INFRARED LASER BASED WIRELESS TOUCH SCREEN

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Abstract— **In this paper we designed a infrared touch screen hardware system aiming to provide multiple screens touch screen facility with the help of a single ARM Kit with maximum possible sensitivity. We use ARM 7 processor LPC2132 to collect the Coordinates from the sensor matrix and send the coordinates to the respected CPU on wireless mode. In the design we are using infrared LASER and IR sensors matrix on X and Y coordinate of screen to capture the touching coordinates on the screen which provide high sensitivity and maximum durability with less maintenance and with facility of reparability of damage. with the design of Lasers and IR Sensors we also provide the facility of expandability to the user with the reuse of the screen to any size of screens to be provide touch sensitivity.**

Keywords-component; Multiple Screens touch facility with single kit, Wireless Data transfer, ARM Hardware and Software system, Expandability, Maximum Sensitivity, Reparability.

I. INTRODUCTION

With the development of touch screens now the need is to provide a touch screen which should be more Durable more feasible to environment and human use and should be repairable also how if the same touch provide the customer touch screen facility to multiple screens/objects (with the help of a single kit). In order to provide a high sensitive and high detection capacity with help of almost all types of obstacles I have designed a touch screen used of Laser Matrix coupled with Sensors to detect the touch on the screen. With the next attractive feature of data transfer between Touch screen Hardware and Application Hardware (ARM kit and CPU) in wireless mode it has removed dependency of placement of the Circuit and made it most versatile touch screen. With the Expandable feature of our Laser Touch screen it has made the screen most compatible touch screen with the use of touch screen application hardware, where user can just increase the amount of LASER's in order to support the extendibility of the touch screen. And user can use the same touch screen even if the screen which he needs to be provided touch sensitivity is of different size.

II. THE FRAME OF THE SYSTEM

The theory of infrared multi-touch technology is that N numbers of infrared Lasers are placed on the X and Y axis of the screen which will define the horizontal and vertical coordinates and exactly to the opposite there will be IR sensors which will be continuously sensing the LASER light. When the Finger touch the screen infrared light will be shielded from sensors, the design of the matrix coordinates depend upon the ARM 7 processor which controls the infrared LASER, IR Sensors and respectively deals with the signals which sensors provide. And final information of touch points is sent to the host Computer by wireless communication driven by ARM7 processor. As shown in the Fig 1.

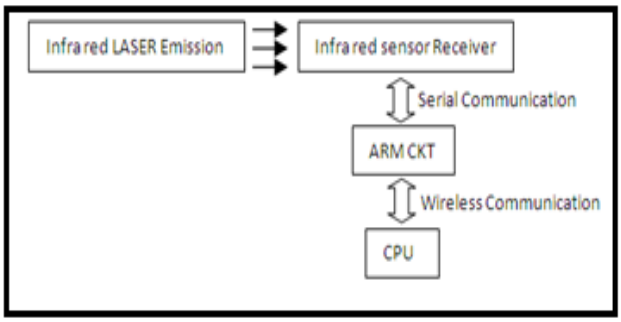

Figure 1 The Frame Diagram of the System.

III. INFRARED LASER EMISSION AND SENSOR RECEIVER MECHANISM

A. INFRARED LASER EMISSION MECHANISM

In this paper we have selected LASERs for transmitting Light as the LASERs have strong luminous intensity, larger transmission distance and narrow emission spectra than IR and other light emitting sources. The LASERs are driven by LM1117 chip designed power supply circuit. Having a regulated, fast, power saving and constant power supply. The diagram of infrared Laser emission mechanism is shown in Fig 2.

