Touch & Dine

A Multi-Touchable Restaurant System

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***Abstract* — Efforts have been taken by restaurants to adopt information and communication technologies such as PDA, wireless LAN, costly multi-touch screens etc. to enhance dining experience. This paper highlights some of the limitations of the PDA-based food ordering system and costly Multi-touchable E-restaurant management system and proposed the low cost Multi-touchable Restaurant Management System as a solution. The system consists of the multi-touchable interactive dining menu that allows customers to make order conveniently on the developed multi-touchable dining table during the busy hours using their fingers. Orders made by the customers will be updated instantly to a centralized database and subsequently reach the cashier and the kitchen module respectively. Management staff could use the system to manage the restaurant operations digitally, starting from the creation of food items for the multi-touchable interactive dining menu to deleting it or to manage orders from customers all the way to billing it. The system was built using JDK, J2SE, JNI, JMF, Tomcat Apache Server, Express PCB, MySQL database on top of NetBeans framework.**

***Keywords*— Multi-touchable Interactive Dining Menu; Multi-touchable dining table; Wireless Local Area Network (WLAN);**

I. *INTRODUCTION*

The advancement of Information and Communication Technology (ICT) has led to an increasing number of industries to use web as a medium for information exchange. In the restaurant sector, web-enabled computer system was suggested to manage the traffic flow of orders, generating proper billing reports, reduce customer waiting time, increase the efficiency of work flow and to reduce error margins [1]. Modern wireless device such as Personal Digital Assistant (PDA) has been adopted into restaurant system to replace the conventional way of taking orders using pen and paper. With such a computer system, repetitive tasks in restaurants could be delivered with minimum errors, if not none [2].

However, the PDA-based food ordering system has known limitations such as the requirement of training of attendants, the need of having attendants to operate, the inefficiency during peak hours and small screen size [2] and the Multi-touchable restaurant Management System has limitations such as touch screens used are of mostly capacitive type or resistive type which are costly. Hence by introducing an infrared touch screen problem of cost is eliminated and the efficiency is increased by excellent cursor stability and accessibility meets the rigorous standards, guaranteeing you fast, efficient and painless procedure runs. It is designed to reduce your operating costs and give your staff more time for value-added activities. This solution provides excellent functionality at a highly competitive price, and comes complete with in-built help systems. The multi-touchable dining table will be operated by customers themselves and orders made will be processed by the restaurant management system. This paper describes the implementation of the low cost multi touchable restaurant management system with aims to enhance the dining table service. The system consists of multi-touchable interactive menu that allows customers to view and order food on top of dinning table by using their fingers and the orders will be transmitted directly to the restaurant's server in real time. The system allows different staff personnel to access the centralized server to perform daily works digitally in a systematic work flow. For example, chefs in the kitchen could use the system to view and prepare food the moment customer made their order, while the cashier could use it to pre-processing bill. From time to time, restaurants manager could access the system to evaluate the business status by generating billing reports, make necessary changes to the food items in the multi-touchable dinning menu, updating advertisement etc.

The rest of the paper is organized as follows. Section 2 gives brief review on multi-touch technology, restaurant ordering system. Problems faced by PDA food ordering system, problem of high cost of touch screens available in the market and the proposed solutions are described at Section 3. Section 4 describes the detail implementation of the proposed low cost touch screen. Finally conclusions are given in Section 5.

II. *LITERATURE REVIEW*

A. IR Multi-Touch Technology

Multi-touch technology is an enhancement to the existing touch technology whereby users are allowed to control and

perform operations simultaneously on the electronic visual displays using multiple fingers or gesture inputs. Large displays such as from the tabletop and the wall-screen are deemed to be essentials when dealing with multiple users sharing the same display for information visualization purposes. It is reported that the social interaction is highly improved among users using a shared display and input [3]. Users using multi-touch tabletop technology are provided with natural direct manipulation and are granted full control to the digital content by using just fingers [4]. This eliminates the need of having input devices such as keyboard and mouse that require additional space.

The use of touch-screen interfaces for industrial computer systems continues to grow. Though there are many reasons for this, chief among them is the fact that this technology eliminates the need for a keyboard or traditional mouse offering in their place a simple, direct interaction with graphical icons that represent the specific task at hand. This helps keep plant-floor operators focused on their application, and can be used by most operators regardless of their computer skills. Moreover, touch screens may be used with a gloved hand eliminating the need for the operators to remove their gloves prior to operating the system.

