DESIGN OF A DUAL KEYBOARD

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ABSTRACT

The design of a computer keyboard with dual function is proposed. This computer keyboard called Dual Keyboard can function both as a normal keyboard and as a pressure sensitive keyboard. The proposed device has a switch that decides the function. The keyboard makes use of sensors placed beneath the keys to measure the pressure applied on the key by the user. This device has many applications. In this study, it is applied to mitigate Denial of Service (DoS) attack.

Keywords: Pressure Sensitive, Computer, Sensor, Security, FSR, DoS

1. INTRODUCTION

Keyboard is the standard input device. A small modification to the traditional computer keyboard is attempted to make the computer keyboard more innovative and interactive.

The proposed computer keyboard has dual functionality. It works as a normal keyboard for regular works. For special applications, it works as a pressure sensitive keyboard, since pressure sensitivity is not always required.

The basic idea for pressure sensitive keyboard was drawn from Electronic Musical keyboards that have switches under each key. Depressing a key connects a circuit, which triggers tone generation. This motivated the research, to place pressure sensors under each key to measure the pressure of the depressed key. The Dual Keyboard while working as a pressure sensitive keyboard is used to mitigate Denial of Service, which is discussed in Section 4.

1.1. Literature Review

There is a considerable amount of work done in pressure sensitivity for many interactive systems. Buxton (2007) outlined touch computing systems and pressure sensitive devices. Ramos *et al*. (2004) explored the design space of using the continuous pressure sensing

capabilities of styluses to operate multi-state widgets. The authors had also presented the taxonomy of widgets. Many studies were conducted in using pressure sensitivity to enhance GUI objects.

Ramos and Balakrishnan (2005; 2007) introduced *pressure marks*-pen strokes, where the variations in pressure made it possible to indicate both a selection and an action simultaneously. Zagler *et al*. (2013) in their FASTY program have examined methods to improve text generation for disabled people. This program included the use of pressure sensitive keyboard with an interface box. Loy *et al*. (2005) have investigated how keystroke pressure strengthened the security over traditional password-based authentication system. They compared its performance with that of the conventional timing based keystroke technique. The authors also investigated the use of combined keystroke pressure and latency for the verification process. Hidetoshi and Kurihara (2007) proposed an authentication system using keystroke dynamics. In the study the authors illustrated how sensed pressure can be used for accuracy measurement and durability against intrusion using key-logger. Bergadano *et al*. (2002) in their article, addressed the problem of user authentication via keystroke dynamics. They presented a new keystroke analysis technique that helped to solve two of the problems related to keystroke analysis: The mentioned intrinsic

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variability of typing and the possibility of typing errors. Dietz *et al.* (2009) discussed about a practical pressure sensitive keyboard. They replaced the existing keyboard membranes. Henderson *et al.* (2002) used signals resulting from tapping a rhythm on a pressure sensor and explored this waveform for authentication. The Piezo-electric and Piezo resistive sensors are screen printed on a thin layer, which is then glued with an object. The sensors are robust, thin (70 microns) and inexpensive. Henderson and Hartel (2000) have stated that the sensors can easily be integrated into objects of various shapes, including smart cards and handheld devices such as PDAs and tools.

2. PROPOSED SYSTEM

A Computer keyboard with a dual mechanism is proposed. An On/Off switch is used which determines the function of the keyboard. When the switch is "On", the keyboard functions as a pressure sensitive keyboard. When the switch is "Off" the keyboard functions as a normal keyboard. **Figure 1** Shows the flowchart of the dual keyboard functioning.

In the process of designing the pressure sensitivity in keyboard, various experiments were conducted. Section 3.1 explains the experiment, observation and inference for the selection of sensors. Section 3.2 describes the experiment, observation and inference to decide the placement of sensor. The system configuration incorporating the results of section 3.1 and 3.2 is presented in Section 3.3. The test results and output is shown in Section 3.4.

Experiment 1

2.1. Selection of Sensors

The selection of the sensor material was done after a considerable study. The sensors considered were: P-876 Patch transducer, Piezo capacitor and FSR. The comparison of the above said materials was carried out on four dimensions i.e., the size of the sensor, the cost of each sensor, availability and accuracy in output. The comparison is shown in **Table 1**.

P-876-Piezo sensitive sensors are cost significant. The analog circuitry to monitor the sensor is very complex. Adhesive of the sensors to the metal covers requires a special adhesive.

