Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 11, pp.40982-40988, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

DEVELOPMENT OF AN EMBEDDED SYSTEM BASED TOUCH SCREEN SOLUTION

[1,] *Naresh Kumar, [2]Dr. Pardeep Kumar and [3]Sunita Rani

[1]FET, SGT University, Gurgaon
[2]YMCA University of Science & Technology, Faridabad, India
[3]Bhagat Phool Singh Mahila Vishwavidyalaya, India

ARTICLE INFO

Article History:
Received 22nd August, 2016
Received in revised form
19th September, 2016
Accepted 08th October, 2016
Published online 30th November, 2016

Key words:

Embedded system,
Touch screen,
Capacitive,
PIC,
Microcontroller,
Sensor.

ABSTRACT

Any electronics system is the comprises of basically three units: first is an input device to give the command to the system, second is the processor to perform the specific operation according to the command received and last is output device to get the result in the different form of information like graphical form, mechanical work, numerical value etc. Generally all the available input devices uses the different type of switches, these all devices have different no. of demerits such as large power consumption, bulkier in size, occupy large space etc. in order to eliminate all these limitation we have another advanced technology that is touch screen. In the field of touch screen technology we have different type of resistive touch screen technology. But they also have some disadvantage so our main focus on to design new capacitive touch screen devices or to design new algorithms to detect the touch event on the specific location of touch screen device. In this new algorithms methods we uses the concept of capacitance of the device when there is touch will be occurred, this increases capacitance is the combination of parasitic capacitance & finger capacitance of the touching body. This relative increasing capacitance increases the Γ (time constant) which decreases the frequency of signal generated at the time of touching the devices. Now this increases capacitance of the device by touch event can be identified by the decreases frequency or the increases time for which touch screen produce the voltage signal. And then assign the specific operation to each touch portion of the screen.

Citation: Naresh Kumar, Dr. Pardeep Kumar and Sunita Rani, 2016. "A Geographical Appraisal of Health Care Facilities in Lakshadweep Islands", *International Journal of Current Research*, 8, (11), 40982-40988.

INTRODUCTION

Review terms

- Electronic devices made by semiconductor or/and conductor which allow the flow of current in a specific direction or may be try to restrict the flow of current, and finally perform a specific operation as per the configuration.
- Entity/module is the group of electronic devices, with the help of a specific arrangement of these devices it produce a specific function. Each time this module can be used in different application by replacing a large electronic circuit.
- System comprises various module in a single unit and finally used in a specific application. Broadly system consist input device, central processor, output device module.
- An embedded system is the microcontroller based system which is designed for a specific application as per need.

Corresponding author: Naresh Kumar,
FET, SGT University, Gurgaon.

As an embedded system uses a microcontroller as a central processor of the system so microcontroller is single time programmed. Hence an embedded system perform the specific work throughout his life

Major issues with input device module and solution

After analyze various types of available input device modules for the electronics industry, it is conclude that some of areas have to be workout.

- Large power consumption in various electronic switches.
- Need of lubricant in various mechanical switches.
- Bulkier in size.
- Large space occupied by the switches.
- Weight of mechanical switches

After continuous research in this field, most suitable solution of general input devices may be touch screen module. In the today's scenario, there are various touch screen technologies available. We proposed development of an embedded system based touch screen solution to overcome the problems with general peripherals.

Introduction to touch screen module

A touch screen is an electronic visual display input device module. The touch screen has two main attributes (Touchscreen, 2016).

- It enables one to interact directly with what is displayed, rather than indirectly with a cursor controlled by a mouse or switch.
- It performs its function without requiring any intermediate device that would need to be held in the hand. Such displays can be attached to computers, or to networks as terminals.

A. Various type of Touch Screen (Falcidieno, 2010)

- Capacitive touch screen technology
- Surface capacitance
- Projected capacitance Touch (PCT) technology
- Surface acoustic wave touch screen
- Infrared touch screen
- Dispersive signal technology
- Acoustic pulse recognition
- Four wire resistive touch screen
- Five wire resistive touch screen
- Eight wire resistive touch screen

B. Construction of touch screen input device module

Typically there are four layers (Capacitive sensing, 2016)

- Top polyester layer coated with a transparent metallic conductive coating on the bottom.
- Adhesive spacer.
- Glass layer coated with a transparent metallic conductive coating on the top.
- Adhesive layer on the backside of the glass for mounting.