The four most commonly used touch screen technologies include resistive, capacitive, infrared and SAW (surface acoustic wave). Each technology offers its own unique advantages and disadvantages. Resistive and capacitive touch screen technologies are the most popular for industrial applications. But the infrared touch screens are cost effective and have more efficiency such as excellent cursor stability, accessibility is excellent, all kinds of stylus materials can be used.

Infrared is the earliest and the most reliable touch screen technology, due to the improvement of LED materials. The lifetime of infrared touch screen is much longer and more stable in operation. Infrared Touch Screen is a touch frame which is usually installed in front of the display screen. The frame is integrated with printed circuit board which contains a line of IR-LEDs and photo transistors hidden behind the bezel of the touch frame. Each of IR-LEDs and photo transistors is set on the opposite sides to create a grid of invisible infrared light. The Infrared Touch Screen controller sequentially pulses LEDs to create a grid of IR light beams. When a user touches the screen, enters the grid by a stylus which can interrupt the IR light beams, the photo transistors from X and Y axes detect the IR light beams which have been interrupted and transmit exact signals that identify the X and Y axes coordinates to the host. Its strengths include high sensitivity, wear resistance (with glass overlay that reaches 7H in scratch hardness), a long lifecycle of over 300 million repetitive touches at a single point, over 95% transmittance, and the LEDs have a basic lifecycle of 50,000 hours. Based on the requirements for specific application, the number of LEDs can be adjusted according to increase response speed or increase density for applications involving drawing, writing or as a sensor for gaming applications.

Thus, the adaptation of the IR Multi-touch technology into a restaurant table will be of great combination as the restaurant table can now acts as a dining table, a platform for digital meal ordering using fingers on the table surface, and an entertainment platform while waiting for the food to be served. This will hopefully enhance customers' dining experience especially during the peak hours.

B. Restaurant Ordering systems

Restaurants are always one of the main industries that have been supporting the economy for decades. The usual instruction process of a meal ordering in a restaurant begins with customers making an order through waiter, and then passing the information to kitchen staff for food preparation, and finally reaches to cashier to record the billing [5]. However, often mistakes and delays will occur throughout the ordering process resulting in unsatisfactory among customers. Thus, new technologies and approaches are introduced into restaurants with the aim of improving efficiency and minimizing errors of the food ordering system. One of the technologies that been adopted by the restaurant is the PDA-based food ordering system and Multi-touchable restaurant Management System using high cost touch screens. Various applications have been developed specially for such restaurant ordering system, which include iMenu, a web-based ordering system that runs on wireless connection and Easy-Order, the first application developed to communicate with computers to deliver e-commerce tasks [6]. Different such technologies and tools generally improved their operation efficiency, reduced operation costs, and improved service quality and different types of touch screens developed in the market such as capacitive , resistive, SAW (Surface Acoustic Wave), etc.

Another important aspect of restaurant ordering system is the dining menu. Dining menu must to be informative, attractive and updated all the time for customers to make order easily. A restaurant owner introduces new promotions, new food menus and new attractive announcements. By doing so, dining menu is frequently changed, which involve huge amount of money and time. Errors are also prone to happen in the dining menu. Thus, digitalized dining menu was introduced in some restaurants that provide customers with a computer to access the digital menu and make order accordingly at their table [7]. By introducing digitalized menu, a proper system where it allows managers and staff to modify and update the dining menu, the workflow and its contents without much hassle is sought after. A web-based restaurant management system is a good approach in terms of functionality, flexibility and cost.

III. *PROBLEM FACED BY PDA FOOD ORDERING SYSTEM, PROBLEM OF HIGH COST OF TOUCHSCREEN AND THE PROPOSED SOLUTION.*

For the PDA-based ordering system, upon customer arrival,

restaurant's attendant will escort them to their seats and present them with conventional menu. The attendant will attend to other table while waiting for the customers to make their decisions. Once the customers are ready to make an order, the attendant will assist the customers to make the orders using a PDA.