Piezo Capacitor - The sensors do not provide steady state information on the press of the sensor.
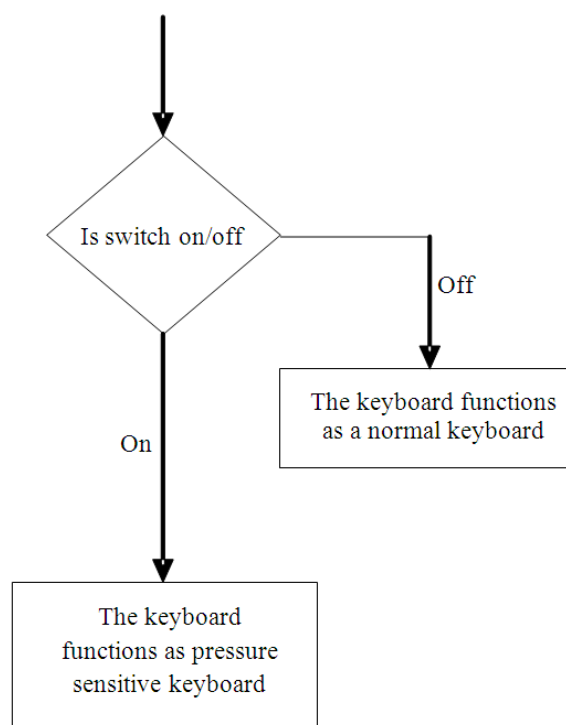The smaller the size of the piezo sensors, the cost is high as compared to FSR.

Fig. 1. Flow chart for dual keyboard functioning

The force applied on the keyboard by normal human lies between 0-20 lbs. The sensors considered were tested. **Table 2** shows the reading of the corresponding voltage when finger force is applied on the sensors. From the table we can infer that FSR was the only sensor to respond to the above said human applied pressure. The other two sensors needed very high pressure than usual. **Figure 2** shows the comparison chart.

From the above **Table 1 and 2**, **Fig. 2** and from the above discussion, it is concluded that FSR is the best choice.

The shape of FSR is circular, with 12mm in diameter and 0.55 mm in thickness. The sensor consists of two thin, flexible polyester sheets which have electrically conductive electrodes deposited in varying patterns. The inside surface of one sheet forms a row pattern while the inner surface of the other employs a column pattern. The intersection of these rows and columns creates a sensing cell. The spacing between the rows and columns varies according to sensor application and can be as small as ~0.5 mm.

Table 1. Comparison of pressure sensors

Sensors	Shape	Size	Cost	Availability	Accuracy
P-876	Square	10*10 mm	High	Under development	±3%
FSR	Circle	12 mm	Low	Easily available	±3%
Piezo capacitor	Rectangle	6*3.7 mm	Very high	Easily available	±2%

Table 2. Comparison of pressure sensors with respect to force applied

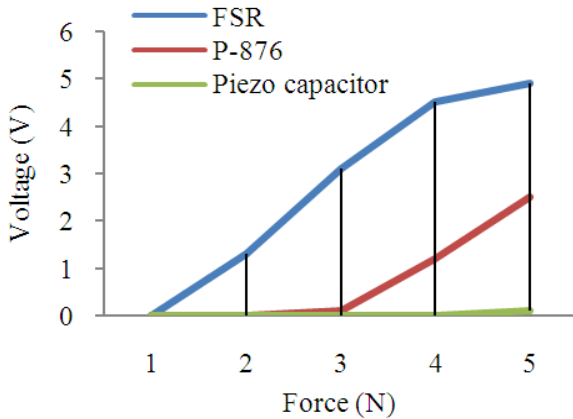| Force (lb)	Force (N)	FSR-voltage across R	P-876 voltage across R	Piezo capacitor voltage across R
None	None	0V	0V	0V
0.04 lb	0.2 N	1.3 V	0V	0V
0.22 lb	1 N	3.1 V	0.1V	0V
2.2 lb	10 N	4.5 V	1.2V	0V
22 lb	100 N	4.9 V	2.5V	100 mamp

Fig. 2. Comparison chart

Experiment 2

2.2. Placement of Sensors Inside the Keyboard

In the traditional computer keyboard, there is a rubber dome beneath the key, below the rubber dome there is a Printed Circuit Board (PCB) which forms the top layer or top contacts, the next comes the space layer with a hole in it. Following the space layer is the bottom layer or bottom contacts which is again another printed circuit board. Usually when a key is pressed the dome touches the top contact which squeezes the space layer and touches the bottom contacts, the circuit is thus closed and the signal is passed. The traditional keyboard layers are shown in the **Fig. 3**.