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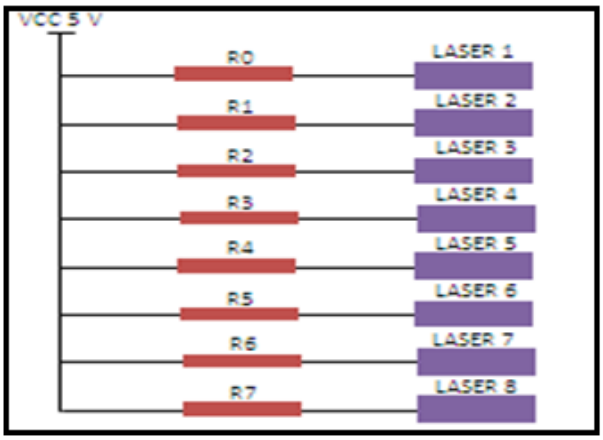

Figure 2 The Infrared LASER emission mechanisms

B. INFRARED SENSOR MECHANISM

According to luminous properties and physical properties of the infrared emission tube which is driven by Multiple LASERs, we have select IR sensor which has higher light detection efficiency. Here we have use the comparator circuits for converting the current figure difference send by Sensors in order to change the state of the IO pins of the ARM High and Low which in case leads to the Coordinate calculation. This diagram of Infrared sensor mechanism is shown in the Fig 3.

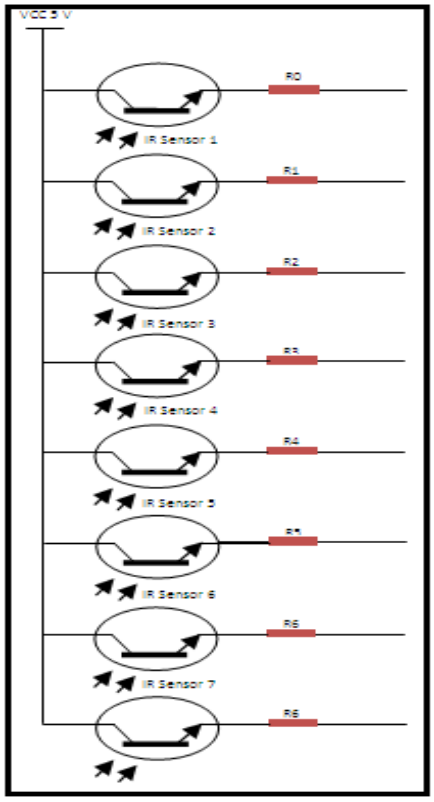

Figure 3 The IR Sensor Mechanism.

IV. THE CONTROLLER DESIGN

A. RESET & CRYSTAL DESIGN:

RESET DESIGN:

Reset is used for putting the microcontroller into a 'known' condition. That practically means that microcontroller can behave rather inaccurately under certain undesirable conditions. In order to continue its proper functioning it has to be reset, meaning all registers would be placed in a starting position. Reset is not only used when microcontroller doesn't behave the way we want it to, but can also be used when trying out a device as an interrupt in program execution, or to get a microcontroller ready when loading a program.

In order to prevent from bringing a logical zero RESET pin accidentally, RESET has to be connected via resistor to the positive supply pole AND a capacitor from RESET to the ground. Resistor should be between 5 and 10K and the capacitor can be in between 1µf tp 10 µf. This kind of resistor capacitor combination, gives the RC time delay for the µc to reset properly.

As shown in the above circuit we are connecting an RC circuit to the RESET (pin 57) of µC .The ARM µC has an active low reset, therefore we connect an RC circuit. As shown the capacitor is initially at 0v.It charges via the supply through a 10 kohm resistance in series, therefore the reset time of our circuit is:

R*C = 10kohm * 0.1 µf = 1 Msec

Recommended time of reset = 1 µsec Here the RC time can vary from 10 µsec to 1 msec.

