UNIVERSITI PUTRA MALAYSIA

FRAUD DETECTION SYSTEM FOR ROTOR PAY PHONE

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FRAUD DETECTION SYSTEM

FOR ROTOR PAY PHONE

NURWARDIAH BINTI SPIAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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To mak, abah

To my beloved husband

To Tasnim, Aishah and Abdul Rahman

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the partial requirements for the degree of Master of Science

FRAUD DETECTION SYSTEM FOR ROTOR PAY PHONE

By

NURWARDIAH BINTI SPIAN

October 2007

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Pay phone, also known as public telephone, is very vulnerable to fraudulent abuse. Rotor pay phone is determined as most prone set to fraud. TM Berhad estimates loses millions of ringgit each year due to fraudulent activities. To help in battling the growing worldwide problem of pay phone fraud, a fraud detection system was developed.

The system is developed in order to cater many types of frauds, commonly happen to Rotor pay phone in Malaysia such as line tapping, line cutting, shorting and grounding fraud. It does not deteriote voice quality of pay telephone or introduces significant delay during normal pay phone operation such as dialing, conversation and metering signal.

The system comprises of two sets of fraud detection modules; Anti Fraud Device 1 (AFD1) and Anti Fraud Device 2 (AFD2). AFD1 is installed inside pay phone set,

whereas AFD2 is installed in TM exchange. The system is based on a signal exchange between AFD1 and AFD2. When the pay phone handset is off-hook, the AFD1 and AFD2 will communicate with each other to detect any fraud. As soon as fraud is detected, the line will be terminated by AFD2.

The system has been tested successfully using TM Berhad line infrastructure. The results obtained shows the system can caters most of pay phones which are located in urban areas. This will help TM Berhad to greatly reduce loses due to fraud.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SISTEM PENGESAN PENIPUAN UNTUK TELEFON AWAM ROTOR

Oleh

NURWARDIAH BINTI SPIAN

Oktober 2007

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Telefon bayaran atau dikenali juga sebagai telefon awam, amat terdedah kepada penipuan. Telefon awam Rotor dikenal pasti sebagai jenis yang paling banyak dan paling mudah menghadapi masalah ini. TM Berhad telah menganggarkan kerugian jutaan ringgit setiap tahun kerana aktiviti penipuan yang dilakukan oleh pengguna yang tidak bertanggungjawab. Jadi, untuk mengatasi masalah yang semakin meningkat bukan sahaja di Malaysia, malah di seluruh dunia ini, satu sistem yang dapat mengatasi masalah ini telah dibina.

Sistem ini dibina untuk mengatasi penipuan-penipuan yang sering berlaku kepada telefon jenis Rotor di Malaysia, seperti penipuan melalui pemintasan talian telefon, penggantian set telefon, pintasan litar dan pembumian. Sistem ini dibina supaya ia tidak mengganggu kualiti suara pengguna semasa penggunaan telefon tersebut dan ia juga

tidak menyebabkan operasi normal telefon awam terganggu atau menjadi lambat seperti isyarat panggilan, percakapan dan caj.

Sistem yang dibangunkan ini mempunyai dua modul pengesan penipuan, iaitu Alat Anti Penipuan 1 (AFD1) dan Alat Anti Penipuan 2 (AFD2). AFD1 dipasang di dalam set telefon, manakala AFD2 dipasangkan dalam ibusawat TM. Penipuan dapat dikesan melalui penukaran mesej antara AFD1 dan AFD2. Apabila ganggang telefon diangkat, AFD1 dan AFD2 akan berhubung antara satu sama lain untuk mengesan penipuan. Jika penipuan dikenal pasti, talian telefon akan diputuskan oleh AFD2.

Sistem ini telah diuji di makmal. Keputusan yang diperolehi menunjukkan penipuan ke atas telefon awam jenis Rotor telah berjaya diatasi. Penemuan ini dapat membantu pihak TM Berhad mengurangkan banyak kerugian yang disebabkan oleh penipuan ini.

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Last but not least, I would like to thank everyone though not mention here, but have contribute in one way or another to the completion of my project. May Allah bless them all, InsyaAllah.

