Measurement and Analysis of the Electromagnetic Emanations from Video Display Interface

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Abstract—The monitor display can be eavesdropped by measuring and analyzing the compromising electromagnetic emanations. These electromagnetic emanations of video display interfaces are generated by electric signals on the display panel or the cable between the computer and the monitor. In this paper, the radiated signals from video display interface of Video Graphics Array (VGA) cable are measured and analyzed. The leaked signals are received by near-field probe connected to the digital oscilloscope. The received signals are reconstructed by signal processing, and reconstructed display is compared with original display.

Keywords—TEMPEST; compromising electromagnetic emanations; video display interface; VGA cable

I. INTRODUCTION

It has been reported that the compromising electromagnetic emanations from the peripherals contain information of the computer by discovery of van eck phreaking in 1985 [1]. After that, the researches of the electromagnetic emanations, also known as TEMPEST, have been conducted consistently. The research about possibility of data transmission by electromagnetic emanations was performed [2]. By this research, there are potential threats of the eavesdropping of screen information. However, display devices under test are limited to the Cathode Ray Tube (CRT) monitors. So, further studies for electromagnetic emanations of Liquid Crystal Display (LCD) monitors are demonstrated [3], [4]. Also, the possibility of information leakage from LCD devices using standardized video interfaces such as Video Graphics Array (VGA) and Digital Visual Interface (DVI) was determined. Moreover, the research about compromising emanations of LCD TV sets is accomplished recently [5]. It is hard to analyze the newest LCD TV sets because they have high-resolution graphics. By the way, being different from most of previous researches, the study about analysis of the electromagnetic emanations from cable of video display interface was conducted [6].

This paper presents the analysis of electromagnetic emanations from VGA cable which is widely used as interconnect of analog video display interfaces. The radiation mechanism of the VGA cable is demonstrated by analyzing transmitted signal on the cable and radiated signals. Leaked signals are measured by using near-field probe with digital oscilloscope and reconstructed by using signal process on software.

II. PRINCIPLE OF ELECTROMAGNETIC EMANATIONS

A. VGA interface

VGA is the analog type video display interface. There are two primary signals in the VGA interface: RGB video signals and synchronous signals. RGB video signals consist of three signals: Red, Green, and Blue. They are transmitted from mainboard to display devices through the VGA cable. The voltage level of each color signals is digitized to 256 sample levels. For example, if display color is black, then all the three video signals have zero voltage level. And if displayed color is white, then all the three video signals have maximum voltage level. So, it means that values of RGB signals depend on the displayed color. The synchronous signals consist of two signals: horizontal and vertical synchronous signal. They depend on the monitor resolution standardized by Video Electronics Standards Association (VESA). Fig. 1 shows the pinout of female DE-15 socket of VGA connector. RGB signals and synchronous signals occupy their own signal lines.

B. Electromagnetic emanations

When the signal transit high to low level or low to high

Fig. 1. Pinout of the female DE-15 socket of VGA connector
level at short time, there are large impulse current and huge change of voltage level. The large impulse current during the short time period induces large electromagnetic radiation with reference to the Maxwell’s equations. In other words, the compromising electromagnetic emanations are generated by signal transition edge. Fig. 2 shows the signal transition edge of video signal and the electromagnetic emanations. There are large electromagnetic emanations at the signal transition time. So, the original video signals can be determined by the peaks of electromagnetic emanations which mean that transition edge of the original signals.

III. MEASUREMENT AND ANALYSIS

Monitor resolution of device under test (DUT) is 800 × 600 × 60 Hz. It means that the number of pixels on width line is 800 and that of on height line is 600. In fact, there are hidden pixels which are not seen in real. For this monitor resolution, the number of all pixels on width line is 1056 and that of on height line is 628. The meaning of 60 Hz is that the one frame of display is shown on the monitor during 1/60 seconds. The display on the monitor consists of some texts which have different font size with gray scale.

Fig. 3 shows the experimental setup for measurement of electromagnetic emanations from the VGA cable. Near-field probe used in this experiment is H-field probe which has frequency range from 30 MHz to 1 GHz. The distance between the VGA cable and near-field probe is 5 centimeter. The sampling rate of digital oscilloscope is 500 MHz and the time range is set to 50 milliseconds for measuring at least two frames of video signals. Fig. 4 shows the raw data of the electromagnetic emanations. It consists of periodical signals and the duration is 16.7 milliseconds which mean a reciprocal number of 60 Hz.

Fig. 5 shows the power spectrum of the electromagnetic emanations when the VGA cable is connected on/off. There are three primary frequency bands which have more power at the cable connecting on than that of connecting off. Through the band-pass filtering with each frequency band, it is demonstrated that bandwidth from 153 MHz to 175 MHz is the most effective to the signal processing. The signal-to-noise ratio (SNR) which is improved by the band-pass filtering is maximized at that bandwidth.

The reconstructed display from the electromagnetic emanations with band-pass filtering from 153 MHz to 175 MHz is shown in Fig. 6. Because the peaks of the electromagnetic emanations are generated on signal transition
edge, the boundaries of texts are reconstructed. The monitor resolution information such as horizontal and vertical synchronous frequency can be achieved by using cross-correlation. After that, the number of pixels on the width and height line can be calculated by synchronous frequencies. However, the process of inferring pixel numbers is not conducted in this research.

IV. CONCLUSION

In this paper, the electromagnetic emanations from video display interface are measured and analyzed. The mechanism of electromagnetic radiations of VGA cable is investigated by analyzing video signals of that. The compromising electromagnetic emanations of VGA cable are measured by H-field probe and digital oscilloscope at the short distance. Measured signals are analyzed by using data of display mode such as horizontal and vertical synchronous frequency. Reconstructed display is achieved from measured signals with signal processing.

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