

# Design and Development of “ $\mu$ Meter” - An Innovative Bluetooth Application

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## **ABSTRACT**

*Bluetooth today, has conquered almost all mobile devices including Personal Digital Assistants (PDAs), handhelds, smart phones and mobile phones. Unlike the internet, where one has to rely on a third party to provide a wireless connection, Bluetooth is inexpensive and easily available with no dependence on manufacturers or service providers and can prove beneficial in short range communication. Aiming to inculcate wireless benefits in classrooms with virtually no expense and in an attempt to achieve more interactivity with students, a Bluetooth application “ $\mu$ Meter” is developed using Bluetooth technology to form a Wireless LAN in a classroom. . It helps to boost interactivity with students, thereby making classes more effective. In this paper, we first give a brief overview of Bluetooth technology and its applications. Details of the application development platform and Bluetooth requirements are then given. The results of the “ $\mu$ Meter” application are presented, followed by the conclusion and recommendations on future work.*

## **KEYWORDS**

*Bluetooth, lecture improvement, ubiquitous system,  $\mu$ Meter.*

## **1. INTRODUCTION**

Improving our teaching and learning process has been a topic of research ever since the beginning of schools, colleges and universities. The development of more innovative but easy to implement tools for teaching and learning is a continuous and necessary process. Students learn best when they are actively involved. With the introduction of more and more teaching and learning tools, students can learn outside the classroom as well as inside. Whereas learning outside the classroom is possible with the help of diverse systems such as Lectopia [1], WebCT [2] or Blackboard Learning System [3], PebblePad [4] and internet sites such as Wikipedia [5] etc., learning inside the classroom has been less varied with OHPs becoming obsolete and power point presentations dominating lectures since their introduction.

Ubiquitous systems bring the possibility of introducing unique attractive features to lectures. In modern times, wireless technology is successfully establishing itself in every area of life. Whether it be a question of national security, traffic control, or in the world of entertainment,

wireless technology has proved its mettle in every area of living. Many television programs which involve rapid audience feedback rely on wireless technology. Such types of feedback systems assist in capturing audience attention, in addition to gathering their views. However, wireless technology is still not widely used in our classrooms in spite of having much potential to improve lectures and student learning; the reason being its expensive infrastructure. Bluetooth is one technology which, besides being cheap, can be used to acquire the benefits of wireless technology in our classrooms.

The use of Audience Response Systems in large lecture groups is becoming common in many universities. Their use in engaging students attending lectures having a large number of students has been attempted in various areas. Hand-held Audience Response Systems, commonly known as "Clickers" [6], enable a lecturer or presenter to engage their audience in a more interactive presentation by gathering and displaying audience responses to questions during the session and responding to the pattern of response immediately. It ensure that students learn in their classes, rather than simply gathering materials in classes to be scrutinised at a later stage, this project results in classes that are much more interesting, since there are serious interactions with students. "Clickers" [7] and or 'Keypad Interactive' [8] are available which use infrared or radio frequency technology to transmit and record student responses to questions. But the cost of these systems is a downside with setup cost alone of several thousand dollars. These systems may also require an on-site technician to operate. The students have to purchase remote units too and then register them for use in a course thereby introducing the possibility of losing them and every new device has to be registered first for use in a course.

With the increased usage of mobile technologies such as PDAs and smart phones, and the implementation of mobile phones with Bluetooth technology, the availability of Bluetooth devices to be used as a means of communication has become a commodity and inexpensive to implement. Development in applications that can take advantage of wireless devices has become a global mandate, with major development in Bluetooth, which neither relies on a third party (internet service provider) nor demands any fees of users to interact with anyone in their device's range.

This paper aims to demonstrate one such application through its design and development. The next section of this paper gives a brief overview of Bluetooth technology and its applications. Section 3 gives details of the application development platform and Bluetooth requirements. In Section 4, we describe the "µMeter" application, followed by the conclusion and notes for future work.