C. Operation & functioning in capacitive touch screen

The tissue of the human body is filled with conductive electrolytes covered by a layer of skin, a lossy dielectric. It is the conductive property of fingers that makes capacitive touch sensing possible. Placing a finger near fringing electric fields adds conductive surface area to the capacitive system. The additional charge storage capacity added by the finger is known as finger capacitance, Cf. The capacitance of the sensor without a finger present is denoted as Cp, which stands for parasitic capacitanc. The fundamental components of a capacitive sensing system are a programmable current source, a precision analog comparator, and an analog mux bus that can sequence through an array of capacitive sensors. A relaxation oscillator functions as the capacitance sensor in the system presented in this article.

D. Algorithm to detect touch event on touch screen

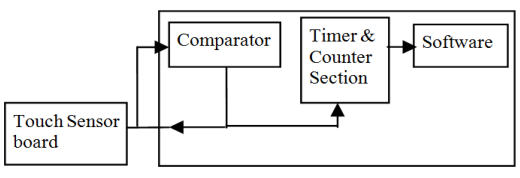

Fig. 1. Touch screen based system

$$C = \frac{\varepsilon_o \varepsilon_r A}{d};$$

Ɛr is permittivity of free space
Ɛr is relative dielectric constant;
A is area of platesin meter square
D is distance between plates in meters &
C is capacitance

Fig. 2. Capacitance generating in a system

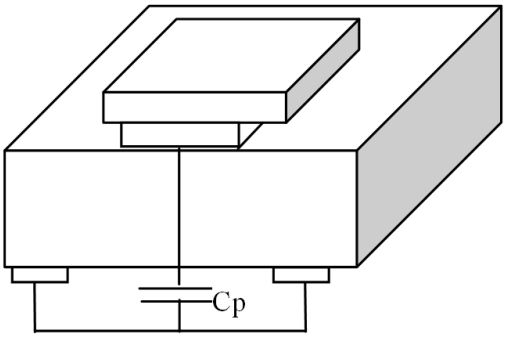

Fig. 3. Capacitance before touch

Figure 3 shows the touch screen board which have a parasitic capacitance between two end's of touch screen. Figure 4 shows the touch event on the touch screen which occurs by finger. At this time there is another capacitance generated between upper conductive layer & finger, Finger capacitance (Cf).

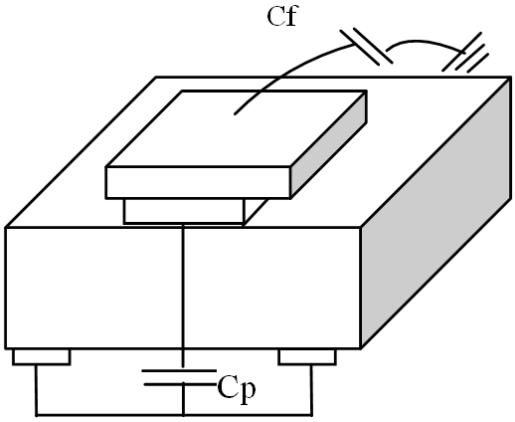

Fig. 4. Capacitance generated in touch screen sensor after occurring touch event

Figure 5 shows electrical equivalent circuit of touch screen before & after touch event occurs on the screen. Sensor capacitance (Cs) of the individual button is Cp & (Cp+Cf) before & after touch event respectively.

Before Touch, Sensor Capacitance (Cs) = Cp

After Touch, Sensor Capacitance (Cs) = Cp + Cf

Fig. 5. Equivalent capacitance circuit before & after occurring touch event button

Figure 6 shows touch screen output signal waveform before the touch event where time constant parameter (τ) is equal to product of R & Cs. Fig. 7 shows touch screen output signal waveform after touch event where time constant parameter (τ) is equal to product of R & (Cp+Cf).

