

Acknowledgement

I gratefully acknowledge my supervisor Dr. Abd Elrasoul G. Elzebaidi, who had been always there to listen and to give advice. It's upon him where I experienced the beauty of the meeting of the scientists' knowledge and humility, which was an inspiration to me. I also would like to express sincere appreciation to Associate Prof. Mohammed Mohammed Zahra and Dr. Nadir Mohammed Hasanien; they showed me different approaches to handle a research problem. Also they introduced me to the most useful websites and information sources regarding my thesis. Great thanks go to my uncle Dr. Ahmed Mohammed Sharif for always being there for me, and always provide good advices.

I am charmed by the hospitality I received at the center of Engineering & Technical Studies (CETS); for that I am grateful to them. I am much in Dr. Arbab Ibrahim Arbab and Miss. Taghreed Ahmed Fadeel debt for the great help they offered to me with mathematical equations inside the thesis. I am grateful to Mr. Waddah from Cambridge library for his attention and Kindness, and keeping the library as quite as possible.

Special gratitude goes to my youngest brother Alaa Eldin Mukhtar and youngest sister Eman Mukhtar; he typed the first chapter of this thesis, she helped in the presentation design. I

was extraordinary fortunate in having my aunt Khadeeja Hamid and my uncles Hassan & Hussein Omer Ibrahim; she is the one who taught me how to write a thesis in the right format, they have always been such a support to me and to my father, actually if we did not have them many of our achievement would never take a place in the reality world .

My dear friend Mohammed Abdalla Ibrahim and Mr. Muez Ebeid helped me by handling the grammar and language usage in the thesis so I am beholden to them. Special gratitude goes to my dear friend Mutaz Hassan Abd El-Motaal; he was a great help in a lot of issues related to the thesis. Special thanks to gigapedia, citeseer, and Wikipedia web sites publishers, for gathering this huge amount of knowledge in one place. Also special thanks go to google publisher for developing such a reliable search engine.

Where would I be without my family? My parents deserve special mention for their inseparable support and prayers. My Father, Mukhtar Nasr, in the first place is the person who put the fundament of my learning character, showing me the joy of intellectual pursuit ever since I was a child. My Mother, Arafa Hamid, is the one who sincerely raised me with her caring and gently love. Words fail me to express my appreciation to my husband Abubakr whose dedication, love and persistent confidence in me, has taken the load off my shoulder.

I am thankful to all colleagues and friends who made many of my life moments memorable and valuable experiences. Finally, I would like to thank everybody who was

important to the successful realization of this thesis, as well as expressing my apology that I could not mention personally one by one.

Dedication

To my dear parents Arafa & Mukhtar, my precious lovely husband Abubakr, my sweet brothers and sisters Nasr, Eman, Alaa, , Omer, Sara, Amna, Mohammed, and Nour, my stepmoms Khalda and Huda, and my best friend Rania. You always have been such a support and inspiration; you are the best that anybody could ever have in his life....

To everyone had ever contributed in building the knowledge and experience I have....

To everyone who spent some of his time reading this thesis, trying to benefit from it.....

I dedicate this modest attempt.....

Hind Mukhtar

Abstract

Many of localization techniques are available now a day's such as Global Positioning System (GPS), Infrared, Ultrasound, and Bluetooth localization systems, Wi-Fi enabled devices and cellular mobile phones. Each of these techniques has its own advantages and disadvantages, but for their continuous network connectivity, low power consumption, wide adoption and their ability to offer indoor outdoor place detection capabilities cellular mobile phones are the best choice for location enhanced applications. There are five basic cellular positioning methods- proximity sensing, lateration, angulation, dead reckoning, pattern matching- that measure many observables by different techniques. These cellular positioning methods varies a little bit according to the network they had been implemented on; as in GSM they turned up to (Cell ID + Timing advance, E-OTD, U-TDoA, and A-GPS) or in UMTS the turned up to (cell based methods, OTDoA-IPDL, and A-GPS). Those positioning techniques give a clue about two to four unknowns of the position (latitude, magnitude, altitude, and time). The more positioning techniques are combined, the more accurate positions are obtained.