In the design of Computer Keyboard by Hidetoshi and Kurihara (2007) have not mentioned anything about the placement of sensors. But they have used cork as a sensor attachment.

In the design of Pressure sensitive Keyboard by Dietz *et al.* (2009) they have replaced the top contact, spacer layer and bottom contacts with specially designed membrane.

Initially the sensors were placed between the key and the dome in a traditional keyboard. After prolonged usage, it was found that the sensors did not long last and got damaged.

The sensors cannot be placed elsewhere after the dome because the circuit has to close in order to register the key stroke.

So, the sensor was placed below the bottom contacts. The placement of Sensor beneath the bottom contacts is shown in **Fig 4**.

When the key is pressed, the dome strikes the top contact which squeezes the space layer and touches the bottom layer, the force applied on the key is sensed by the pressure sensor which is placed under Neath the bottom layer. The horizontal circuit is closed separately when the space layer touches the bottom layer, thus allowing current to run through it. This indicates the "Key Down" or else it is "Key Up".

The results of these experiments were incorporated in the final design.

2.3. System Configuration

Figure 5 Shows the system configuration of the Dual Keyboard. The design tells how the system is functioning. The sensor placed keyboard (Dual Keyboard) is configured with the PC. The data from each sensor are sent to the ATMega Microcontroller through a Multiplexer and an A/D converter. It is converted to 10-bit digital data in 1.0000 kHz rate. An 8-bit data is retained temporarily in a buffer. The size of the buffer is 1,048,576-bit, so that it can preserve the measured data 65,536 ms. Depending on the PC's request the unsent data from the buffer is sent to the PC via USB. The rate of transmission of data is 12 Mbps. Each request is issued to PC by hitting the key. The data is sent through the USB.
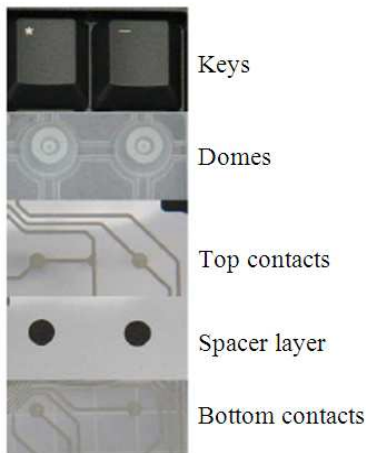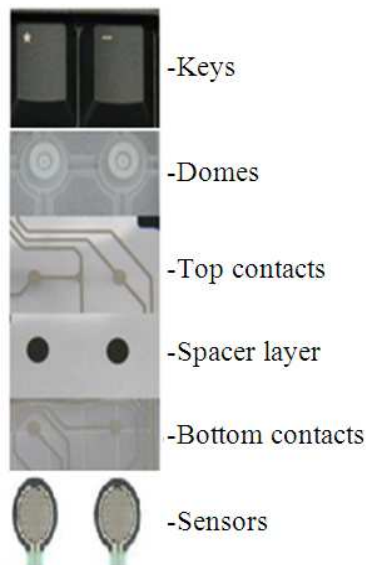
Fig. 3. Traditional membrane keyboard

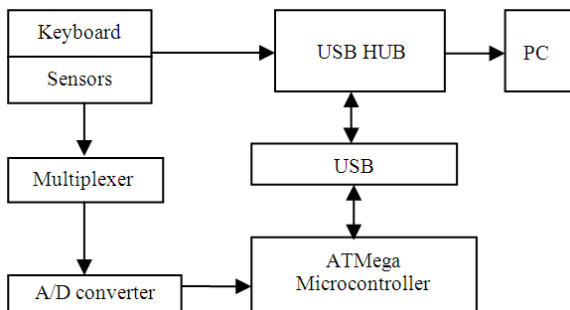**Fig 4.** Keyboard layout with sensors placed

Fig. 5. System configuration of dual keyboard

Fig. 6. Prototype of the dual keyboard

The Sensors are arranged in a row and column manner. The positive VCC is supplied to the one end of the sensor circuit using the ATMega development board. The other end of the sensor is connected to 10kΩ fixed resistor. The resistor is then connected to ground. Current flows from the ATMega board, to the sensor. The output is taken across fixed resistor. When the pressure is applied to the sensor, the voltage across the 10 k resistor varies according to the pressure applied. The varied analog voltage is converted in to digital using A/D converter. The sensor signal is then processed using Atmega microcontroller. By using multiplexer maximum number of sensors can be connected to the microcontroller. The output is sent to the PC via USB. The prototype of the Dual Keyboard is shown below in **Fig. 6**. In **Fig. 7** the conceptual circuit is given.