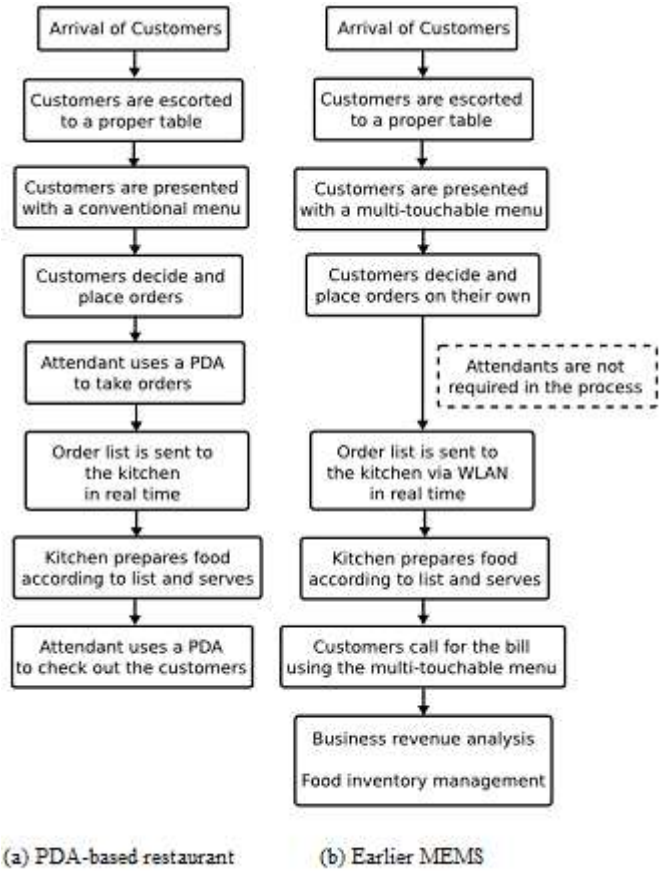


Figure 1.Service procedures for the PDA-based restaurant and the Proposed Low Cost MEMS

The orders will be sent to the kitchen and the food will be prepared accordingly. Whenever the customer wants their bill to be settled, restaurant's attendant will use a PDA to check the customer's orders and generates a bill. The overall service procedures when ordering food using a PDA are shown in Fig. 1(a) [2].

Nevertheless, there are certain limitations to the PDA-based ordering system. For instance, conventional menu is still being used to present food items. Any update to the food items such as pricing, availability, promotions etc. will require manual modification to the menu. Besides, conventional menu usually has limited amount of information. Thus, attendants will need to understand the menu well enough to provide additional aids to the customers when making an order. Human memory may then become a liability especially when food items are updated frequently. Furthermore, during the ordering process, the customers will not be able to view the ordered food list from the PDA device as the screen size is rather small. In order for the orders to be taken without errors, the attendants handling the PDA devices will require comprehensive training as well as to understand how the device works [7]. The PDA-based ordering system requires continuous replacements and charging of batteries for long hours of usage, thus creating inconveniences to the attendants as they will need to place the PDA on the charging station whenever not using it.

There are also certain limitations to the Multi-touchable E-restaurant Management System. Touch screens available in the market are of capacitive, resistive or SAW (Surface Acoustic Wave) types which are very costly. Limitations of capacitive touch screen are not operating able with stylus until up till it is of conductive material. If customers are wearing gloves for capacitive touch screen they have to remove it, will not work speedily with the pencil, if customers finger is wet again it fails to detect the touch, will not function properly in the presence of moisture or high humidity. One more disadvantage of capacitive touch screen not in a particular sense though, it is expensive, offers less durability hence short life is another drawback. The drawbacks of resistive touch screens include its inability to support multi-touch gestures, its poor visibility in direct sunlight and its lesser durability. The top layer on a resistive touch screen is made of soft, flexible material which can be damaged much more easily than glass. It also may need recalibrating from time to time. It is unable to sense touch of stylus and hand at a time. There is need to define the touch by activating the sensor for one and deactivating for the other. Drawbacks of SAW the technology cannot be sealed; it can be adversely affected by surface contaminants and water, making it unsuitable for many industrial or commercial applications. The contaminants can cause dead spots on the screen, requiring periodic cleaning of the sensor and sometimes recalibration. Due to the way the technology works it can also be susceptible to data "noise", can be affected by large amounts of dirt, dust in the environment.