The need of locating people has increased apparently than ever before because of many reasons; such as security purposes of emergency situations, terrorism and crime prevention. Not forgetting the effect of such service in increasing the revenues per user for Cellular Communication Service Providers by launching many of attractive feasible services; such as enquiry information services, community services, traffic telematic, fleet management and logistics, marketing and value added technologies.

A program by Turbo C++ has been prepared to simulate the process of mobile location determination using tri-angulations technique. The limits of time dedicated for the thesis forbids the availability of making a simulation for all other positioning techniques, so they had been left for further scopes.

In all operating mobile localization technologies there are always errors that affect the accuracy of location determination process in cellular networks, and add $\pm(10\text{m} \sim 10\text{km})$ according to the positioning technology used, reducing these errors margins is always an interesting subject for further researches.

Key words: Positioning in cellular systems, location determination techniques, and location management.

مستخلص الدراسة

يوجد الكثير من التقنيات المتاحة لتحديد المواقع في هذه الأيام: مثلاً النظام العالمي لتحديد المواقع (ن.ع.ت) ، أنظمة الأشعة الحمراء، الموجات فوق الصوتية، والبلوتوث و أنظمة الهواتف الخلوية المحمولة . كل من هذه التقنيات تمتاز بعدد من الأفضليات وأيضاً لا تخلو من العيوب. لكن لميزات تغطية شبكتها المستمرة، قلة إستهلاكها للطاقة وإمكانية تحديد المواقع الغير محدّدة بطبيعة المكان (مغلق أو مفتوح) تعتبر الهواتف الخلوية الخيار الأفضل لتطبيقات التوقيع المعززة. هناك خمس طرق أساسية لتحديد المواقع في شبكات الهاتف الخليوي (الإستشعار عن قرب، قياسات الوقت، قياسات الزوايا، التآرجح الميت و نمط المطابقة) تقيس متغيرات التوقيع المختلفة. نسبة لتعدد طرق تطبيقها في شبكات الهواتف الخلوية المختلفة يختلف تصنيفها فمثلاً في شبكات النظم العالمية للمحمول (ن.ع.م) تؤول هذه التقنيات إلى (هوية الخلية + الوقت المقدم، مراقبة فارق الوقت المعززة (م.ف.و-م)، الفرق الوقتي لحدوث الإشارات في الوصلة الخلوية (ف.وق.إ-و.ع) و نظام تحديد المواقع العالمي المساعد (ن.ت.ع-م) ، أما في شبكات النظام العالمي للاتصالات (ن.ع.إ) فتؤول إلى (الطرق المرتكزة على الخلية، الفارق الوقتي المراقب مع فترة التعطيل في الوصلة السفلية (ف.و.م-ف.ت.و.س)، نظام تحديد المواقع العالمي المساعد (ن.ت.ع-م)). تقنيات تحديد المواقع هذه تعطي قيمة من متغيرين إلى أربعة (خط الطول، خط العرض، الارتفاع و الزمن). كلما أستخدم عدد أكبر من تقنيات تحديد المواقع في عملية التوقيع الواحدة كلما أمكن الحصول على نتائج ذات دقة أعلى.

تزايدت الحاجة لتحديد مواقع البشر لتصبح ملحة أكثر من أي وقت مضى. وذلك نتيجة لأسباب أمنية مثل سرعة توفير المساعدة لأصحاب الحالات الطارئة ولمقاومة الإرهاب ومنع الجريمة. تقنية كد تقنية تحديد المواقع لا بد وأن يكون لها أثر كبير في زيادة أرباح شركات الهاتف المحمول وذلك بتمكين الزبائن من الإستفادة من عدد من التطبيقات الإضافية؛ كتوفير معلومات عن الخدمات العامة (فنادق، مطاعم، أسواق، مطارات، ... إلخ)، الخدمات الإجتماعية (الدرشة) ، خدمات المرور، إدارة الأساطيل، التسويق، وتقنيات (التكنولوجيا القيمة المضافة (ت.ق.م)).