CRYSTAL DESIGN

Pins OSC1 & OSC2 are provided for connecting a resonant network to form oscillator. Typically a quartz crystal and capacitors are employed. The crystal frequency is the basic internal clock frequency of the microcontroller. The manufacturers make available PIC designs that can run at specified maximum & minimum frequencies, typically 1 MHz to 32 MHz. State Cycle for the Crystal is as shown in Fig 4

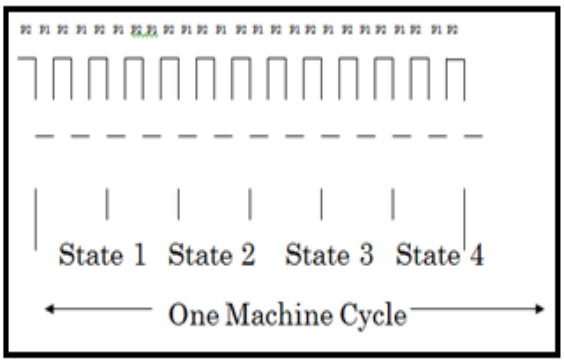

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Figure 4 State cycle for the crystal

2nd VCC and GND is at 15 and 16 NO. Pins of LCD. Used to drive the backlight of LCD. 100 ma current

Total current consumption = 3ma + 100ma = 103 ma

So, in order to reduce the current requirement we are connecting a 330 ohm resistance in series with the backlight pin VCC. This reduces the current consumption to (100ma / 330ohm = 0.303 ma)

Therefore new total current consumption = 0.303ma+3 ma =3.303 ma.

B. RS 232:

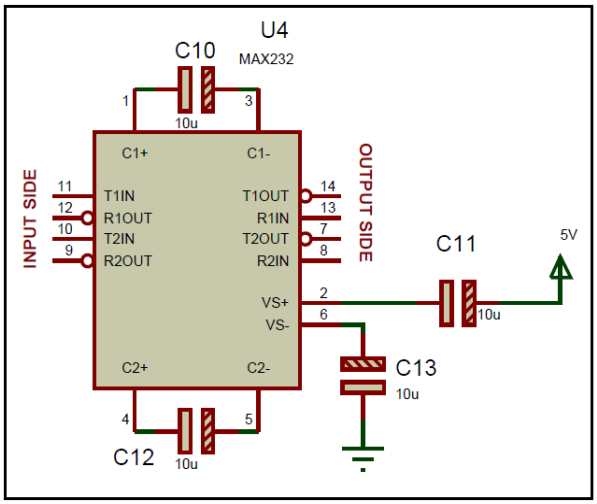

Figure 5 Crystal Circuit.

RS 232 IC is a driver IC to convert the µC TTL logic (0-5) to the RS 232 logic (+-9v).Many device today work on RS 232 logic such as PC, GSM modem, GPS etc. so in order to communicate with such devices we have to bring the logic levels to the 232 logic (+/-9v).Here as we can see the RS 232 chip has 2 pairs of TTL and 232 logic via,

Pair 1: Pin 7, 8, 9, 10 of RS 232
Pair 2: Pin 11, 12, 13, 14 of RS 232

We can use any one pair in our project either 7,8,9,10 pair or 11,12,13,14 pair. if we require 2 serial ports then Depending on the requirement of the project we may have to use both the pair in the same project. The µC works on TTL logic (0-5 v).So to convert the TTL logic to 232 logic we use the 4 capacitors connected to the RS232 IC. These capacitors are called charge pumps used to convert the TTL voltage to the +/- 9 v swing required by the 232 IC.

Dual Charge-Pump Voltage Converter

The MAX220–MAX249 has two internal charge-pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation. The first converter uses capacitor C1 to double the +5V input to +10V on C3 at the V+ output. The second converter uses capacitor C2 to invert +10V to -10V on C4 at the V- output.