In view of the problems mentioned, the Low cost touch screen that uses multi-touchable dining table as an interface for customers to order food by simply touching on the digitalized dining menu is proposed. The system consists of an infrared multi-touchable dining menu developed on top of NetBeans framework to provide solutions to the problems mentioned. The problems faced by the PDA-based ordering system and the high cost MEMS and its' proposed solutions are summarized according to different events during the food ordering process. The categories are menu presentation, the process of taking of orders, order transfers and business analysis. In terms of menu presentation, the multi-touchable dining menu, enriched with multimedia components will be presented to the customers so that the menu is attractive, informative and easy to use. The digitalized menu will be displayed on the table surface that allows multiple customers to view and to make order simultaneously. As for the menu

modification, an authoring system is built to allow restaurant manager to update the menu at anytime. For the process of taking order, customers could use the multi-touchable dining menu to manage their own order list themselves, eliminating or reducing the needs of having an attendant when making an order. Human workforce could be greatly reduced using this approach which translates to cheaper labor cost. Using this approach, attendants are not require or have minimum training before using the multi-touchable dining menu to order food as the ordering steps are simple and intuitive. This paper highlights the implementation of low cost IR touch screen; customers can use touch screens easily without any limitations such as use of stylus, work speedily even with pencil, wet fingers can be recognized, higher durability, supports multi-touch gestures, top layer is made of strong glass which cannot be damaged easily, etc. And also customers will have full freedom to order food themselves without the assistant of attendants, which is very useful during the peak hours. With customers managing their own order list, errors resulted from miscommunication between customers and attendant during food ordering process could be minimized. The Low cost screen is integrated with a centralized database system where customers' orders will be directly submitted to the system without any information loss or error throughout the order transferring process. The kitchen and the cashier will receive real-time information update and thus there will be no delay in the order transfer process. With the integrated database system to store customers' orders, accuracy and efficiency in generating and producing the total billing amount is guaranteed. Managers could use the screens to generate daily/monthly revenue reports, perform analysis on sales, inventory checking on raw materials etc. In short, the proposed system provides the possibilities to replace the role of attendant in taking orders and transferring them to the kitchen with the proposed system, minimizing if not eliminating the workforce needed in the process of ordering food. Errors when taking order would reduce a customer can use touch screen easily. Besides, the proposed system covers an implementation of low cost IR Touch Screens, to facilitate the digitalization of the restaurant management process. The effectiveness of the system is believed to bring a whole new experience to restaurant customers where customers are able to make order themselves easily on their table using fingers.

IV. *IMPLEMENTATION OF MULTI-TOUCHABLE RESTAURANT MANAGEMENT SYSTEM AND IR TOUCH SCREEN*

Infrared touch screen technology is based on "legacy" technology and is becoming increasingly replaced by Resistive or Capacitive touch systems. Over the years, Infra-red bezels have proven to be a very reliable technology for use in ATMs, Food Service and Preparation, KIOSK, Medical Instrumentation, Process Control Systems, and Transportation Tracking applications. It does not incorporate any sort of "overlay" that could inhibit screen clarity or brightness, but instead, uses a special bezel of LEDs (light emitting diodes) along with diametrically opposing phototransistor detectors which surround the glass of the of the display surface as shown in figure 2. The controller circuitry scans the screen with an invisible lattice of infra-red light beams just in front of the surface that directs a sequence of pulses to the LED's. It then detects information at the location where the LEDs have become interrupted by a stylus or finger. The infrared frame housing the transmitters can impose design constraints on operator interface products. A simple IR touch screen can be developed using microcontroller 89c51, level shifter MAX 232, and a set of transistors, diodes, pull up resistors and op-amp, circuit diagram for IR Touch Screen is shown in Fig. 3. A few limitations are: that they usually require low resolution output of the monitor, can produce activation without touching the screen and the cost to produce the special Infrared bezel is quite high.

1) *Hardware Interface:* Touch Screen which recognizes the multiple touches of the users simultaneously.

