DATABASE CORRELATION FOR GSM LOCATION IN OUTDOOR AND INDOOR ENVIRONMENTS

A dissertation submitted to the
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degree of Master of Science in Telecommunications

By

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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Abstract

Accurately estimating the location of a Mobile Station is a key requirement to effectively provide a wide range of Location Based Services over mobile network. Since the mobile phone has become a common device in today's society, location based services are very popular among cellular subscribers. Hence developing cellular positioning techniques has been a key research problem and numerous localization solutions have been proposed. These include technologies such as Cell ID, angle and time of arrival methods and fingerprinting methods.

This thesis presents fingerprinting based positioning techniques suitable for different outdoor and indoor environments. Thus multiple positioning techniques are proposed, implemented and evaluated for different environments. Three outdoor trials in areas falls under urban, suburban and rural areas and two indoor trials in two multi storey buildings were used for evaluation. The ultimate solution proposed in this thesis is not a single positioning technique; rather it presents several positioning techniques that achieve optimum performance in each test environment.

This thesis proposes a novel fingerprint collection process for outdoor positioning and introduces a more accurate correlation algorithm. This thesis reports 67% positioning error as 112 m, 299 m and 221 m for urban, suburban and rural areas respectively. Experimental results show that the proposed positioning methods achieve accuracy far better than Cell-ID and trilateration approaches for the tested network environments especially for rural area. The 67 % positioning error for rural area is 1045 m and 1386 m with basic Cell-ID and trilateration techniques while proposed fingerprinting based technique reports 67% positioning error as 221m.

With indoor positioning this thesis reports 50% positioning error as 20.5m and 8.7m for the selected two buildings. Also it was possible to accurately differentiate between floors in these multi storey buildings. Results achieved for Building 2 is reasonable when compared with the results reported in a similar study by Veljo Otsason *et al. (2005)*.

To all my teachers,
for their support, encouragement and guidance

To my parents,
for their love, understanding and encouragement

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2G -	2nd generation
3G -	3rd generation
3GPP -	3rd Generation Partnership Project
AOA -	Angle Of Arrival
BCCH -	Broadcast Control CHannel
BS -	Base Station
BTS -	Base Transceiver Station
CDF -	Cumulative Distribution Function
CDMA -	Code Division Multiple Access
Cell ID -	Cell Identification
DC -	Database Correlation
E-911 -	Enhanced 911
E-OTD -	Enhanced Observed Time Difference
FCC -	Federal Communications Commission
FDMA -	Frequency Division Multiple Access
GPS -	Global Positioning System
GSM -	Global System for Mobile Communications
LBS -	Location Based Services
LOS -	Line Of Site
LMU -	Location Measurement Unit
MATLAB-	MATrix LABoratory
MLE -	Maximum Likelihood Estimation
MS -	Mobile Station
NLOS -	Non Line of Sight
NMR -	Network Measurement Report
OTD -	Observed Time Difference
p.d.f -	Probability Distribution Function
PCS -	Personal Communications Services
RMS -	Root Mean Square
RSS -	Received Signal Strength

RSSI	-	Received Signal Strength Indicator
RTD	-	Round Trip Delay
SIM	-	Subscriber Identity Module.
SMS	-	Short Message Service
TA	-	Timing Advance
TDOA	-	Time Difference of Arrival
TOA	-	Time of Arrival
TDMA	-	Time Division Multiple Access
WGS-84	-	World Geodetic System 1984
WLAN	-	Wireless Local Area Network
UMTS	-	Universal Mobile Telecommunications Systems