2.4. Working and Testing of Dual Keyboard

Figure 8-12 respectively shows examples of keystrokes. The User has pressed the keys 'a', 'e', 'i', 'o', 'u'. In the graph the upper wave represents the "Key Down" and the lower wave indicates the "Key Up". The user has repeatedly pressed each letter, which can be seen in the fluctuations of the graph. If the user presses harder the upper panel is more or it is short.

2.5. Application-to Mitigate Denial of Service

In this section, the Dual Keyboard while working as a pressure sensitive keyboard is used to mitigate denial of service is discussed.
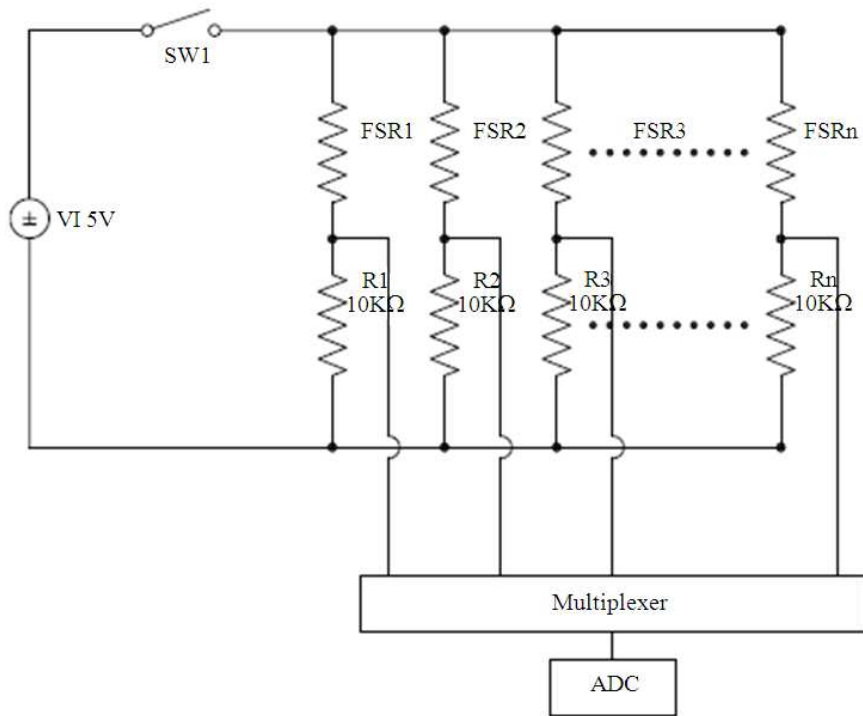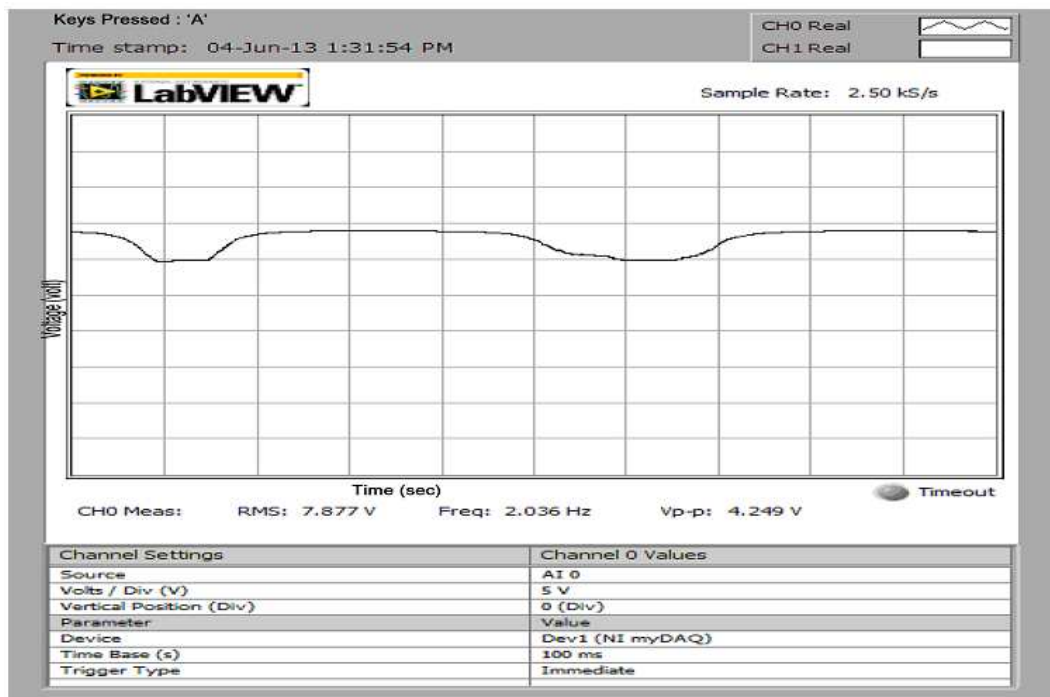
Fig. 7. Circuit for dual keyboard

