>
<tr>
<td>Speaker</td>
<td>8-ohm Speaker</td>
<td>20/-</td>
</tr>
<tr>
<td>Touch PAD</td>
<td>4x4 Key Pad</td>
<td>20/-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>260 (INR)</strong></td>
<td></td>
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</tbody>
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Table 1: Typical implementation’s cost analysis

6. Conclusion

The constrained features of conventionally implementation Electronic Book by LeapFrog and Fisher-Price were One Time Programmability, Fixed Components, Less and Non Accessible Memory and difficulties and limited scope with new Content update. This simple and cost effective implementation of Featherweight Electronic Book is addressing and incorporating the solutions of various potential problems which have been noticed in similar products. The goal of content development and updating the Book with new content which was the central theme behind developing an Architecture using ATmega 8-Bit RISC Processor has been achieved fully and comprehensibly using MMC card which is compatible with PC and also with a Microcontroller like ATmega-162 using SPI mode of data transfer. PWM Signal Generation capability microcontroller has brought down the cost by skipping the use of DAC for audio generation. Generation of Audio analog wave from Pulse Width Modulated signal has been achieved by a 5th order Active low Pass filter which has been realized using Low power op-amps and Discrete components like resistors and capacitors. The Remarkable features of design are LOW POWER Consumption (working on 3.3 V), COMPACT Size of system and capability of SERIAL Interface through RS-232 Port with PC for Debugging Purpose whenever required. The quality of audio is as good as is AM radio.

7. Acknowledgment

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8. References