C. LCD SECTION

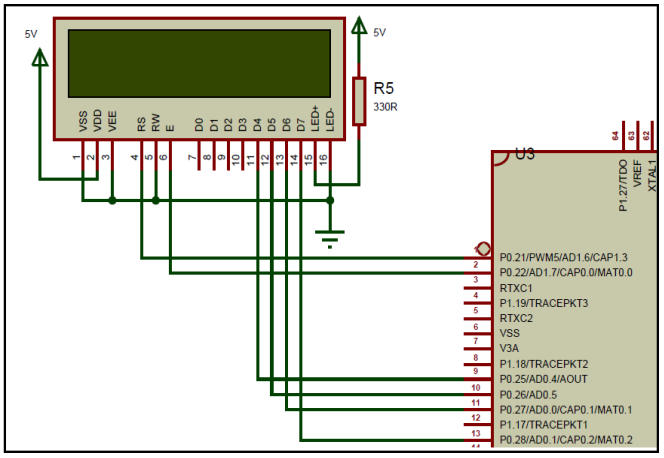

Figure 6 LCD Connections.

LCD has 2 power sources:

a) VCC and GND is at 1 and 2 NO. pins of LCD. Used to drive the LCD 3ma current consumption.
b) VCC and GND is at 15 and 16 NO. pins of LCD. Used to drive the backlight of LCD. 100 ma current

Total current consumption = 3ma + 100ma = 103 ma

So, in order to reduce the current requirement we are connecting a 330 ohm resistance in series with the backlight pin VCC. This reduces the current consumption (100ma / 330ohm = 0.303 ma).

Therefore new total current consumption = 0.303ma+3 ma =3.303 ma.

LCD data and control lines:

LCD has 8 / 4 data lines and 3 control lines .The 4 data lines of LCD (pin 11 to pin 14 of LCD) are connected to port 0 of the µC (0.25 , 0.26 , 0.27 , 0.28).The control lines are LCD RS, LCD R/W ,LCD E. In this we are connecting only 2 lines, via, LCD E and LCD RS. The LCD RD/WR pin is grounded, since we only write into the LCD and never read from LCD. These 2 lines are connected to the port 0 (0.21 , 0.22) of the ARM µC. The LCD RS is for selecting the data or

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the code register .The LCDR/W is for choosing between reading or writing on LCD. LCDE is for enabling or disabling the LCD.

V. THE ABTI-GLARE INTERFACE DESIGN

In LASER based touch screen we are using Light as a mode of conduct for detecting the touch. The interruption of light falling on IR sensors detects the touch. But as the environment contains many light factors which will be disturbing the IR sensor mechanism. When the environmental light reduces the Light sensing capacity of the IR sensor. So in order to improve the Detection of the light interruption we need to capture the difference in light falling on the IRs.

So in order to detect the difference we have to use 24 pairs of comparator circuit to compare 16 by 8 Matrix, 16 lasers on horizontal axis and 8 lasers on vertical axis of the screen. We are usingLM358 in comparator circuit. Which will calculate the Current difference and pass the ON OFF option which will be further supported by PULL UP registers for making the IO pin of the ARM high or low? When a figure or any hard device will interrupt the laser there will be change in sensor current which will be detected by the Comparator circuit and high or low pulse will be sense by the IO pin of the ARM with the help of PULL UP registers which will ultimately provide the coordinates of the touch on the screen. The circuit diagram of Comparator is shown Fig 7.

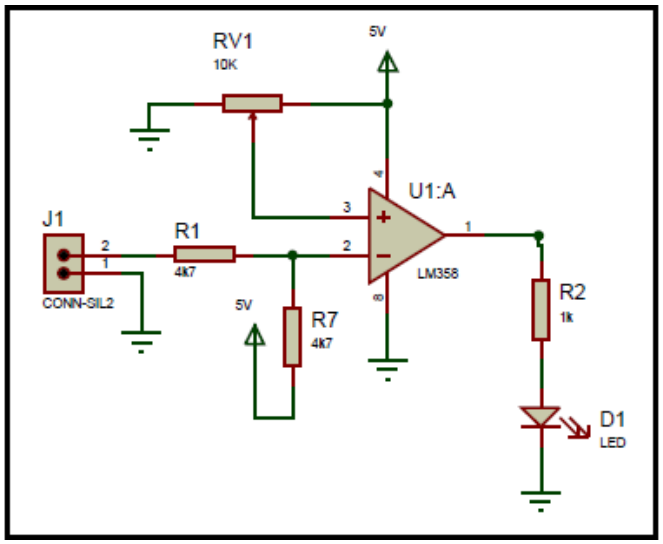

Figure 7 Comparator Circuit

VI. POWER SUPPLY DESIGN OF THE PROJECT :

The circuit diagram of regulated power supply is shown in Fig 8.