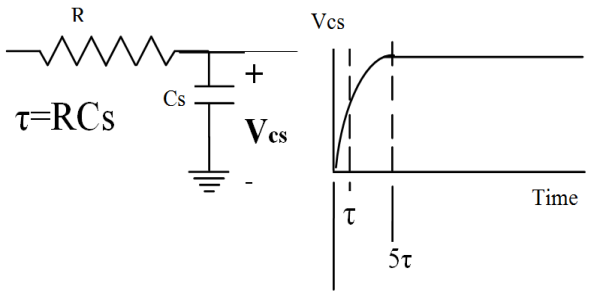

Fig. 6. Touch screen output signal before touch event

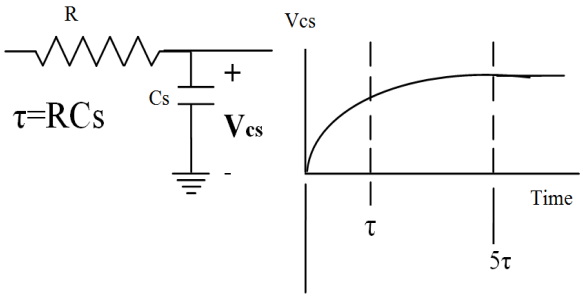

Fig. 7. Touch screen output signal after touch event

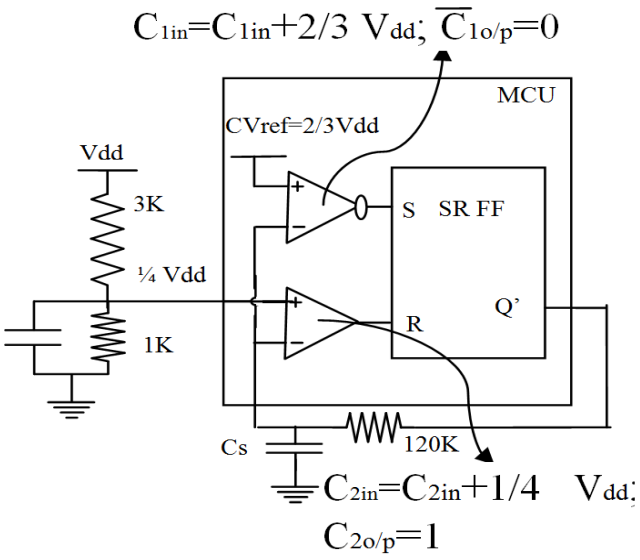

Fig. 8. Relaxation oscillator circuit

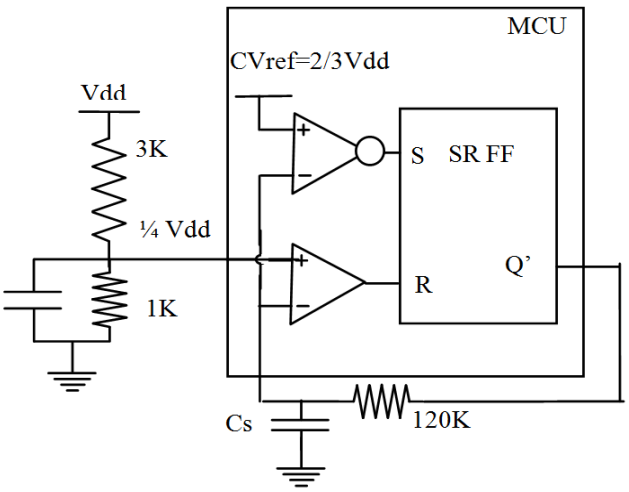

Fig. 9. Relaxation oscillator circuit

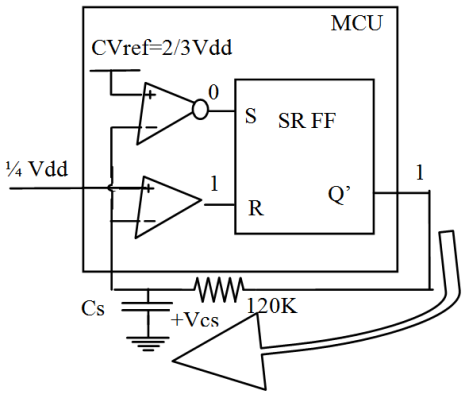

Fig. 10. Oscillator operations

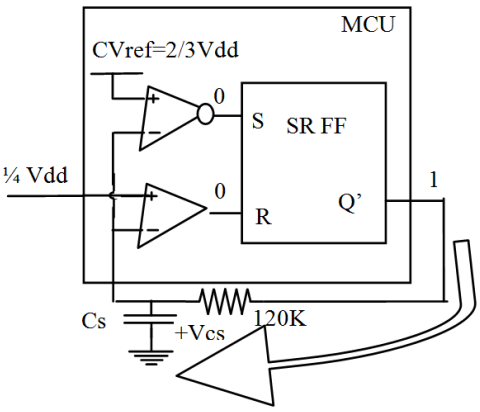

Fig. 11. Oscillator operation

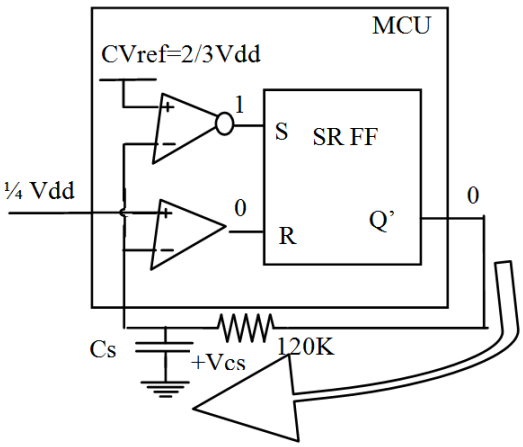

Fig. 12. Oscillator operation

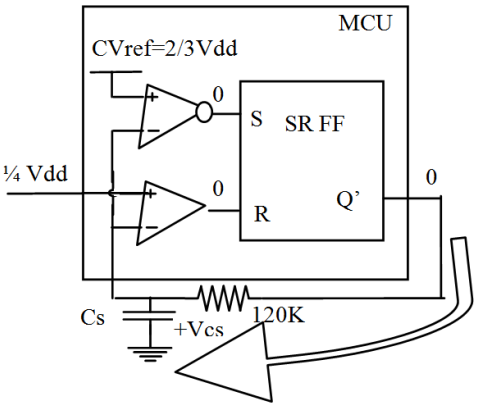

Fig. 13. Oscillator operation

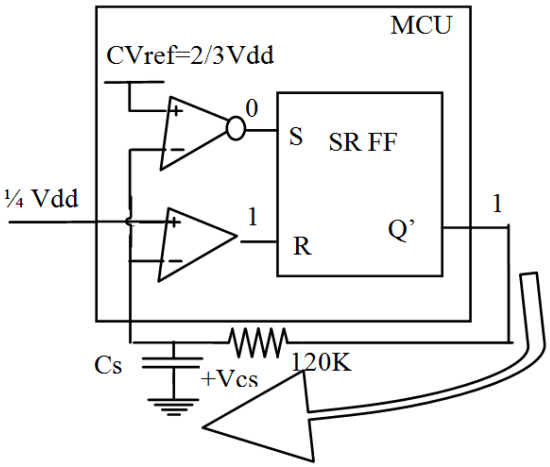

Fig. 14. Oscillator operation

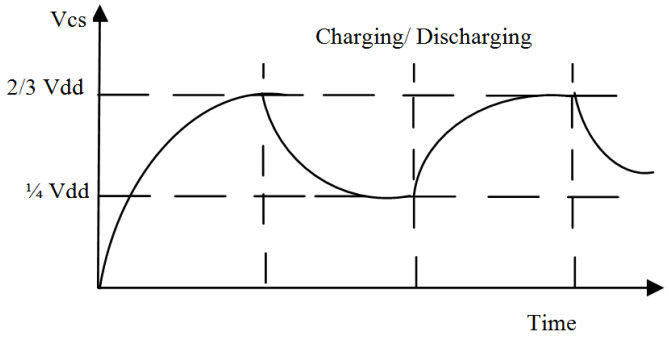

Fig. 15. Vcs voltage Charging & discharging waveform

Hardware setup structure

A. Central processor module

Central processor, heart of a system play most important role in functioning which may be microcontroller or an advanced intelligent system. Here PIC microcontroller is used as a central processor module to receive the signal from touch screen in the form of variation in the respective port connected to the touch panel. Selection of PIC microcontroller depends upon following constraints.

- New designed system should be small as much as possible so it occupies small space & it should be portable.
- New system consumes less power as much as possible, so it can perform their operation with a limited source of energy.
- New system should be respond as fast as possible to the given command from the touch screen display.

B. Touch Board interfacing

On-chip Cap Sense Module (CSM) create a relaxation oscillator to perform touch sensing. The period or frequency of the relaxation oscillator can be measured, and when the sensor is touched, the frequency will dropped the period will increase, indicating a touched condition. When any additional capacitance is added to the circuit, the fixed current source will now charge the circuit to a lower voltage. This change is how the microcontroller detects a touch event (Archive, 2016). Some the available touch sensor board are described as

- **8-key one_to_one board** is an 8-channel plug-in board which can be interfaced with any of the 8 channels of the 16 channels provided in the evaluation board. Touching any one of the keys on the touch sensor board will light up the corresponding LED in the evaluation board.
- **12-key matrix touch sensor board** is an array of 12 keys in a 4x3 matrix form where each key is interfaced through two channels. The software is for the Matrix Key board through channels 8 to 14 in PIC16F.
- **2 & 4 Channel slider touch sensor board t**ouching anywhere along the length of the slider board causes all the LEDs to light up as a bar graphs that is representative to the position of the touch