تم تنفيذ عملية محاكاة تحديد مواقع الجوال بإستخدام تقنية (ثلاثي- قياسات الزوايا). ولكن نتيجة لمحدودية الوقت المخصص لهذه الأطروحة إنعدمت إمكانية إجراء محاكاة لجميع تقنيات تحديد المواقع في شبكات الهواتف الخلوية ولهذا تم تركها لفرص أوسع أخرى.

جميع التقنيات بصورة أو أخرى تحتوي على مصادر خطأ تقلل من دقة البيانات المأخوذة عنها، كما هو الحال في تقنيات تحديد المواقع في الشبكات الخلوية. حيث أن قيمة هامش الخطأ المضافة تتراوح بين (10متر ~ 10كلم). يعتبر التقليل أو التخلص إن أمكن من هوامش الخطأ هذه موضوعاً محفزاً للمزيد من الأبحاث.

كلمات	تقنيات تحديد مواقع المتجولين, عمليات التموّقع في الشبكات
مفتاحية:	الخلوية وإدارة التموّقع.

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List of Abbreviations:

1G,2G, 3G, 4G	First, second, third, and fourth generation of mobile networks
3GPP	3 rd Generation Partnership Project
3GPP2	3 rd Generation Partnership Project 2
A-FLT	Advanced Forward Link Trilateration
A-GPS	Assisted GPS
ALI	Automatic Location Identification
AMPS	Advanced Mobile Phone System
ANI	Automatic Number Identification
AoA	Angle of Arrival
API	Application Program Interface
ARPU	Average Revenue Per User
ASK	Amplitude-shift Keying
AT	Absolute Time
ATD	Absolute Time Difference
AuC	Authentication Center
BCCH	Broadcast Control Channel
BCD	Binary-Coded Decimal
BCH	Broadcast Channel
BSC	Base Station Controller
BSIC	Base transceiver Station Identity Code
BSS	Base Station Subsystem
BSSAP	Base Station Subsystem Application Part
BSSAP-LE	Base Station Subsystem Application Part LCS Extension
BTS	Base Transceiver Station
CA	Cell Allocation
CAS	Call- Associated Signaling
CBC	Cell Broadcast Center
CC	Country Code
CDM	Code Division Multiplexing
CDMA	Code Division Multiple Access
CDR	Call Detail Record
CGI	Cell Global Identity
CI	Cell Identifier
CoO	Cell of Origin
CPICH	Common Pilot Channel
CS	Circuit - Switched
DBMS	Database Management System
D-GPS	Differential GPS
DoA	Direction of Arrival
DRNC	Drifting Radio Network Controller
DTMF	Dual Tone Multi – Frequency
ECEF	Earth Centered Earth Fixed
EDGE	Enhanced Data Rates for GSM Evolution
E-FLT	Enhanced Forward Link Trilateration
EIR	Equipment Identity Register
ELIS	Emergency Location Immediate Request

ELRS	Emergency Location Reporting Service
E-OTD	Enhanced Observed Time Difference
ETSI	European Telecommunication Standards Institute
EVDO	Evolution-Data Optimized
FCC	Federal Communications Commission
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
FHSS	Frequency Hopping Spread Spectrum
FSK	Frequency-shift Keying
GEO	Geostationary Earth Orbit
GERAN	GSM/EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GIS	Geographic Information System
GMLC	Gateway Mobile Location Center
GMSC	Gateway Mobile Switching Center
GMSK	Gaussian Minimum Shift Keying
GMT	Greenwich Mean Time
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GSN	GPRS Support Node
GTP	GPRS Tunneling Protocol
HLR	Home Location Register
HOW	Handover Word
HPSA	High Speed Packet Access
Hz	Hertz
IDE	Integrated Developed Environment
IEEE	Institute of Electrical and Electronics Engineers
IMS IP	Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IMT-2000	International Mobile Telephony System 2000
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITU	International Telecommunications Union
LA	Location Area
LAC	Location Area Code
LAI	Location Area Identifier
LAN	Local Area Network
LBS	Location-Based Services
LCAF	Location Client Authorization Function
LCCF	Location Client Control Function
LCF	Location Client Function
LCS	Location Service
LER	Location Enabler Release
LMU	Location Measurement Unit
LoS	Line of Sight
LSAF	Location Subscriber Authorization Function
MAC	Medium Access Layer