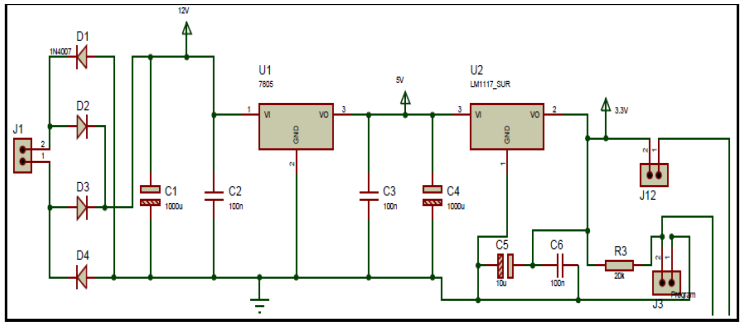

Figure 8 The Regulated Power Supply.

5 V Power Supply:

The basic step in the designing of any system is to design the power supply required for that system. The steps involved in the designing of the power supply are as follows,

1) Determine the total current that the system sinks from the supply.

2) Determine the voltage rating required for the different components.

The bridge rectifier and capacitor i/p filter produce an unregulated DC voltage which is applied at the I/P of 7805.As the minimum dropout voltage is 2v for IC 7805, the voltage applied at the input terminal should be at least 7 volts .C1 (1000 µf / 65v)is the filter capacitor and C2 and C3 (0.1 pf) is to be connected across the regulator to improve the transient response of the regulator. Assuming the drop out voltage to be 2 volts, the minimum DV voltage across the capacitor C1 should be equal to 7volts (at least).

The average voltage at the output of a bridge rectifier capacitor filter combination is given by

$$Vin(DC) = Vm - Idc / 4 f C1$$

Where , $Vm=\sqrt{2}\,Vs$ and Vs = rms secondary voltage

Assuming Idc to be equal to max. load current, say 100mA

$$C = 1000\,Gf / 65v\ ,\ f=50hHz$$
$$19 = Vm - 0.1 / 4*50*1000*10^{-}6$$
$$19 = Vm - 0.1 / 0.2$$
$$Vm = 19.5\ volts$$

Hence the RMS secondary Voltage

$$Vrms = vm / \sqrt{2}$$
$$= 19.5 / \sqrt{2}$$
$$= 19,5 / 1.4421$$
$$= 13.5\ volts$$

So we can select a 15v secondary Voltage In our system most of the components used require 5 V as operating voltage such as micro controller, MAX 232, MCT2E etc. The total current, which our circuit sinks from the power supply, is not more than 100 mA. We have used Regulator IC 7805 that gives output voltage of 5V.The minimum input voltage required for the

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7805 is near about 7 v. Therefore we have used the transformer with the voltage rating 230v-10v and current rating 500 mA The output of the transformer is 12 V AC. This Ac voltage is converted into 12 V DC by Bridge rectifier circuit.
The reasons for choosing the bridge rectifier are:
a) The TUF is increased to 0.812 as compared the full wave rectifier.
b) The PIV across each diode is the peak voltage across the load =Vm, not 2Vm as in the two diode rectifier

Output of the bridge rectifier is not pure DC and contains some AC some AC ripples in it. To remove these ripples we have used capacitive filter, which smoothens the rippled out put that we apply to 7805 regulators IC that gives 5V DC. We preferred to choose capacitor filters since it is cost effective, readily available and not too bulky.

