Abstract—New technologies are invented and developed in order to simplify communication among people living over a wide area. These technologies rely on creating faster and easier ways of posting announcements. Current ways of announcement require more funds and time when proposed routinely. The “i-Display using Smart Phone Application” is a mobile technology that allows communication with a PIC, using Internet connection. This is done by creating an application that is connected to a microcontroller in order to output a message. This procedure provides an easy way to advertise widely. The work is composed of two aspects: the software and the hardware. The former is mainly the android application and the microcontroller program, while the hardware is composed of the converter, the microcontroller and the display board with all related electronic components. This process operates using a 3G internet connection. The “i-Display” application allows the user to change the message on the LED board by using his/her smart phone in an easy, low cost and very fast way.

Keywords-component; i-display; LED board; PIC program; android application.

I. INTRODUCTION
A. Statement of the problem

Advancement in advertising and announcement methods have been increasing in the past few years, leading to the simplification of communication among people living in places that extend over large areas, at the same time making the posting of announcements faster and easier.

Some companies and markets around the world are using LED boards for advertising, for any information can be displayed on the LED display ads in any desired place. In addition, these boards can show more effects compared to the traditional view of a cable screen [1].

Current advertising techniques are extremely costly. They require more money and time when proposed routinely since they require a dedicated employee to arrive to the targeted place of advertisement; thus, adding the cost of the transportation and all the equipment needed for changing or updating the ads [1]. Recent announcements are all based on computers that are connected via wires, whereas the need is to have new ways of communications that go with the new trends and technologies.

B. Primary Discussed Solutions

The first discussed solution was to build the mobile application on an iPhone since it is one of the newest technologies available nowadays. The application is built on a specific developer called the XCode with its specific language the cocoa. This solution came to a dead end due to many reasons. First, the application that was under construction couldn’t be used before publishing it and getting the approval from the Apple Company; a process that requires a lot of time. Second, the language used didn’t not support all platforms. It is specific to be used on iPhones; thus, limiting its use.

The second discussed solution was to build a J2ME application where the message could be sent via Bluetooth to be displayed, but this solution reached a dead end since J2ME is not anymore compatible with new smart phones. Furthermore, the Bluetooth range does not support more than 100 meters, which is not our target.

C. Proposed Solution

The appropriate solution is to build an application for android mobile phones which can be used on a wide range of mobiles such as Samsung, HTC, etc. The application contains a field where the message is to be written, and a send button in order to send the message to the router then to the converter and finally to the LED board to be displayed.
D. Relevance of this Work

The i–Display project presents several new features that improve the way of announcement by making this process less expensive, much faster, efficient, supports wider range and is applicable in many fields other than advertizing. All this is done using a simple android mobile application that is connected to a programmed microcontroller via a 3G Internet connection.

II. Background Information

This part addresses and discusses the commonly used software applications and hardware parts; the accurate combination of which will lead to the production of this project.

A. Software

The software part is made up of the smart phone application and the microcontroller program.

- Eclipse

Eclipse is a Java-based open source platform that allows a software developer to create a customized development environment (IDE) from plug-in components built by Eclipse members. The Eclipse SDK (which includes the Java development tools) is meant for Java developers. Users can extend its abilities by installing plug-ins written for the Eclipse Platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules [4]. The android emulator is offered with eclipse, which is a virtual mobile device that runs on the pc in order to test Android applications before using it on a physical device.

- MPLAB IDE V8

MPLAB Integrated Development Environment (IDE) is an integrated toolset for the development of embedded applications using Microchip’s PIC Microcontrollers. It is easy to use and it also runs as a 32 bit application. It includes a host of free software components for fast application development and debugging [5].

- HyperTerminal

HyperTerminal is a program that can be used to connect a computer to another one, telnet sites etc. The connections are made by means of a modem, a null modem cable which is used to emulate modem connection or an Ethernet connection. HyperTerminal is designed to be an easy-to-use tool, but it is not meant to replace other full-featured tools [6].

- Proteus PCB Design

Proteus PCB design combines the ISIS schematic capture and ARES PCB layout programs to provide a powerful, integrated and easy to use suite of tools for professional PCB design. All Proteus PCB design products include an integrated shape-based auto router and a basic SPICE simulation capability as standard. So, this package is a professional schematic capture module, professional PCB layout module, hardware accelerated display technology, board auto placement and basic simulation program [7].

B. Hardware

The hardware consists of six major parts.