## **2. BLUETOOTH TECHNOLOGY AND ITS APPLICATIONS**

Bluetooth wireless technology [9] is a short-range communications technology intended to replace cables connecting portable and/or fixed devices while maintaining high levels of security. The key features of Bluetooth technology are robustness, low power, and low cost. Bluetooth specification defines a uniform structure for a wide range of devices to connect and communicate with each other. Bluetooth technology operates in the unlicensed industrial,

scientific and medical (ISM) band at 2.4 to 2.485 GHz, using a spread spectrum, frequency hopping, full-duplex signal at a nominal rate of 1600 hops/sec.

There are many different Bluetooth applications which have been commercially developed. Bluetooth can be used to connect mobile phones to offices' landline telephone sets and employees can make calls even when not at their desk from their landline number with the help of their Bluetooth enabled phone [10]. Bluetooth enabled handhelds may also be used as three way phones. At home, the phone functions as a portable phone. Outside the house, it functions as a normal mobile phone. And when your phone comes within range of another mobile phone with built-in Bluetooth wireless technology, it functions as a walkie-talkie [11]. Another Bluetooth application, Bluetooth Passport [12], allows the user to login and logout of his/her PC by turning on the Bluetooth on their PDAs.

To summarize, Bluetooth has the potential to connect many types of devices, for instance a watchpad [13] and indoor location based applications [14]. With the widespread adoption of Bluetooth in all electronic devices, development into such applications is cost efficient and has become mandatory for achieving short range wireless connectivity.

### 3. DEVELOPMENT PLATFORM AND SYSTEM REQUIREMENTS

The application proposed in this paper requires:

- Visual Studio 2008 as a development platform,
- C Sharp as the programming language and
- Windows Mobile 6 Professional SDK



Figure 1. Microsoft Bluetooth Dongle

It is being tested on Bluetooth devices provided by Microsoft, as shown in Figure 1, i.e. the Bluetooth stack on the device should be "Microsoft Bluetooth stack". 32feet.net library [15] provided by In The Hand Ltd. [15] is used for development of the application.

### 4. $\mu$ METER

The application " $\mu$ Meter", developed in this paper aims to boost interactivity in classrooms by transferring lecture files to students and receiving their feedback when required by the lecturer. Figure 2 demonstrates " $\mu$ Meter" in action in a classroom. The initial application interface is as shown in Figure 3.



Figure 2.  $\mu$ Meter in Bluetooth LAN [17]



Figure 3.  $\mu$ Meter User Interface

On clicking the “Transfer File” button, the application executes the Transfer File function discussed in Section 4.1 and on clicking the “Receive Feedback” button, the application executes the “Get Feedback Function” discussed in Section 4.2.

#### 4.1 Transfer File

The lecturer usually revises the topics of the previous lectures before starting a new one but does so hurriedly, making it impossible for an absentee to understand what is going on. What can instead be done is, besides the usual review of topics, he may use the “Transfer File Functionality” discussed here to transfer the previous lecture’s file onto the devices of all the students. This kind of application may also be used in a variety of places such as conferences, presentations, group discussions etc. The application design is shown in Figure 4.

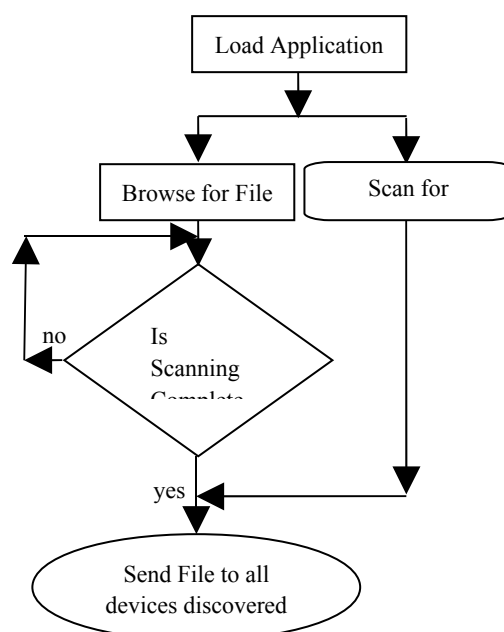


Figure 4. Design of File Transfer

On loading the application, a different thread starts scanning the area for discoverable Bluetooth devices in the range. This is achieved by using DiscoverDevices() function. On clicking the transfer file button shown in Figure 3, the user is asked to browse for the file he desires to be sent. When file selection is done, the application waits for the device discovery thread to stop so that a complete list of nearby Bluetooth devices is now available. The selected file is then individually transferred to each device by means of the OBEX (Object Exchange) mechanism.