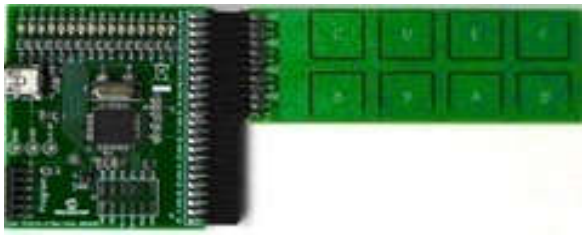

Fig. 16. One to one touch board connected with board

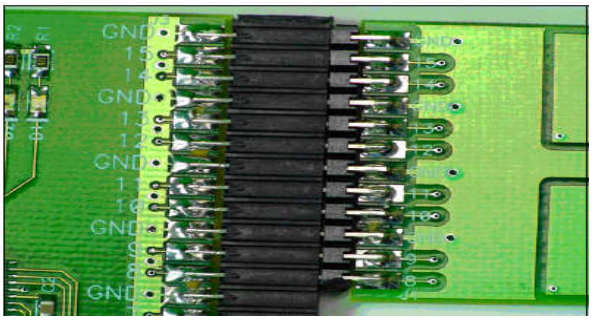

Fig. 17. Interfacing channels with 8-key touch board

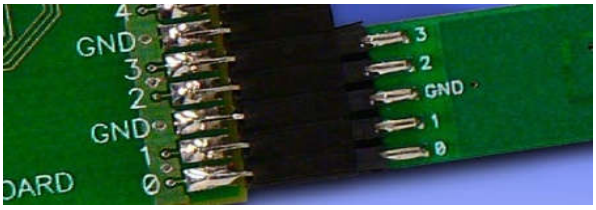

Fig. 18. Interfacing channels with 4-channel slider touch board

Development of touchscreen based solution

Place the developing application on a flat surface near the computer where no objects underneath the board. The CSM Evaluation Board uses the PICkit Serial Analyzer to communicate with PC.

Fig. 19. Setup of the embedded system

A. Working Layout for touch screen based Solution

It comprises following important parts.

1. CSM evaluation Board has following features.

- PIC 16F7XX is the central part of an embedded system which can be programmed as per the application.
- J1 (Programming Header) is 6-pin header used to connect the board to compatible programmer.
- J2 (I2C PIC Kit Serial analyzer) is used in In-Circuit-Serial Programming.
- Connector J3 & J4 are used to command evaluation board through touch sensor.
- J5 (USB mini-B Receptacle). Is used to provide regulated power supply of 3.3 V to the evaluation board.
- 16 LEDs in the evaluation Board are driven by the microcontroller through PORTD and PORTE.

2. Interface Touch sensor board with CSM Evaluation Board.
3. After the hardware connections are done, open the working project in the MPLAB IDE and make the required changes for the corresponding touch board.
4. Download the Hex file onto the evaluation board using the MPLAB ICD 2 interface.
5. Test the working of the respective touch boards as per application.

B. Interfacing of various touch screen sensor to the board

- Interfacing of 1-to-1 touch board in b/w Led's actuators & evaluation board is comprises by table 1.
- Interfacing of matrix touch board in with evaluation board & allotment of actuators with corresponding keys are given by the table 2.

Table 1. Pattern of key's to led through port's

LED 16	←	PORT.15	←	Key F
…..	…..	….	….	….
LED 11	←	PORT.10	←	Key A
LED 10	←	PORT.9	←	Key 9
LED 9	←	PORT.8	←	Key 8

Table 2. Pattern of the matrix board to the controller

Port.14	Key 0	Key 1	Key 2	Key 3
Port.13	Key 4	Key 5	Key 6	Key 7
Port.12	Key 8	Key 9	Key 10	Key 11
	Port.8	Port.9	Port.10	Port.11

Table 3. Command actuator pattern

LED15	*Key 0*	*Key 1*	*Key 2*	*Key 3*
LED14	*Key 4*	*Key 5*	*Key 6*	*Key 7*
LED13	*Key 8*	*Key 9*	*Key 10*	*Key 11*
	LED9	LED10	LED11	LED12

Table 4. Interfacing of two slider board to the evaluation board

LED 1	←	PORT.0	←	SLIDER 1—Mode 0
LED 2 & 1	←	PORT.1 & .0	←	SLIDER 2 &1—Mode 1
LED 2	←	PORT.1	←	SLIDER 2—Mode 2

- Interfacing of slider two touch sensor with evaluation board & actuator specified by table 4

Software module

A. Touch Sensitivity

The response of the sensor to fingertip touch is influenced by many factors:

- Touch areas
- Voltage and current levels
- Ambient humidity
- Static buildup and so on.