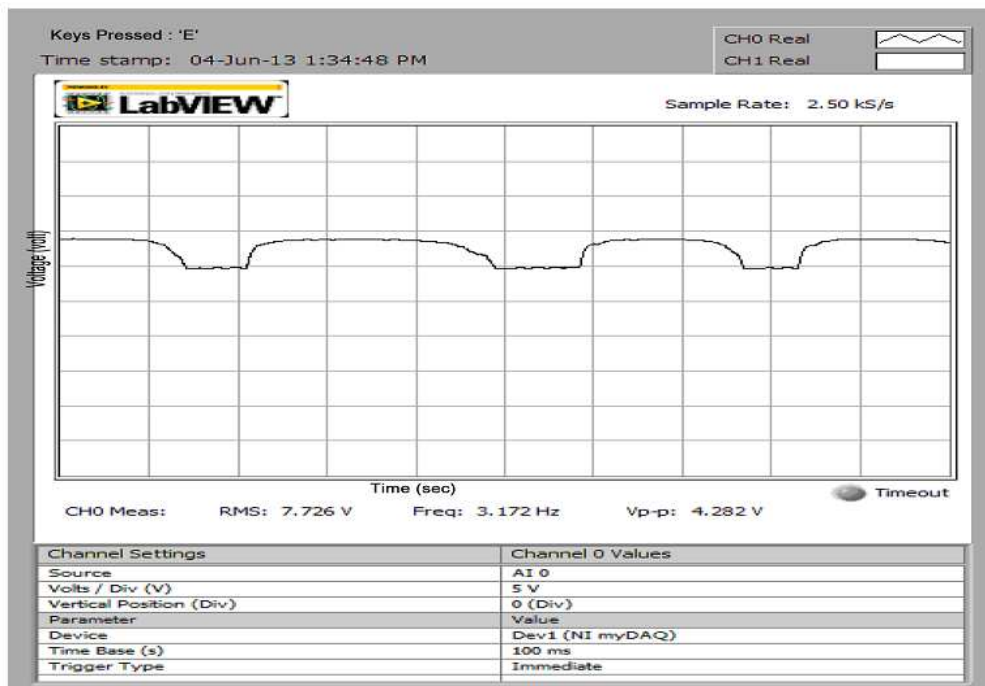**Fig. 8.** Graph showing voltage fluctuation when the key 'A' is pressed