Functions used in the application are as follows:

(1) Functions provided by 32feet.net [15]:

- BluetoothClient.DiscoverDevices();
- ObexWebRequest();
- ObexWebRequest.ReadFile();
- ObexWebRequest.GetResponse();
- ObexWebResponse.Close();

(2) Functions provided by Microsoft [16]:

- OpenFileDialog();
- OpenFileDialog.ShowDialog();

A list of all the devices to which file was sent is illustrated in Figure 5.

The clients who do not want the file may simply discard the request sent to them. There is also a timeout set in case there is no response from the client device.

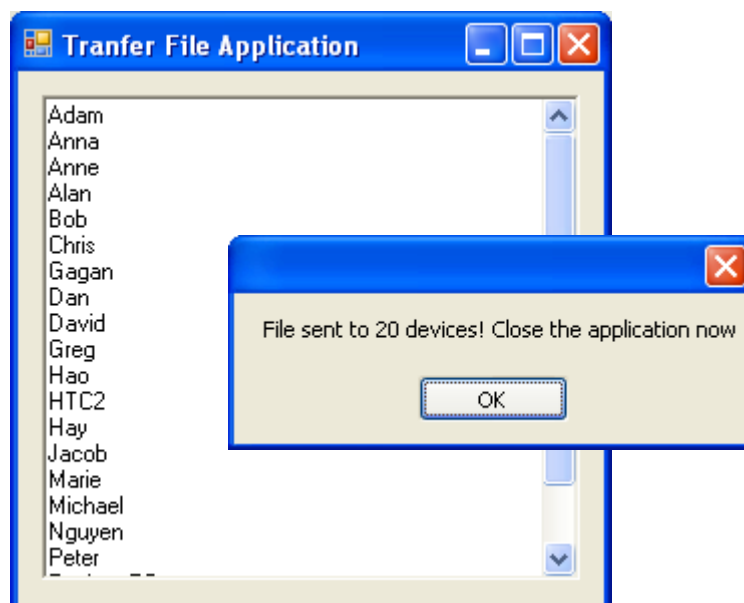


Figure 5. Interface for File Transfer

## 4.2 Get Feedback Function

Here the lecturer asks every student to send a text file containing “yes” or “no”, indicating whether or not to proceed ahead in the lecture. This function receives the files thus sent and generates a graph showing relative percentages of “yes” and “no”. This generation is dynamic and the lecturer notices the alterations in the graph as more files are received and can decide accordingly. The application design is shown in Figure 6.