B. Consideration to programming

- The touch sensor solution uses the PIC16F microcontroller's CSM and all 16 of the microcontroller's A/D input channels to monitor the touch interfaces.
- A touch on copper pad electrodes make small changes in capacitance. By continuously monitoring for these changes, the CSM can determine when a touch event occurs.
- A total of 16 LEDs are connected to the PORTD & PORTE on evaluation board.
- The microcontroller uses its on-chip transceiver to communicate to the PC.
- No external power supply required for touch sensor solution.

Result and validation of touch screen system: An embedded system has been developed as per application & tested for individual key detect. Experimental result is in the form of signal waveform before & after touch event on the touch screen sensor.

A. Evaluation board communication with from 1-to-1 board

Table 5 consist transmitted information before touch event for all ports through them board is connected to evaluation board. Table 6 consist information transmitted after touch event occurs.

Table 5. Information transmitted before touch event

Port No.	Vpp (mv)	Freq. (Hz)	Clk cycle	+ve Clk time	-ve clk time
08	118	305.2	3.28 ms	300µs	2.98ms
09	120	306.7	3.26ms	316µs	2.93ms
10	122	305.6	3.27ms	176 µs	3.09ms
11	118	306.3	3.26ms	324µs	2.92ms
12	116	306.3	3.26ms	336µs	3.26ms
13	118	306.7	3.26ms	344µs	2.92ms
14	118	306.0	3.27ms	352µs	2.94ms
15	120	306.0	3.27ms	108µs	3.16ms

Table 6. Information transmitted after touch occurs

Key No.	PORT	Vpp (mV)	Freq. (Hz)	Clk cycle (ms)	+ve clk part	-ve clk Part
Key 8	Port 8	120	282.4	3.54	596 µs	2.96ms
Key 9	Port 9	120	279.6	3.58	640 µs	2.93ms
Key A	Port 10	122	275.3	3.63	660 µs	2.97ms
Key B	Port 11	128	270.2	3.70	388 µs	3.27ms
Key C	Port 8	118	274.1	3.65	688 µs	2.94ms
Key D	Port 9	126	275.3	3.63	660 µs	3.01ms
Key E	Port 10	124	277.1	3.61	684 µs	2.90ms
Key F	Port 11	124	277.4	3.60	692 µs	2.94ms

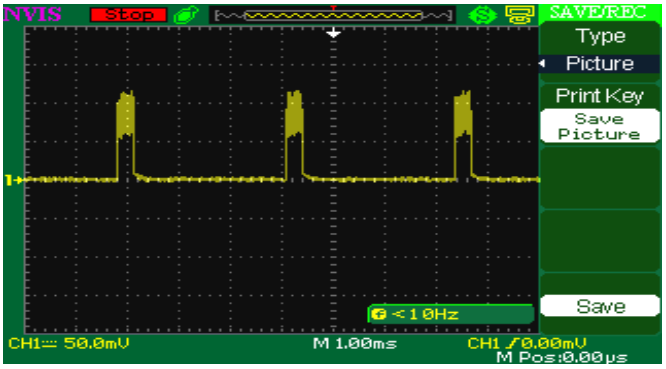

Fig. 20. Signal waveform from 1-to1 board at port.8 before touch

Similarly signal characteristics can be measure at port.9 to port.15 before any touch event occurs as given in table 6.

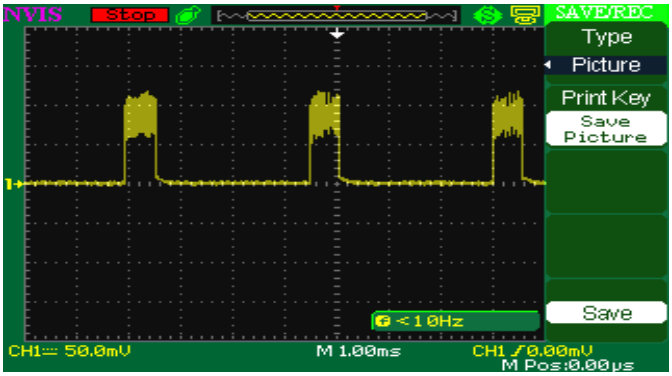

Fig. 21. Signal waveform at port.8 when key 8 at touch occurs

Similarly signal characteristics can be measure at port 10 to 15 when touch occurs at key no A to F given by table 6.