- PIC Microcontroller

PIC microcontrollers (Programmable Interface Controllers) are electronic circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timers or to control a production line and much more. They are found in most electronic devices such as alarm systems, computer control systems, phones; in fact, in almost any electronic device. There exist many types of PIC microcontrollers although the best are probably found in the GENIE range of programmable microcontrollers. These are programmed and simulated by Circuit Wizard software. PIC Microcontrollers are relatively inexpensive and can be bought as pre-built circuits or as kits that can be assembled by the user [8]. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, appliances, power tools, office machines and toys. A microcontroller can be considered a self-contained system with a processor, memory and peripherals and can be used as an embedded system [9].

- TCP/IP Converter (EX – 9132 Converter)

TCP/IP converter series is a low-cost, high performance design. The EX-9132 converter is a smart LAN device that transfers data to a detected serial port; it has the capability to be easily connected to special serial devices. By a careful selection of high quality with competitive price components in the world, EX-9132 product made
network connectivity possible with affordable cost for virtually all kinds of devices. TCP/IP converters are designed to make the users’ serial devices Internet ready instantly. One of its features is the data conversion between RS-232 and Ethernet, in which it converts the TCP/IP package data/signal into serial device data/signal [10].

- **Router**

  It is a network device that forwards packets from one network to another. Based on Internal routing tables, routers read each incoming packet and decide how to forward it. The destination address in the packets determines which line (interface) outgoing packets are directed to. In large-scale enterprise routers, the current traffic load, congestion, line costs and other factors determine which line to forward to. Most routers in the world sit in homes and small offices and do nothing more than direct Web, e-mail and other Internet transactions from the local network to the cable or DSL modem, which is connected to the ISP and Internet. Setting at the edge of the network, they often contain a built-in firewall for security; this firewall serves all users in the network without requiring that the personal firewall in each computer be turned on and configured [11].

- **Data SIM Card**

  A subscriber identity module which is known as SIM card is used for GSM phone subscribers. It includes the user’s identity, location, phone number, network authorization data, personal security keys, contact lists and stored text messages. It is very efficient; it is characterized by its authentication and encryption in order to protect user’s data [12].

  A SIM card is compatible with all phone types; thus, it can be used with any phone. There is also the “DATA SIM CARD” that is used only for the 3G Internet connection that is new in Lebanon; it is suitable for mobile phones, laptops etc.

- **3G Dongle**

  The dongle is a small device that is used like the USB and which allows the user to access the Internet with a 3G mobile broadband connection by using the data SIM card. They are very flexible to be used more than fix lines connections since they can be used on the go [13].

- **LED Matrix Board**

  LED is an electronic component that conducts current in only one-way direction; it emits light when current passes through. LEDs are available in white, red, orange, yellow, green and blue. When LEDs are combined together they form what is called LED “LED matrix”, in which the LEDs are arranged in rows and columns [14].

### III. MATERIALS AND METHODS

The smart phone application (android application) allows the user to type a message to be displayed. The message is then sent wirelessly via the cell phone infrastructure to a router. This router is connected to a converter which converts its Ethernet input into a serial output that feeds a PIC microcontroller input. The microcontroller processes this sequence and sends it to its output ports then to a matrix of LEDs to be displayed on.

**A. Materials**

This section shows and describes the materials used to design and implement the “i-Display Using Smart Phone Application”, the Technicolor router TG582n with the 3G dongle, PIC Microcontroller 16F877A and EX-9132 converter. The Technicolor TG582n supports the most secure wireless security mechanisms, allowing users to communicate and access data with efficient link quality and the highest level of network security; it supports the use of USB 3G adapter. Thus, this is the appropriate device that can be used with the dongle to give the 3G connection [2]. Since 3G Internet connection can be used by having the Data SIM inserted in the 3G dongle, it gives the user Internet connection no matter where he/she is. Therefore, the dongle is inserted into the Technicolor that is configured in order to provide the connection needed. The converter plays an important role in sending the message. When the message is sent from the mobile phone to the router, its output feed the input of the EX connected to the LAN port via the network connector RJ45. The LAN LED light when the connection is successful [3]. The PIC microcontroller used in the implementation of “i-Display Using Smart Phone Application” is PIC PIC16F877; it is CMOS FLASH-based 8-bit microcontroller which is upward compatible with the PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self-programming, an LCD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. Thus, the main role of this PIC is to accept the parallel or serial lines of data from the decoder to the LED display [4].
B. Methods

The android application is a main part that the user has to deal with. This application was built using Eclipse. It is made up of three main parts which are the manifest.xml, the main.xml and the Java file. XML is used to store and transport the data between different applications.