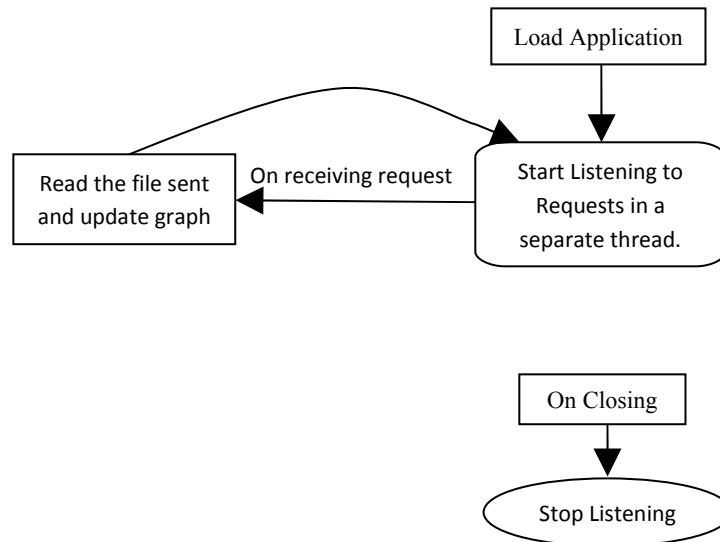


Figure 6. Design of Get Feedback Function

On loading the application, a different thread starts listening to the object transfer requests. As soon as any Bluetooth device tries to establish a connection to transfer a file, the listener accepts the requests and saves the file sent in a repository. The application then reads the file the texts “yes” or “no”. These texts are indicative of whether the lecture up to now has been clear or not. The relative percentage of these two types of files is then calculated and a graph is drawn. The listener continues to listen to more requests once a file with one Bluetooth device is sent. In addition, the application keeps track of the devices which have already sent the file and does not consider any data from them if they try to send again. Moreover, any file containing text other than that required is saved in a folder named “junk files”.

Functions used in the application are:

(1) Functions provided by 32feet.net [14]:

- ObexListener();
- ObexListener.Start();
- ObexListener.GetContext();
- ObexListenerContext.Request();

- ObexListenerRequest.WriteFile();
- ObexListener.Stop();

(2) Functions provided by Microsoft [15]:

- Directory.Exists();
- Directory.CreateDirectory();
- Directory.Delete();
- Directory.Move();
- Threading.Thread();
- Threading.ThreadStart();
- Thread.Start();
- Uri.UnescapeDataString();
- File.ReadAllText();
- string.Trim();
- string.TrimStart();
- string.ToLower();
- string.Equals();
- Control.CreateGraphics();
- Graphics.Clear();
- SolidBrush.SolidBrush();
- Graphics.DrawString();
- Font.Font();
- Graphics.DrawLine();
- Graphics.FillRectangle();
- Rectangle.Rectangle();

On receiving the files, the application appears as in Figure 7. The graph on the left shows the percentage of files with “yes” and “no”.