- *Specifications*

a) IBM PC/Compatible (Machine Compatibility):

This Infra Red Touch screen is compatible with IBM PC/ 360 machines. It can be implemented above IBM PC/ 360 series.

b) Parallel Port (Hardware Interface):

To implement Infra Red Touch Screen, We'll be using a parallel port using which we can interface the hardware with the system.

c) Mct2e (Octo-Coupler):

This MCT2E serves as an isolator. In case if the voltage increases beyond the expected ratio then it can damage the system. This octo-coupler (Mct2e) will burn itself but it won't allow the voltage to interface with system. So for the sake of system's safety this octo-coupler is used.

d) OP-07 (Op-amp):

Op – 07 serves as a comparator. Use of this Op-07 is it compares positive voltage and negative voltage.

e) 74LS245 (Buffer):

Buffer can also act as an isolator. Here 74LS245 is used to control scanning of the hardware matrix designed by us. Depend on the size of matrix, buffers will be added to the circuit board.

f) 74LS138 (Decoder):

This IC is used to select the buffer. It selects one buffer at a time. Here it controls scanning of the matrix by enabling one buffer at a time and it scans the whole screen more than 32 times in 1 second.

g) IR – LED's and Photo-Transistor (Sensors):

Pair of IR – LED's and Photo-Transistor which acts as a sensors. IR – LED which act as a transmitter and Photo transistor acts as a receiver. Using this pair of IR – LED's and Photo-Transistor the hardware matrix is created.

h) Express PCB:

Express PCB is free PCB software and is a snap to learn and use. For the first time, designing circuit boards is simple for the beginner and efficient for the professional. The board manufacturing service makes top quality two and four layer PCBs. Fig. 4 shows the snapshot of Express PCB.

i) Java Native Interface:

The Java Native Interface (JNI) can be used to permit Java programs to communicate with C programs. We begin by compiling the Java program and the C program at the command prompt (i.e. outside of Eclipse) using the MinGW gcc compiler. Once the programs are compiled and executing correctly, we show how the programs can be integrated into an Eclipse project using the CDT plug in.

j) Input Output Devices:

Input output devices such as keyboard; mouse and monitor with proper working system must be provided to admin. Input output devices along with proper working printer must be provided to the cashier.

2) Software Interface

a) Embedded C:

Use of embedded processors in passenger cars, mobile phones, medical equipment, aerospace systems and defence systems is widespread, and even everyday domestic appliances such as dish washers, televisions, washing machines and video recorders now include at least one such device. There is a large - and growing - international demand for programmers with 'embedded' skills, and many desktop developers are starting to move into this important area. Because most embedded projects have severe cost constraints, they tend to use low-cost processors like the 8051 family of devices considered in this book. These popular chips have very limited resources available: most such devices have around 256 bytes (not megabytes!) of RAM, and the available processor power is around 1000 times less than that of a desktop processor. As a result, developing embedded software presents significant new challenges, even for experienced desktop programmers.

b) Keil:

Keil development tools for the 8051 Microcontroller Architecture support every level of software developer from the professional applications engineer to the student just learning about embedded software development. The industry-standard Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, Single-board Computers, and Emulators support all 8051 derivatives and help you get your projects completed on schedule. The Keil 8051 Development Tools are designed to solve the complex problems facing embedded software developers. When starting a new project, simply select the microcontroller you use from the Device Database and the µVision IDE sets all compiler, assembler, linker, and memory options for you. Numerous example programs are included to help you get started with the most popular embedded 8051 devices. The Keil µVision Debugger accurately simulates on-chip peripherals (I²C, CAN, UART, SPI, Interrupts, I/O Ports, A/D Converter, D/A Converter, and PWM Modules) of your 8051 device. Simulation helps you understand hardware configurations and avoids time wasted on setup problems. Additionally, with simulation, you can write and test applications before target hardware is available. When you are ready to begin testing your software application with target hardware, use the MON51, MON390, MONADI, or FlashMON51 Target Monitors, the ISD51 In-System Debugger, or the ULINK USB-JTAG Adapter to download and test program code on your target system.

c) Java Platform Standard Edition (J2SE):

Java Platform, Standard Edition or Java SE is a widely used platform for programming in the Java language. It is the Java Platform used to deploy portable applications for general use. In practical terms, Java SE consists of a virtual machine, which must be used to run Java programs, together with a set of libraries (or "packages") needed to allow the use of file systems, networks, graphical interfaces, and so on, from within those programs.