3V Power Supply Design:

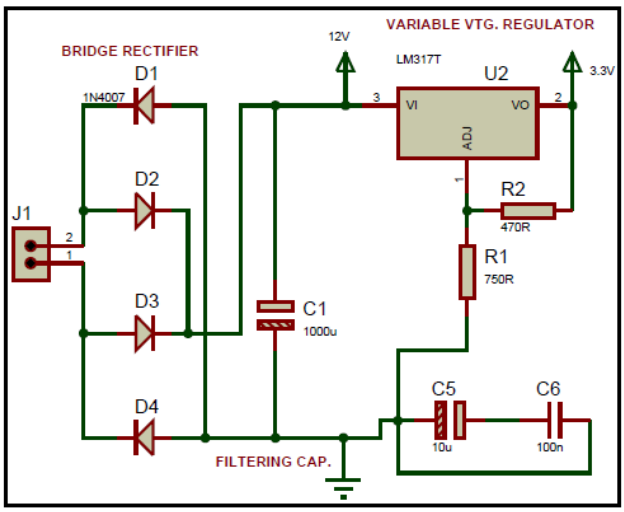

Figure 9 3V Power Supply

The formula for calculating the output voltage of ARM is (As given in the datasheet of LM317)

Assuming R2=470 ohms and I adj =0 then,

Vout= 3.3v = 1.25v (1+R2/450)
3.3v/1.25v= (450+R2)/450
2.64* 0.45 Kohm = 0.45kohm+R2
1.18 – 0.45kohm=R2
R2=738 ohms

Nearest Value of resistance is 750 ohms Therefore with R1=450 ohms and R2=750 ohms we get an o/p of 3.3v

VII. THE TOUCH POINT LOCATION

When all the IR sensors are given power a particular amount of drain current passes through the circuit. When the lasers are powered on and focused on the Sensors, sensors detect the light intensity and there is reduction in a drain current which is the first recorded current or taken as initial current. Now when any obstacle cuts the laser beam and the light focused on the sensor is disturbed then current flowing through the circuit increases. This change in the drain current is compared with the help of the comparator circuit before obstruct and after obstruct. Which is then passed as high or low pulse to ARM IO which are enhanced with the help of PULL UP registers and then IO of that particular IR sensor is turned high which in case detects the touch.