B.Evaluation board communication with from 1-to-1 board

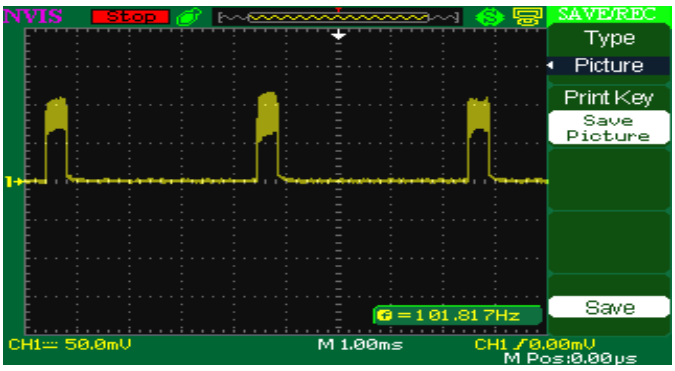

Fig. 22. Signal waveform from Matrix board at Port.8 before touch

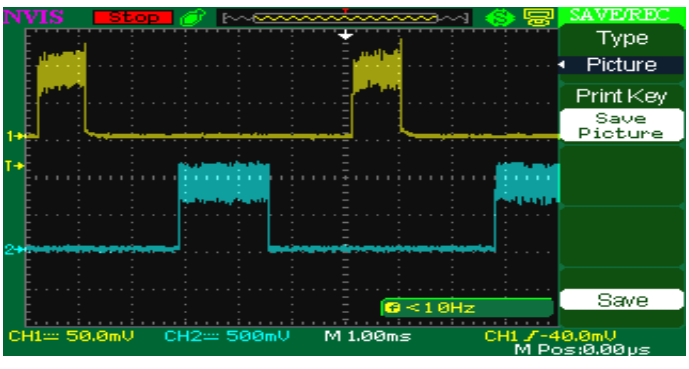

Fig. 23. Signal at port.8 & .1 when key 0 on Matrix board touched

Table 7. Signal strength before touch occur

Port No.	Vpp (mv)	Freq. (Hz)	Signal Period (ms)	Period of +ve Part	Period of -ve Part
8	118	248	4.03	340µs	3.69ms
9	118	246	5.08	1.10ms	3.93ms
10	118	247.5	4.04	400 µs	3.66ms
11	118	247	4.05	400µs	3.64ms
12	132	196.8	5.08	1.15ms	3.88ms
13	118	246.7	4.05	550µs	3.51ms
14	120	248	4.03	176µs	3.86ms
15	120	247.2	4.04	76µs	3.98ms

Table 8. Information transmitted after touch occurs

Key	PORT	Vpp (mv)	Freq. (Hz)	Clk cycle (ms)	+ve clk Part	-ve clk Part
Key 0	Port 8	134	168.5	5.93	864 µs	5.04s
	Port 14	122	168.2	5.94	1.72ms	4.22
Key 1	Port 9	122	176.5	5.66	760 µs	4.08
	Port 14	122	175.8	5.69	1.60ms	4.08
Key 2	Port 10	116	172.6	5.79	856 µs	4.94
	Port 14	128	172.6	5.79	1.64ms	4.14
Key 3	Port 11	114	173.9	5.75	692 µs	5.06
	Port 14	126	173.8	5.75	1.76ms	3.97
Key 4	Port 8	120	159.2	6.28	912 µs	5.37
	Port 13	130	159.2	6.28	1.98ms	4.21
Key 5	Port 9	118	177.8	5.62	664 µs	4.93
	Port 13	126	178.4	5.60	1.68ms	3.89
Key 6	Port 10	116	177.4	5.64	676 µs	5.03
	Port 13	120	175.5	5.70	1.76ms	3.94
Key 7	Port 11	120	171.4	5.83	804 µs	5.03
	Port 13	128	171.2	5.84	1.82ms	4.02
Key 8	Port 8	122	176.3	5.67	700 µs	4.96
	Port 12	130	176.6	5.6	360 µs	5.30
Key 9	Port 9	122	166.7	6.0	916 µs	5.03
	Port 12	122	162.4	6.16	1.78ms	4.38
Key 10	Port 10	116	161.9	6.18	776 µs	5.40
	Port 12	116	163.3	6.12	2.17ms	3.95
Key 11	Port 11	116	170.3	5.94	1.77ms	4.16
	Port 12	120	170.3	5.87	916 µs	4.96

Similarly signal characteristics can be measure at port 9 to port 15 before any touch occurs & values given by table 7. Similarly signal characteristics can be measure at pair of two port when touch occurs at respective key as given in table 9.

C.Evaluation Board Communication with two Slider board

Two slider board have three mode of working as mode 0 to mode 2.