d) Java Development Kit:

The Java Development Kit (JDK) is a Sun Microsystems product aimed at Java developers. Since the introduction of Java, it has been by far the most widely used Java SDK. On 17 November 2006, Sun announced that it would be released under the GNU General Public License (GPL), thus making it free software. This happened in large part on 8 May 2007. Sun contributed the source code to the Open JDK.

e) NetBeans:

NetBeans refers to both a platform framework for Java desktop applications, and an integrated development environment (IDE) for developing with Java, JavaScript, PHP, Python, Ruby, Groovy, C, C++, Scala, Clojure, and others. The NetBeans IDE is written in Java and can run anywhere a JVM is installed, including Windows, Mac OS, Linux, and Solaris. A JDK is required for Java development functionality, but is not required for development in other programming languages. The NetBeans platform allows applications to be developed from a set of modular software components called *modules*. Applications based on the NetBeans platform (including the NetBeans IDE) can be extended by third party developers.

f) JCF:

The Java collections framework (JCF) is a set of classes and interfaces that implement commonly reusable collection data structures. Although it is a framework, it works in a manner of a library. The JCF provides both interfaces that define various collections and classes that implement them.

3) Communication Interface

a) Apache Tomcat:

Apache Tomcat (or Jakarta Tomcat or simply Tomcat) is an open source servlet container developed by the Apache Software Foundation (ASF). Tomcat implements the Java Servlet and the Java Server Pages (JSP) specifications from Sun Microsystems, and provides a "pure Java" HTTP web server environment for Java code to run. Tomcat should not be confused with the Apache web server, which is a C implementation of an HTTP web server; these two web servers are not bundled together. Apache Tomcat includes tools for configuration and management, but can also be configured by editing XML configuration files.

b) Servlet:

The Java Servlet API allows a software developer to add dynamic content to a Web server using the Java platform. The generated content is commonly HTML, but may be other data such as XML. Servlets with Java Server Pages are the Java counterpart to dynamic web content technologies such as CGI/PHP or ASP.NET/VBScript, Java Script, C Sharp. Servlets can maintain state across many server transactions by using HTTP cookies, session variables or URL rewriting.

The Servlet API, contained in the Java package hierarchy javax.servlet, defines the expected interactions of a web container and a servlet. A web container is essentially the component of a web server that interacts with the servlet. The web container is responsible for managing the lifecycle of servlet, mapping a URL to a particular servlet and ensuring that the URL requester has the correct access rights. A Servlet is an object that receives requests (ServletRequest) and generates a response (ServletResponse) based on the request. The API package javax.servlet.http defines HTTP subclasses of the generic servlet (HttpServlet) request (HttpServletRequest) and response (HttpServletResponse) as well as an (HttpSession) that tracks multiple requests and responses between the web server and a client. Servlets may be packaged in a WAR file as a Web application. Moreover, servlet can be generated automatically by Java Server Pages (JSP), or alternately by template engines such as Web Macro. Often servlet are used in conjunction with JSPs in a pattern called "Model 2", which is a flavour of the model-view-controller pattern.

c) RxTx:

RXTX is a native lib providing serial and parallel communication for the Java Development Toolkit (JDK). All deliverables are under the GNU LGPL license. It was chopped out of a GPS application. The communication support was minimal and buggy. The hope was that the serial communication support would improve by sharing the code with other developers. Since then Sun produced the Com API and RXTX was moved towards supporting this standard. The shared code appears to have worked. The library provides most of the Com API functionality and works much better than the code originally shared. The reason for sharing this code is that a more versatile lib may be developed and released with minimal restrictions.