MAP	Mobile Application Part
MCC	Mobile Country Code
MLP	Mobile Location Protocol
MMS	Multimedia Messaging Service
MNC	Mobile Network Code
MS	Mobile Station
MSC	Mobile Switching Center
MSISDN	Mobile Subscriber ISDN Number
MSN	Mobile Subscriber Number
MSRN	Mobile Station Roaming Number
NAVSTAR	Navigation Satellite Timing and Ranging System
NCAS	non-call-associated signaling
NDC	National Destination Code
NMT	Nordic Mobile Telephone system
NSS	Network Switching Subsystem
OCXO	Oven-Controlled Crystal Oscillator
OMC	Operation and Maintenance Center
OMS	Operation and Management Subsystem
OSA	Open Service Access
OTD	Observed Time Difference
OTDoA-IPDL	Observed Time Difference of Arrival with Idle Period Downlink
PCF	Positioning Calculation Function
PCH	Paging Channel
PDA	Personal Digital Assistant (a hand held computer)
PDE	Positioning Determining Entity
PDN	Packet Data Network
PDP	Packet Data Protocol
PDTCH	Packet Data Traffic Channel
PDU	Packet Data Unit
PMM	Packet Mobility Management
PLMN	Public Land Mobile Network
PN	Public Node
POI	Point of Interest
PRRM	Positioning Radio Resource Management
PS	Packet-Switched
PSK	Phase-shift Keying
PSMF	Positioning Signal Measurement Function
P-TMSI	Packet TMSI
QoS	Quality of Service
QPSK	Quadrature Phase-shift Keying
R’**	Released at year **
RA	Routing Area
RACH	Random Access Channel
RAD	Rapid Application Development
RAI	Routing Area Identifier
RANAP	Radio Access Network Application Part
RFID	Radio Frequency Identification
RIT	Radio Interface Timing

RLP	Roaming Location Protocol
RMS	root mean square
RNC	Radio Network Controller
RNS	Radio Network Subsystem
RRC	Radio Resource Control
RSS	received signal strength
RTD	Real Time Difference
RTT	round trip time
SA	Selective Availability
SAS	Standalone SMLC
SDCCH	Stand-alone Dedicated control Channel
SDM	Space Division Multiplexing
SDMA	Space Division Multiple Access
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SLIR	Standard Location Immediate Request
SMLC	Serving Mobile Location Center
SMS	Short Message Service
SMS-C	SMS Center
SMSS	Mobile Switching and Management Subsystem
SN	Subscriber Number
SNDCP	Sub Network Dependent Convergence Protocol
SNR	signal-to-noise ratio
SPS	Standard Positioning Service
SQL	Structured Query Language
SRNC	Serving Radio Network Controller
SS7	Signaling System No. 7
TA	Timing Advance
TCXO	Temperature-Compensated Crystal Oscillator
TDM	Time Division Multiple Access
TDMA	Time Division Multiple Access
TLM	Telemetry
TMSI	Temporary Mobile Subscriber Identity
TTFF	Time To First Fix
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
U-TDoA	Uplink Time Difference of Arrival
UTRAN	UMTS Terrestrial Radio Access Network
VLR	Visitor Location Register
VoIP	Voice over IP
VPN	Virtual Private Network
VROOOMM	Virtual Real-time Object Oriented Overlay Memory Manger
WAP	Wireless Application Protocol
WCDMA	Wideband CDMA
WiMAX	Worldwide Interoperability for Microwave Access
WWW	World Wide Web