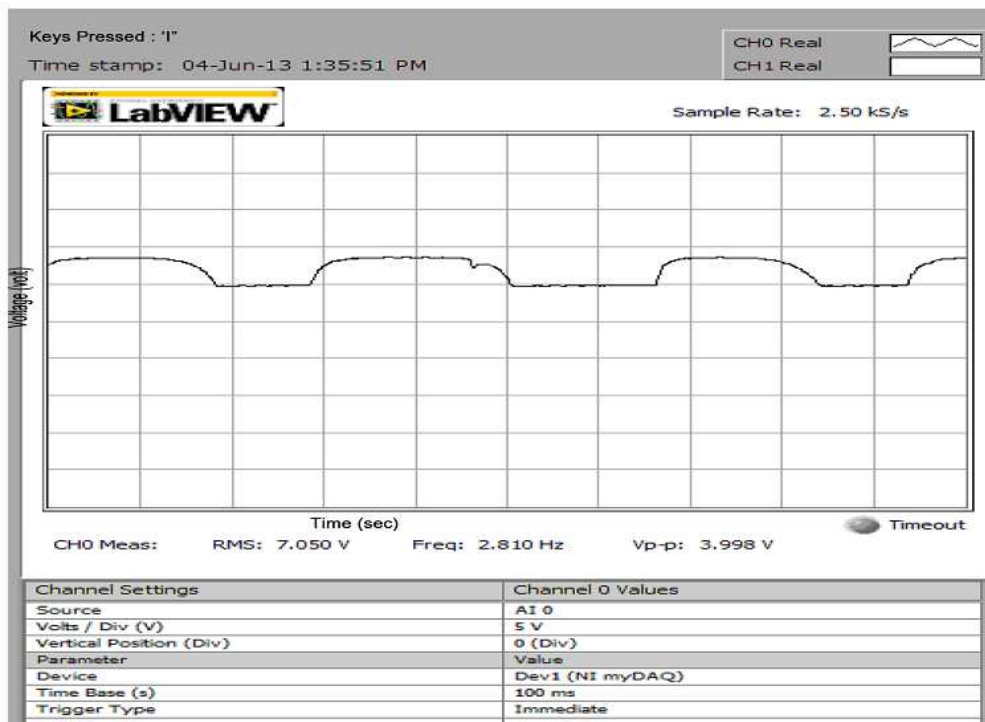**Fig. 9.** Graph showing voltage fluctuation when the Key 'E' is pressed

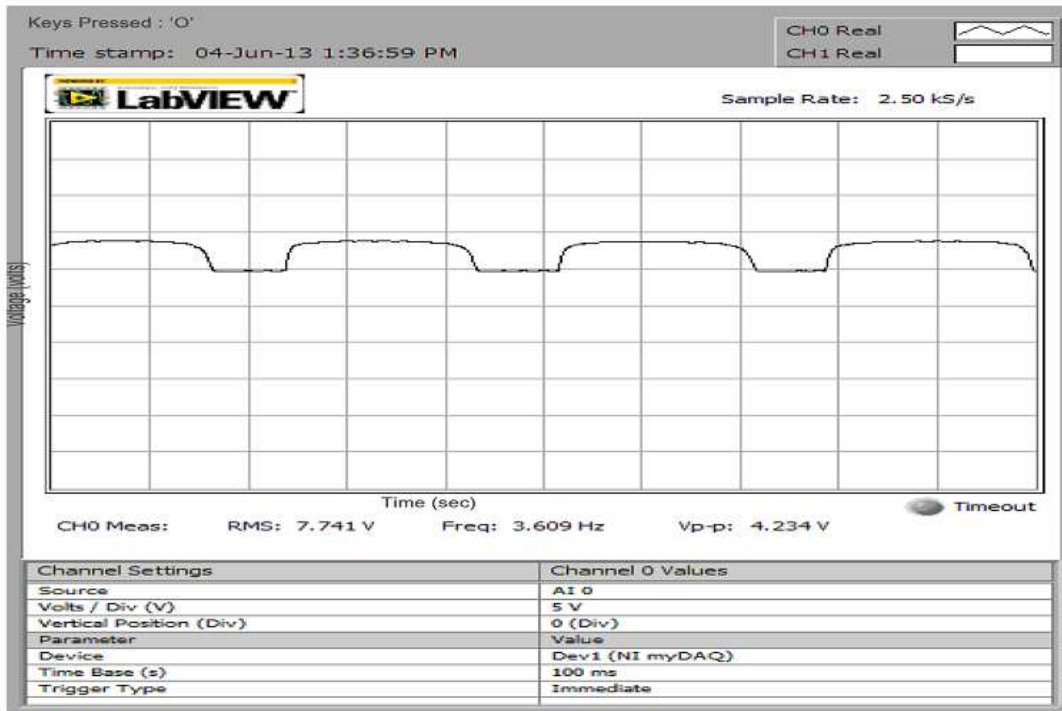**Fig. 10.** Graph showing voltage fluctuation when the Key 'I' is pressed

