Senior Design Proposal
10/4/07

Dream Team

Introduction

Education is of paramount concern in society today. While homeworks, quizzes, and tests are effective means to measure learning, a real-time feedback system would offer another, possibly better, aid to the instructor. We propose a wireless classroom response system. To make the system more accessible to a wide range of students, our system will be based on open standards and open-source technology to reduce cost of the system. For the design, we must consider specific wireless and portable power technologies.

Problem Description

Each group of students learns at a different pace and responds positively to different teaching methods. Measuring student understanding allows an educator to tailor his or her own style to a particular group of students, improving the learning experience for everyone involved. In the typical classroom, this measuring is accomplished through periodic homework assignments and targeting single students with questions. Utilizing these methods exclusively, several lectures could pass before the teacher notices a gap in student understanding.

Currently available devices that attempt to fill this need are flawed in key areas. A commonly used solution, einstruction(tm)'s classroom performance system (CPS), suffers from slow response, non-rechargeable batteries, and an expensive recurring subscription fee. With this hole in the market, it is possible for a small engineering team to develop a cheap and effective product, allowing the teacher to modify each lecture in real time, no matter the size of the audience.

Proposed Solution

The finished system must have several essential components. The user devices must have a user interface that allows the student to enter the information that the teacher requests. It will then need to relay this information to the teacher in some efficient manner. To accomplish this, the device must have some communication link to a central base station that can process and present the data to the teacher. The system must also include a central base station that retrieves the data from the students. To accomplish this, the device must have a communication link between itself and each student's device. It must also have a user interface that allows the teacher to retrieve the information. This can be accomplished through a stand alone solution (i.e. one that is part of the base station) or through a connection to the computer the teacher is using for the lecture.

Demonstrated Features

We have decomposed our possible features into two catagories: primary features and secondary features. Primary features are expected in the final project, while secondary features will be included given sufficient time and resources.

Primary Features:
In class student response data collection, analysis, display
Wireless response unit to base station communication
Wired response unit to computer communication
Wired base station to computer communication
Rechargeable battery power source for response unit
Inexpensive response unit for medium-scale production

Secondary Features:
Microsoft PowerPoint(tm) integration

Available Technologies

The main requirement for the device is wireless communication. There are several available wireless standards. Some design considerations include: low power operation, wireless transeive range on the order of hundreds of feet, and low data rate. The wireless components should be readily available in medium-scale quantities for projects. Two possible technologies are ZigBee and Bluetooth. Both are based on well-defined standards with hardware support from several vendors. The choice of communication standard affects the entire system including the microcontroller, the power system, and the form factor.

The wireless nature of the device demands a mobile power source. While user-installed batteries are simple and shift cost to the consumer, it would be better to have a rechargable battery. Widely used rechargable batteries include: Nickel Cadium (NiCd), Lithium Ion (Li-ion), and Nickel Metal Hydride (NiMH). Options include weight, capacity, and ease of interface to the rest of the system. It could be possible to have a batteryless power source, such as EnOcean's solution (http://en.wikipedia.org/wiki/EnOcean).

Since the response unit is used heavily by a student, it should have an easy to use interface. This includes display and input modules. A display could be as simple as an LED, or as complex as a full LCD screen. While many options exist, important factors to consider for the display include cost, power draw, and reliability. Input should be intuitive, such as a keypad. A popular engineering choice is a matrix keypad, given its low cost and simple connection to a microcontroller.

Engineering Content

The first step is to break the problem down into functional blocks. The engineering then consists of defining the details of these blocks and how to interface between them. To start, the problem can be divided into two parts: individual user 'nodes' and a central base station. Both of these pieces require three major parts: a user interface, a communication link, and a controller. Both pieces will also need interfaces to a personal computer and a power supply.

Now we will look a little closer into each block. Starting with the node, we will look at the user interface (UI). The user interface must be easy to use and functional enough for this application. The UI needs two pieces, an input device and a display. The input device will need to be large enough to allow input of the information needed but as small as possible to limit the size of the overall form factor. The second block of the node is the controller. The controller will most likely consist of an embedded microcontroller. The engineering issue will be to pick a device with enough processing power and functionality to control and interface with the other pieces of the device. The third block, the communication link, will consist of a reliable form of communication that will allow many devices to be used in a single room. Finally, the node will need two other blocks: a power source and an interface to a personal computer. The power source must be reliable and as small as possible. It must be able to efficiently provide the necessary power for the device. The interface to the computer will provide a way for the device to connect to the outside world.

Now we will take a closer look at the base station. The communication link must match with communication link on the node device. The controller will again most likely be an embedded microcontroller. It must have sufficient processing power and functionality to handle the other components that will be a part of the base station. The UI for the base station will require a good deal of engineering. It must provide access to the information collected from the node devices. The user will also need control over data retrieval for "on-demand" use. The UI must also output the data in such a way that it will be useful in the context of classroom feedback. This will entail interfacing with particular computer applications to display the information to the teacher and/or students. Finally, the base station will need two other blocks: a power source and computer input/output (I/O). The power source must be reliable and efficient. The computer I/O will provide robustness to the device for connection to the outside world.

Conclusion

Because student feedback is essential for an instructor to pass information to the students as efficiently as possible, many traditional methods have been employed for many years. These include homework assignments and answering specific questions from students. The technology available today also makes another solution possible. Real-time feedback of student understanding can be accomplished through a student response system. While solutions do exist, they have several drawbacks that have prevented widespread use. Some of these problems include cost to the students and the classroom interface for the instructor. Our solution solves the problem of creating a viable, efficient student response system while also reducing student cost and leaving the system open to future development and improvement. Open-source solutions can keep cost to a minimum by making the solution open to the public. It can also be improved by others who have free access to all documentation and plans.