I certify that an Examination Committee has met on 26.10.2007 to conduct the final examination of Nurwardiah Binti Spian on her degree thesis entitled **"Fraud Detection System For Rotor Pay Phone"** in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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NURWARDIAH BINTI SPIAN

Date: 24 December 2007

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LIST OF ABBREVIATIONS/NOTATIONS/GLOSSARY OF TERMS

BVI	British Virgin Islands
AWG	American Wire Gauge
POTS	Phone On telephone Switching
AC	Attenuating Current
DC	Direct Current
DTMF	Dual Tone Multi Frequency
ROA	Reversal On Answer
CLM	Customer Loop Metering
PNMS	Payphone N Management System
DEL	Single Line Phone
PLRZ	Polarity Line Reversal
PSTN	Public Switched Telephone Network- The part of a Public Telecommunications Network which enables any customer to call and communicate with any other customer either automatically or with operator assistance. A Public Telecommunications Network means a telecommunications network operated by a carrier.
ASK	Amplitude Shift Keying
SPM	Subscriber Pulse Metering
NRZ	Non-Return-to-Zero
LE	Local Exchange
FRAM	Ferroelectric RAM
CPE	Customer Premises Equipment
DTMF	Dual Tone Multi-Frequency

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CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

Pay phone is a public telephone, enables a person to make phone call without requiring the person to be a subscriber to a particular telephone network service provider. Pay phone requires the use an immediate payment in order to make a call from it. A user inserts either the required value for a telephone call in coins or a card representing a call value that can be read by the telephone into a phone to make a phone call.

Pay phones are usually found in public places such as street corners, outside of convenience markets, bus and airport terminals, and shopping malls. Although it is not as frequent, they may also be found in private businesses and homes. This privately operated pay phone, not operated by the telephone network provider, are installed by a private operator at a desired site and connected to the pay phone exchange via a service which accepts all outgoing calls. The private operator pays the lease on this connection and recoups the money from the users of the phone by collecting the payment through coins or telephone card.

There are situations where the pay phone or pay phone connection may be used dishonestly to make calls without providing the appropriate payment. Cable and Wireless General Manager Mr. Vance Lewis described the pay phones as one of the most convenient and popular ways of communicating in the BVI, which means the system is easily vandalized and or fraud [1].

There are several ways that a pay phone could be fraudulently used such as through tampering or vandalism of pay phone to enable calls to be made without providing the correct payment. For example card readers can be short circuited to enable calls to be made without payment. Other methods of fraud involve bypassing the pay phone itself, such as by tapping into the pay phone line to bypass the pay phone, using a normal phone or replacing the pay phone with a normal telephone. As the telephone exchange accepts all calls from the line connecting the pay phone, any call using that line will be accepted, whether the appropriate fee is paid by the user or not.

In this project, a fraud detection system is invented to prevent fraud in pay phones that provides equipment within the pay phone to monitor the dial tone and prevent further calls being made without appropriate payment. The fraud detection system is limited to Rotor pay phone since it has been found that this type of pay phone are the most susceptible to allowing users to make unauthorized call without payment by using tapping or cutting phone line, shorting and grounding the pay phone electronic main board by pin and inducement of current surges [2]. This is due to the mechanical design of the pay phone which makes users easy to do fraud [3].

1.2 System Description

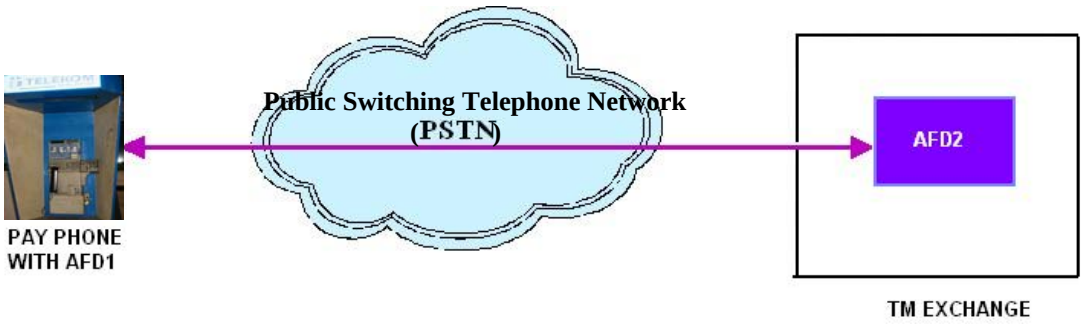

Figure 1.1: System Architecture of Fraud Detection System

The block diagram of a fraud detection system for pay phone is shown in Figure 1.1. The system comprises of two sets of fraud detection modules; Anti Fraud Detection 1 (AFD1) and Anti Fraud Detection 2 (AFD2). AFD1 is installed inside pay phone set, whereas AFD2 is installed in TM Exchange. These modules are connected to each other through Public Switching Telephone Network (PSTN). The system is based on a signal exchange between AFD1 and AFD2. The data exchange takes place on reception of each metering pulse or in particular cases during the phone call. The data, if correct, is interpreted by the AFD2 as presence of a pay phone connected to that telephone line and as confirmation of metering. If this data is missing or incorrect, the AFD2 will open the line immediately, interrupting the current call. If data received is correct, AFD2 will check the first 2 digits numbers. If the numbers are '99', or other free call numbers that has been set, it will be disabled. If other than free call number detected, AFD2 will wait for AFD1 to send security data signal every 1 minutes. If no coins or card value is detected, AFD2 will terminate the line.