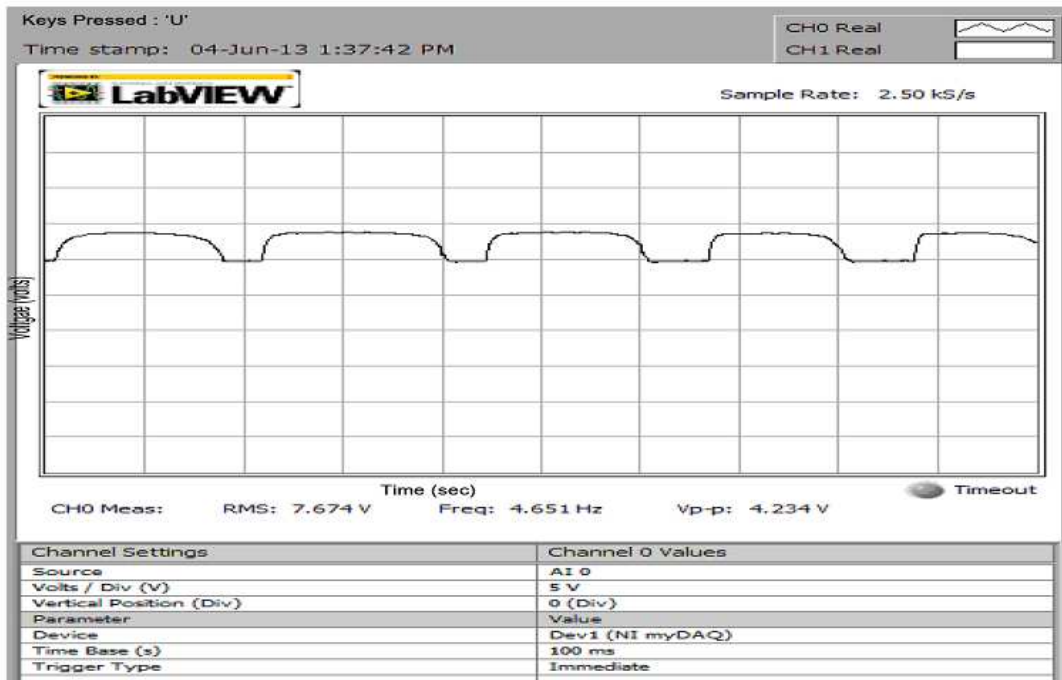**Fig. 11.** Graph showing voltage fluctuation when the Key 'O' is pressed

Fig. 12. Graph showing voltage fluctuation when the Key 'U' is pressed

2.6. To Mitigate DoS

This innovative input device can be used to mitigate Denial of Service (DoS). The main goal of DoS attack on a network is to take out a large website by flooding it with useless traffic.

The aim is to stop the flooding by differentiating between man and bot. Techniques that try to detect such an attack and throttle down malicious traffic prevail today. CAPTCHA is one of the standard technologies used, which requires human-cognitive-processing abilities. Usability and robustness are two fundamental issues with CAPTCHA and they are often interconnected with each other. But, these are compromised by various factors. Usability of CAPTCHA has turned out to be of more consideration. CAPTCHA does not only have usability issues, it is also time consuming. About 200 million CAPTCHAs are solved by humans around the world every day. In each case, roughly ten seconds of human time are being spent. Individually, that's not a lot of time, but in aggregate these little puzzles consume more than 150,000 hours of work each day. What if one could make positive use of this human effort? It is discussed by various authors.

Section 4.2 will explain the process, how Dual Keyboard is used to distinguish man and bot.

2.7. Process

The User downloads any form (email registry, online application form) from the Application Server. As the User fills in the form with the Dual Keyboard, the pressure information is also embedded with the form data. The form is submitted. The submitted form is then evaluated to see whether pressure data exists. If pressure data exists, the form is accepted by the Application Server. As this form is filled by Human (it has manual entry). If pressure data does not exists then the form is discarded. As this form is filled by bot (automatic program), it does not have any manual entry. This concept is discussed by Ragavi and Geetha (2011; 2012a; 2012b).

3. CONCLUSION

As spammers advance, the puzzles get progressively harder and more burdens are placed on humans. What is required is a new test that does measures user heuristics without requiring additional user input. This innovative input device-Dual Keyboard, which is presented above is a solution to it.

The users will enjoy using dual keyboard than using the monotonous Computer Keyboard. Dual Keyboard can be inexpensively mass produced. The keyboard has other applications like Expressive Typing, Authentication, Gaming and many more.

The concept of pressure sensitivity can be extended to mouse, touch screen.

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