Android uses permission-based policies in which all the permissions needed by an application are specified. Since the application must work over an Internet connection, the permission must be made in order to allow the application to work. This permission can be applied by inserting the fragment “android.permission.internet” into the AndroidManifest.xml file. The second part of the application is the graphical user interface that is expressed in the main.xml. It defines the layout structure and holds all the elements that appear to the user. Finally, the click functions of the application are written in file.java, which allows the user to click on the “send” button to forward the message in a socket form to be delivered to the LED matrix board, “Fig.1” and “Fig.2”.

C. Communication Part

The communication part, as shown in “Fig. 3”, is the connection link between the smart phone application and the microcontroller. When the message is sent from the phone via the socket that is composed from the IP address and the port number, the message enters the router that is connected to the TCP/IP converter. At this level, the message is converted from Ethernet message into a serial one, which is the function of the EX. The IP address must be the same at all levels, for this purpose the router was configured in order to allow the communication with the EX that has specific IP address.

D. Microcontroller

The second part in “i-Display Using Smart Phone Application” is the PIC microcontroller program that reads the message received from the mobile application via the serial input and forwards it to the LED Matrix board. Designing the PCB boards was done using Proteus PCB design program. Later on, PIC 16F887 was placed in its socket in order to be connected to the required components; the PIC was connected to the MAX RS 232 via port 26 (RX) that enables the PIC to read the serial sequence from it. The next step was to configure the microcontroller to read from the serial port by defining several subroutines within the assembly code.
The PIC should also be enabled to read the sent message and load it to its EEPROM. The upper case letters are defined in the program. To compare the input with letters predefined in the PIC, a scan test was performed. The microcontroller forwards the message to the LED display board letter one after the other. The horizontal part is made up of seven rows defined from RB0 to RB6, whereas the vertical part consisted of 4 columns that are defined from RD0 to RD3; these outputs are connected to IC-4514 that enables the letter’s sequence to move column by column. To accomplish this, each column of the LED board is connected to an output of the IC-4514. On the other side, this IC is connected to a BC337transistor which enables the LED to light on when the message reaches its destination column. All this process was installed in the PIC and synchronized with an external 4MHz crystal clock.

Figure 4 shows the circuit diagram of the system. Pins RB0 to RB7 are the microcontroller outputs; they are connected as rows in the LED boards. Pin 26 is connected to the serial MAX232 in order to read data. Pins RD0 to RD3 are connected to pins 2,3,22 and 23 respectively, while pin 24 is the master clear. Moreover, pin 23 in the IC is connected to RA0 in the first IC, to RA1 in the second IC and to RA2 in the third IC. All other pins on the IC are connected to the transistors. These pins control the number of LED boards, so we can add more boards while configuring other pins to synchronize them together.

E. Display Part

The text in the interface will scroll on the LED matrix display, in which each 4 LEDs are grouped together to form a pixel. The used LEDs are of a red color (5mm). This part is composed of 3 LED boards having the same structure with the same number of LEDs. The display board consists of 7 rows and 17 columns. Therefore, each board contains $4 \times (17 \times 7) = 476$ LEDs. In order to avoid the overheating of the LEDs, a resistor was added to each pixel.

IV. RESULTS AND DISCUSSION

Different aspects of testing were applied to this project, starting from the smart phone application, the wireless system, the microcontroller program, the functionality of the all systems, to the verification of the displayed result on the LED boards. The hardware parts used are formed by the LEDs, microcontroller chip 16F887, Max RS 232, resistors, capacitors, transistors, and IC regulators LM7805. When the system is operated, the user types a message on the smart phone application, which is already connected to the network, and within few seconds the message is shown on the LEDs. This indicates that the system is functioning normally and all the connections are working properly. As a result of the combination of the above systems, many purposes were achieved at many levels. The most important was the ability to create an easy, low cost and fast way of announcement. The system is powerful enough to be evolved in the market. On a lower level, the user could get a highly safe and accurate data transfer by displaying the announcements needed through the applicable smart phone devices.

V. CONCLUSION

The “i-Display Using Smart Phone Application” allows the user to change the message on the LED board by using his/her smart phone. This way will reduce the usage of wired display boards as well as the usage of preprogrammed boards that show predefined messages. Moreover, this system is flexible to be used with many smart phones like HTC, Samsung and any android phone. Furthermore, this system will help the user to display the message widely since the 3G Internet connection is now affordable everywhere; thus, the user can by a single click change the message wherever he/she is. The user can deal with his/her system in very simple effective and fast way using this technology with a low cost. This technology can be enhanced more by creating the application to suit different phones. It can be improved by changing the type of boards to be displayed on, that is by using advanced display boards; also by changing the output from monochrome to multi-colors and adding some animations. The users of this system may have accounts that will allow them to login in order to change the message; and since the system is using Internet connection, the application can be connected to a web server that allows the user to change the message worldwide.

References