1.3 Research Objectives

The main objective of this work is to conduct a study, design and to develop a system that caters fraud problems in pay phone, installed by TM Berhad, such as line tapping, line cutting, shorting and grounding fraud. This project involves testing using Rotor pay phone, as one of the most prone set to fraud [2], [3]. The design should cater the current fraud detection system problem that introduces significant delay during normal pay phone operation (dialing, conversation and metering signal). The design also should be able to cater for pay phones which are located in urban areas.

1.4 Structure of the Thesis

The thesis is organized into five chapters and 13 appendices. The areas covered in each chapter are detailed in the following sections. The first chapter introduces the subject of the thesis and describes its organization. Chapter two reviews the literature on the background information of pay phone system and Rotor-type pay phone system. Then, methods of fraud commonly happen to pay phone system are described in detail. Readers will understand how users can do fraud to pay phone. Current fraud detection systems are described to show where the idea to develop this fraud detection system is generated. Chapter three describes the design of hardware and software of AFD1 and AFD2. In chapter four the fraud detection system was implemented and tested in the laboratory. The experimental results and discussions are also presented. Finally, chapter five entails conclusion drawn from this work and recommendations for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The purpose of an anti-fraud system for rotor type pay phone is to cancel frauds commonly happen to rotor type pay phone. Common frauds that have been recognized currently are line tapping, pay phone replacement with normal phone or line cutting, pin fraud and piezo fraud. This chapter describes pay phone system, fraud description and current fraud detection system.

2.2 Pay phone System Description

This section describes pay phone system specifications in details.

2.2.1 The Phone Line

A pay phone is usually connected to the telephone exchange by about three miles or 4.3 km of a twisted pair of No.22 American Wire Gauge (AWG) or 0.5mm copper wires, known by Phone Company as “the loop”. Although copper is a good conductor, it does have resistance. The resistance of No. 22 AWG wire is 16.46 Ohms per thousand feet at 77^{o}F (25^{o}C). Wire resistance usually expressed as Ohms per kilometer.

Because pay phone apparatus is generally considered to be current driven, all pay phone measurements refer to current consumption, not voltage. The length of the wire connecting the subscriber to the telephone exchange affects the total amount of current that can be drawn by anything attached at the subscriber’s end of the line.

The voltage applied to the line to drive the telephone is 48 VDC. Pay phone is peculiar in that the signal line also the power supply line. The voltage is supplied by lead acid cells, thus assuring a hum-free supply and complete independence from the electric company, which may be especially useful during power outages.

At the telephone exchange, the DC voltage and audio signal are separated by directing the audio signal through 2uF capacitors and blocking the audio from the power supply with a 5 H choke in each line. Usually these two chokes are the coil windings of a relay that switches the phone line at the exchange. The resistance of each of these chokes is 200 Ω.

During on-hook or not in-use, the DC resistance of telephone line should be about 10 MΩ, and it should draw not more than 5 μA while phone is in this state. When the phone is in use, or off-hook, current drawn to power the phone is between 15 mA to 90 mA.

The phone line has impedance, composed of distributed resistance, capacitance and inductance. The impedance will vary according to the length of the loop, the type of insulation of the wire, and whether the wire is aerial cable, buried cable, or bare parallel wires strung on telephone poles. The impedance is normally assumed to be 600 Ω to 900 Ω.

2.2.2 Bandwidth of the Telephone Line

A Phone on Telephone Switching (POTS) line has a bandwidth of 3 kHz. A normal POTS line can transfer the frequencies between 400 Hz to 3.4 kHz. The frequency response is limited by the telephone transmission system components; transformers and capacitors. Other reason to drop out the lowest frequencies is to keep the possibly strong mains frequency (50 or 60 Hz and its harmonic) humming away from the audio signal we can hear.

2.2.3 Network Interface

The telephone has a circuit called network interface (also called voice network or telephone hybrid) which connects the microphone and speaker to the telephone line. Network interface circuitry is designed so that it sends only the current changes the other telephone causes to the speaker. The current changes which the telephone's own microphone generates are not sent to the speaker. All this is accomplished using quite ingenious transformer circuitry. In theory, the hybrid circuit can separate all incoming audio from the audio sent out at the same time if all the impedances in the circuitry (hybrids on both ends and the wire impedance between) are well matched. Unfortunately, the hybrid is by its very nature a "leaky" device. As voice signals pass from the 4-wire to the 2-wire portion of the network, the higher energy level in the 4-wire section is also reflected back on itself, creating the echoed speech. Since the circuit does not work perfectly, own voice in the speaker still can be heard. The actual amount of signal which is reflected back depends on how well the balance circuit of the hybrid matches the 2-wire line. This has an advantage; some people who use the telephone prefer to hear some of their own voice back. This effect is called 'side tone' and gives