Table 9. Signal strength before touch event

Port No.	Vpp (mv)	Freq. (Hz)	Clk cycle	+ve clk Part	-ve clk Part
Port 0	120	337.3	2.96ms	368µs	2.64ms
Port 1	120	334.6	2.99ms	336 µs	2.65ms

Table 10. Signal strength at touch event occurs

Key	Port No.	Vpp (mv)	Freq. (Hz)	Clk Cycle	+ve clk Part	-ve clk Part
Mode 0	Port 0	120	303	3.30ms	672 µs	2.64ms
Mode 1	Port 0	120	216	4.63ms	604 µs	3.94ms
	Port 1	130	215.8	4.63ms	1.51ms	3.02ms
Mode 2	Port 1	120	196.2	51ms	624µs	4.46ms

Similarly signal strength can be measured in other mode of operation as given by table 10.

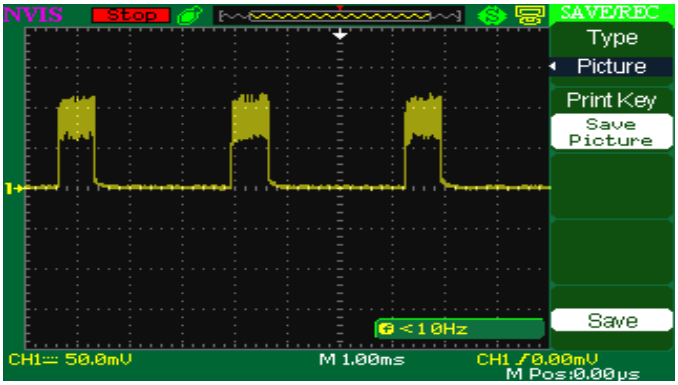

Fig. 24 Signal at port.0 in mode 0 from slider board after touch event

Conclusion and future scope

Paper describe that how the touch event can be detected, & what is the exact position of touch event on the touch screen. In order to support our work, we have developed an application to glow some different LED's connected at the port of controller, & we also make another board to run an DC motor by the finger touch on the key of touch pad. Now we can make the algorithms to detect the touch event on the specific place on the screen. Then we will apply different no. of operation to different part of the touch screen or we can assign different no. of menu's function. After making different function perform on the different touch on the touch pad, we find out the different result in the form of waveform generated by the touch pad before & after the touch event occurred. We also find out all the parameters which are affected how much after the touch event, given in tabular format. In this paper, we have used the concept of capacitance of touch sensor which is increases with the touch event on the touch sensor. On the behalf of performance, touch screen technology find out the large scope in various application. Some of the specific applications are mentioning here.

Large no. of research work has been done in the field of touch screen technology. These fields's are

- To design new touch screen device or
- To design new algorithms to detect the touch event with exact position of touch event.

I have already mentioned these both type of research field, but there may be possible to make new algorithms to detect the touch event. Or to design new touch screen device which uses the different conductor to achieve the entire requirement for a best touch screen in all the different situations. For future work, we can focus to maintain the threshold value at certain limit using other software algorithms. It will augment to detect the finger accurately. We focus to improve the architecture of surface that may increase optical quality of finger touch. However, based on interaction mechanism we can focus on the geometrical model of fingertip that may help in achieving the accuracy in finger touch detection on surface. There is another field of research to detect the multi touch on the same touch screen at the same time

REFERENCES

"Capacitive sensing," in *Wikipedia*, Wikimedia Foundation, 2016. [Online]. Available: https://en.wikipedia.org/wiki/ Capacitive_ sensing

"Touchscreen," in *Wikipedia*, Wikimedia Foundation, 2016. [Online]. Available: https://en.wikipedia.org/wiki/Touch screen.

[online].available:http://www.microchip.com/./ en550192. pdf

Archive, D. 2016. Circuit Diagram chaser Datasheet & application note. Retrieved from http://www.datasheet archive.com/circuit%20diagram%20chaser-datasheet.html

Chang, M., W.-Y. Hwang, M.-P. Chen, and W. Mueller, *Edutainment technologies. Educational games and virtual reality/augmented* .. Springer, 2011. [Online]. Available: https://books.google.co.in/books?

Falcidieno, M. L. *Architectural sciences*. Alinea Editrice, 2010. [Online]. Available: https://books.google.co.in/books?

Gary L. Barrett, Ryomei Omote, Projective capacitive touch screen, information display magazine

Johan Broz, Ted Dimiropoulos, Alex schallmo, Mahreen Younus, ECE 317

Xiaoling Wu, Bang Won Lee, Chulyoung and Seeun Jang, Touchware: A Software Based Implementation for high resolution Touch application, CIT, pp. 1703-1710, 2010

****