Figure 2.IR Touch Screen in the proposed Low Cost MEMS

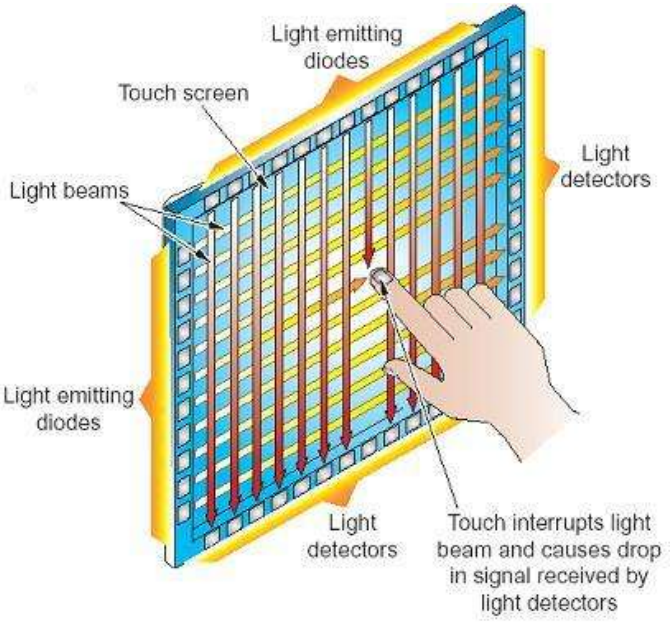
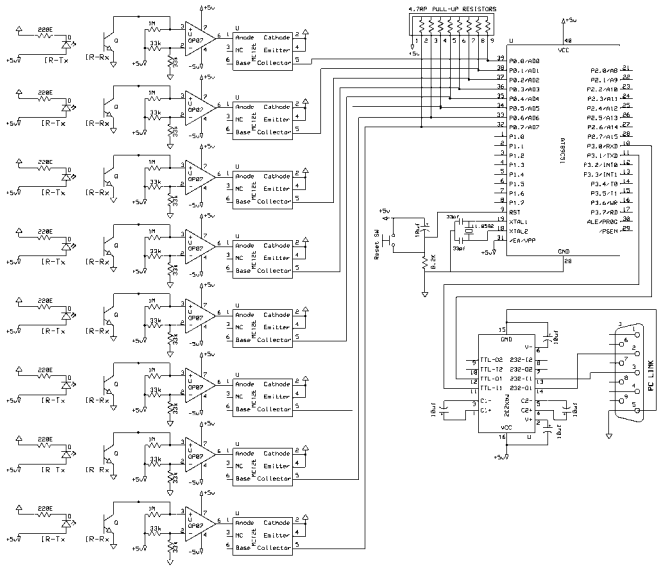


Figure 3.Circuit Diagram for IR Touch Screen



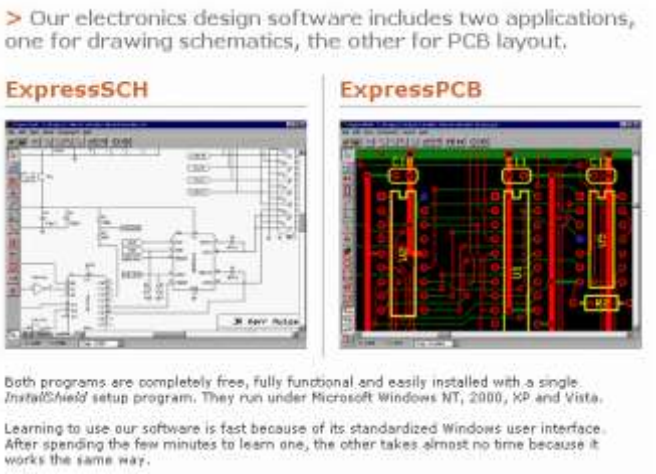


Figure 4.Express PCB

III. *Conclusions*

This paper developed a low cost Multi-touchable screen for restaurant management system using JAVA and other open source tools such as NetBeans that solved the limitation of PDA-based food ordering system and the high cost MEMS. The Low Cost screen provides an interactive view for the customer and shows proper workflow to manage restaurant operations digitally such as ordering, chef and billing systematically. An authoring system was developed as part of the system to allow manager to easily create, update and manage the multi-touchable dining menu. With the Low Cost screen, customers can easily operate the touch screens no longer need to wait for attendant to serve them during the peak hours. Customers themselves could make order on their table surface by interacting with the multi-touchable dining menu using fingers, any time they wish reducing the waiting time for an attendant. In short, the system if implemented properly, could possibly improve the overall restaurant revenue, reducing labor cost, providing a better quality of services, enhance customer's dining experience and the main thing is of Low Cost which can be affordable by restaurant managers.

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