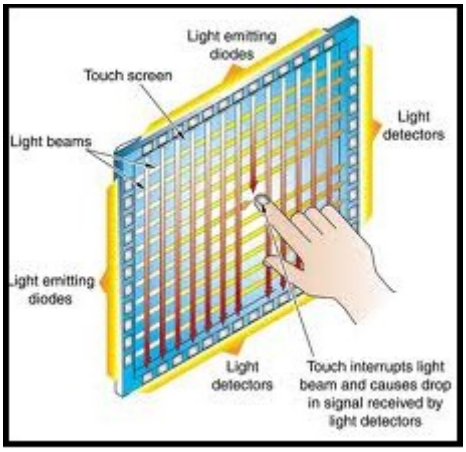

Figure 10 The obstruct diagram of figure touch

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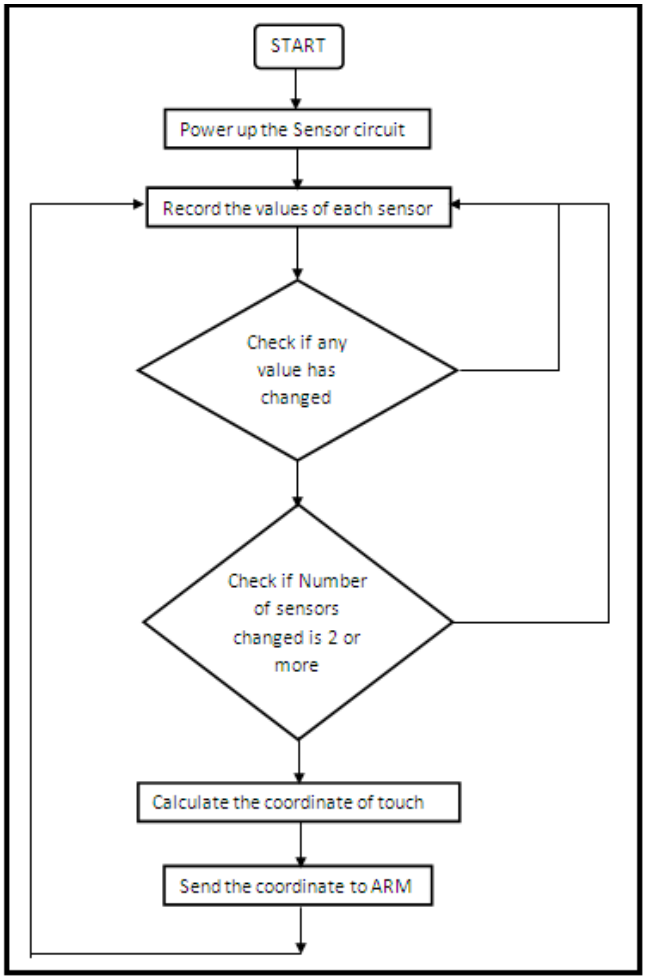

Figure 11 Detecting touch point and calculating touch point.

VIII. MOUSE CLICK EVENT WITH HELP V.B.

The data forwarded by the ARM7 processor which is wirelessly forwarded with the help of RFCC2550 which is collected by the CPU with the relevant circuit at the CPU end this data is been fetched with the help of VB software.

The Visual Basic software takes the data/coordinates provided by the ARM board and then performs the Mouse click operation. This data can be also provide to operate multiple other operations such as operation of buttons or any other functions.

Figure 12 SNAP shot of VB capturing the Data received from ARM 7

IX. COMPLETE ARM BOARD CIRCUIT

In This paper we have used LPC2132 ARM processor which helps us to have 24 IOs for taking direct data from IR sensors via comparators circuit. It provides us to check the data on LCD at ARM board itself. With the help of LCD we can detect various cross check on the data provided by the sensor circuit on ARM board itself. With the help of LPC2132 can make possible wireless communication with the CPU. In this paper we have designed ARM 7 processor board for the calculation of coordinate and passing the values to CPU. We have LCD to monitor the data received from sensor on ARM 7 processor board itself we have designed a regulated Power supply in order to maintain constant and high power requirement of the components. A wireless communication mode between ARM board and CPU is establish in order to remove the placement requirement of the ARM 7 board circuit and CPU. Complete ARM board circuit containing power supply circuit and LCD is shown in Fig 10.

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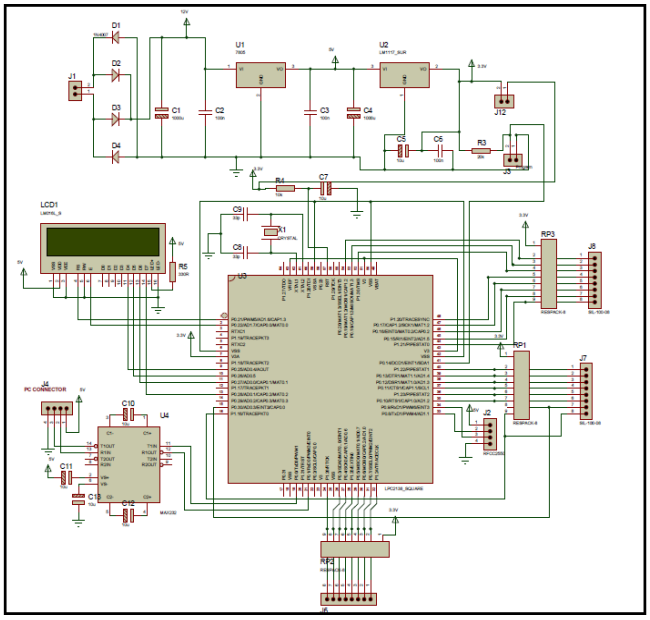

Figure 13. The Layout of Hardware circuit diagram of ARM board and Power Supply.