$$yes\% = \frac{yes}{yes + no} \times 100$$

$$no\% = 100\% - yes\%$$

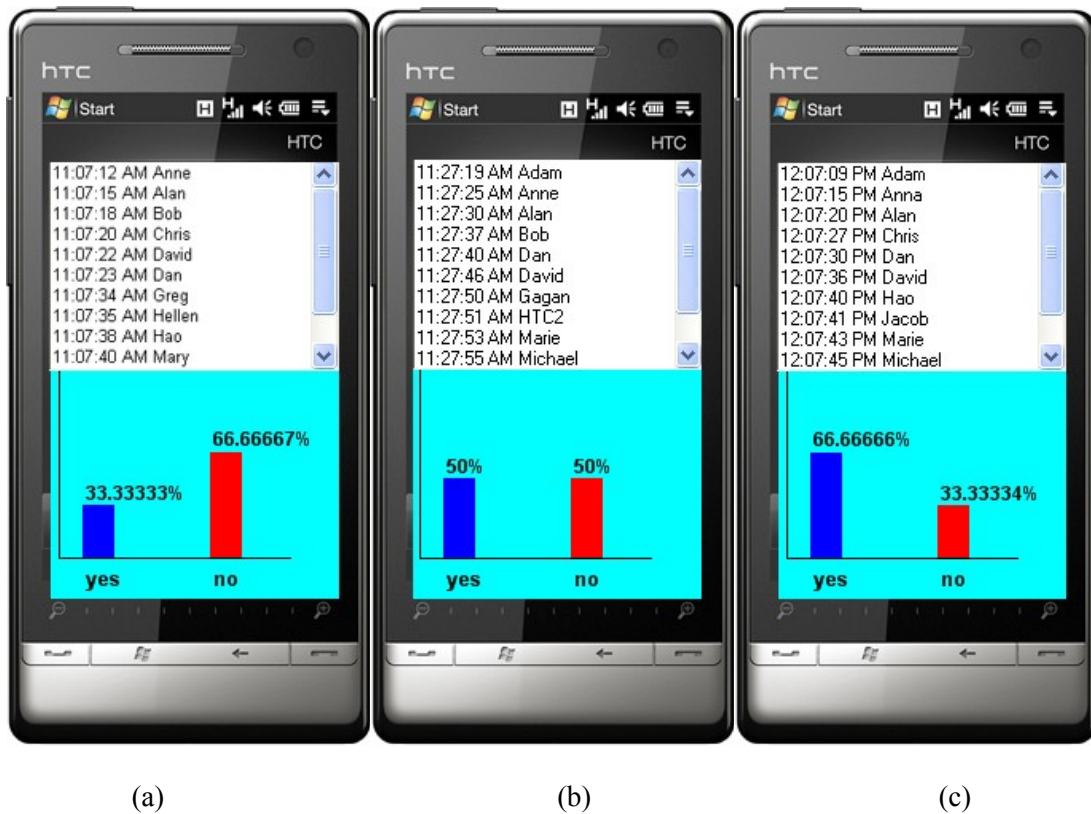


Figure 7. Get Feedback Function

On receiving more files, graph changes dynamically as shown in Figure 7(a), 7(b) and 7(c). Application also keeps a count of junk files received as shown in Figure 7(c) where application has received a total of 18 files, 2 of which were undesired. To keep track of the history, this function also opens a new active window which generates a digital waveform of change in the relative percentages of “yes “ and “no”. One typical waveform is shown in Figure 8.

To summarize, the Transfer File Function transfers a selected file to all of the nearby Bluetooth devices and the Get Feedback Function collects the responses of the students. Here it is important to note that the client devices may consist of any Bluetooth stack but the device on which the application is running must consist of the Microsoft Bluetooth stack.



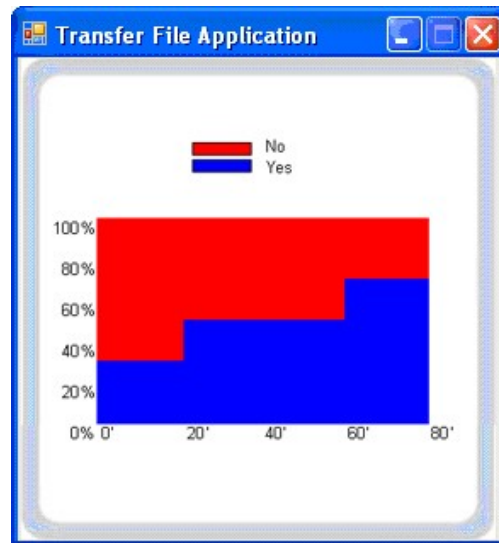


Figure 8. Graph depicting feedback history

## 5. CONCLUSION AND FUTURE WORK

This paper proposes the design and development of ‘ $\mu$ Meter’, an application comprising of two functionalities meant for use in lectures using readily available Bluetooth devices. Audience Response Systems can change the learning atmosphere considerably in a large lecture group. It boosts interactivity with students, thereby making lectures more effective. Bluetooth technology has been identified as something that can be adopted widely to be used as an inexpensive indoor beacon for early developers in their own creative applications. Also the use of Bluetooth as a commodity in lectures typically will interest most students due to uniqueness of this kind of an application, in turn killing the monotony of lectures and making them more exciting.

The commercial systems like “Clickers” are available which use infrared or radio frequency technology to transmit and record student responses to questions. But the cost of these systems is a downside with setup cost alone of several thousand dollars. These systems may also require an on-site technician to operate. The students have to purchase remote units too and then register them for use in a course thereby introducing the possibility of losing them and every new device has to be registered first for use in a course. On the contrary, using already available Bluetooth radio frequency for use in classrooms involves no additional costs both for students and administration. No need of an on-site manager is required here. Also the inconvenience due to registration of a new device is eliminated by the use of Bluetooth. Therefore applications like ‘ $\mu$ Meter’ have a lot of potential to innovate our classrooms on large scale grounds and can be extended to satisfy the functionalities provided by systems like ‘Clickers’ in future.

The proposed system will find wide applications such as control electrical appliances and landline telephones in a house, distribution of data sheets in a conference, data transfer between different devices, in information gathering and analysis for defense force operations. Future work can involve modification of above application to connect one Bluetooth device to multiple clients and transferring data simultaneously using multiplexing techniques thereby decreasing the transmission time.

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