X. PCB LAYOUT

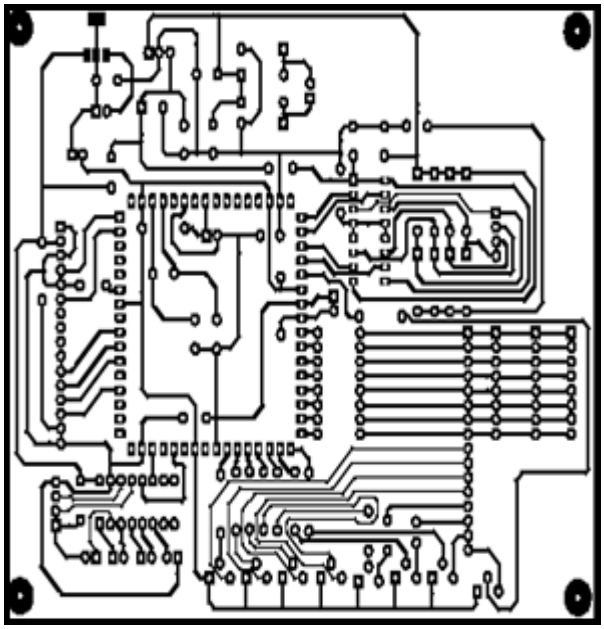

Figure 14 PCB Layout

XI. TOUCH SCREEN FACILITY FOR MULTIPLE SCREENS

In this paper we have additionally added to use a single touch-screen for multiple Screens. In order to operate a touch screen the coordinate information from the touch sensing device to ARM and from ARM to CPU is made. We can construct a architecture which will pass the data to multiple CPUs. This can be made possible with the help of Master and Slave mode operations. Our Master will remain same that is ARM7 board. On the option selected by the user for the screen selection the data will be accepted by that CPU only. This also allow to run the touch screen mechanism irreverent of what type screens are there and what type of operation it is performing the touch screen will perform a Mouse Click operation depending on the coordinates provided by the ARM7 processor.

XII. APPLICATION AND ADVANTAGES

A. Application

1) Operating/controlling multiple machines containing multiple control panels with the help of a single touch screen.
2) Operating screens with distantly placed Operating system (CPU)
3) Providing touch screen facility in strong environment obstacles like magnetic field, and where you can't provide the extra factor to sense the touch like pressure, electrostatic etc.

B. Advantages

1) With the use of LASER's the sensitivity of touch increases tremendously.
2) The sensitivity of the touch will remain same thought the existence of the touch screen and will not reduce with the time like other touch screen.
3) The expansion of the touch screen is possible.
4) The maintenance and repair of screen is also possible in case of any physical damage.
5) In order to operate touch screen no need to consider any factor such as electrostatic or pressure etc.
6) With the help of master slave communication possible in ARM7 architecture single screen can be used to provide touch screen facility to multiple screens.
The wireless communication between ARM7 and CPU finishes the on board placement requirement of the Circuit

RESULT AND DISCUSSION

Main result of the paper is to provide a high sensible touch screen where the sense is not dependent on any factor such as pressure electrostatics etc. the here the paper provide such touch screen which is highly sensible, repairable, durable and expandable. The single touch screen can be used to provide touch screen facility for multiple screens with the help of single ARM kit.

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CONCLUSION

This paper designs a LASER based wireless touch screen. This is based on ARM 7 processor hardware system. The Lasers and sensors are used to make a matrix to collect x and y coordinates. And the data communication is made wireless between ARM7 kit and CPU. We have designed a touch screen to provide touch screen facility for multiple screens.The latest ARM processor has been employed by us who makes the system more compatible. The Mechanism designed helps increase the durability, Flexibility and response of the system. Thus in short all the feature of our system makes it more versatile. In future we will keep on researching how to increase the resolution of the touch screen.

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