COVER SHEET

Tan, Siak Chuan (Andrew) and Wong, On (2004) Wireless Location Aware Applications for Mobile Commerce. In *Proceedings The 5th Asian Pacific Industrial Engineering and Management Systems Conference (APIEMS04)*, Gold Coast, Brisbane.

WIRELESS LOCATION AWARE APPLICATIONS FOR MOBILE COMMERCE

Siak Chuan Tan, On Wong and Charles Watson

Queensland University of Technology

GPO Box 2434 Brisbane Qld 4001, Australia

s77.tan@student.qut.edu.au, {o.wong, c2.watson}@qut.edu.au

ABSTRACT

This paper explores the emerging issues of future mobile computing, reliability, privacy, locality and context aware applications. Different location aware methods with technologies like Infrared Devices, WiFi, GPS and Landmark-based reporting are reviewed. Infrared Devices suffer line-of-sight problems and sunlight interference, GPS will incur connectivity problems for indoor readings, WiFi on the other hand does not share these problems and has the advantage of low cost with high accuracy. Preliminary studies on the role of WiFi in location awareness have been made and different driver platforms for detecting mobile clients are reviewed. Driver development for Microsoft DDK technologies and Linux-wlan kernel packages are explored in detail. The knowledge of location aids the efficiency of management system such as inventory control and customer information services. Services can then be aggregated in a timely and pertinent fashion, enhancing convenience and functionality for the user. WiFi location awareness method is adapted into an inventory control system and it demonstrates the applicability and usefulness of location awareness to e-business. Location awareness can also be adapted to numerous services like tourist systems, shopping assistant, chatting and dating services.

Key Words: E-business; Networks; Knowledge and information management

1. INTRODUCTION

Wireless technology provides numerous services like network printing and Internet access, but the introduction of location awareness (or context awareness) has brought about more services. For example, a doctor can now find the nearest available nurse or emergency operation room, a tourist can find which bus to take and when is it leaving. The goal in location awareness is to know where one is, and to know what services his/her surrounding environment has or can provide.

If a successful implementation of location awareness is available, it can bring about a lot of ‘mobile’ information/services for users on the move. The aims of this project is to research into an effective outdoor system that can provide these unique services, Location Aware Inventory system is a good example for this cause and thus it will be used as implementation for the project.

This paper will first look into the different types of wireless technologies available and why wireless networking is the best medium to obtain context awareness; different methods currently used in the market are also studied. These preliminary studies are important, as they will be the control cases for the new proposed method. We have used the idea of using hamming networks to calculate the user’s context. Hamming networks are a type of neural network used in recognition technologies. By utilising its concepts, we hope to obtain better accuracy and to find a more efficient method.

In section 4, we described our developed application to test the different standard methodologies for location detection; using concepts of neural networks then uses results in comparison to the accuracy of our proposed method. This application obtained different signal readings from a wireless client and attempt to compute and estimate the location of the user, which in turn will allow relevant services to be provided to the user.

2. LOCATION AWARENESS IN WIRELESS NETWORKS

2.1. WIRELESS TECHNOLOGIES

This chapter will attempt to look into the different technologies available in the market; a summary will be made to explain if they are suitable technologies for location detection. There are countless alternatives to technologies to achieve location awareness, and thus examples for more prominent wireless technologies like GPS and infrared LED are used.

2.1.1. INFRARED DEVICES

Infrared Devices [12] are amongst the first technology used to detect location, and can be found in laptops, PDAs and remote controls. There are many restrictions that made Infrared Devices unsuitable for unrestricted movements, For example, a line of sight is needed and its distance is unbearably low. This means that large amounts of equipment are needed to implement it and the accuracy is subject to the environment (i.e. Sunlight)

2.1.2. GLOBAL POSITIONING SYSTEMS

Global Positioning System (GPS) [9] is the only system today that is able to locate the exact position of a GPS receiver anywhere on earth anytime, anywhere, and in any weather. GPS works by having 24 satellites in space orbiting earth. These satellites are positioned in such a way that in theory it is always possible to receive signals from 4 or more satellites anywhere on earth anytime. The main strength of GPS is that it provides precision of up to 10 meters. This is a revolutionary breakthrough in location detection and its precision has caused great interest in military, commerce and private sectors.

There are several disadvantages in GPS. Power consumption for one is a major hindrance for mobile computing. This is crucial as electrical power is always in short supply even for modern mobile computing. Due to satellite reliance, GPS cannot be used indoors effectively and it is subjected to blockages by tall buildings outdoors. Sky scrapers in the cities create an ‘urban canyon’ [19] that block coverage of satellites, causing significant problems for users in cities.

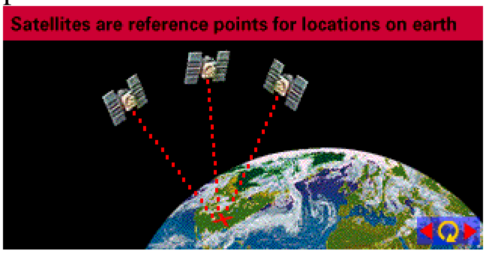

Figure 1. Three satellites used to estimate the position of the receiver.
http://www.trimble.com/gps/how.html

2.1.3. WIRELESS NETWORKS (802.11)

Wireless networking (wlan – wireless local area network) inherits many concepts from its wired predecessors. There are numerous advantages in this technology. Wlan are more convenient, flexible and mobile. Wireless clients need not be fixed to the network jack and workstations can be placed within range of a wireless access point. More importantly, there are numerous devices like hand phones, laptops and Personal Device Assistants (PDAs) that have integrated wireless networking capabilities.

Wireless networks require little configuration to obtain mobility and flexibility. Only wireless Access Points (APs) are needed to bridge wireless clients together, and it can also connect to a wired backbone for WAN connectivity.

IEEE has defined 802.11 as the umbrella protocol for wireless local area networking in 1997 and there are several modifications such as 802.11a, 802.11b and 802.11g [3] [17]. These modifications are made to ensure that wireless networks meet with the consumer demands for speed and reliability. This chapter will discuss more in depth with regards to these protocols.

IEEE 802.11a can obtain a maximum transfer rate of 54 Mbps and has a sound security, but it sacrifices its range and consumes more power. This high speed protocol means that voice and video telephony is possible, but its low effective range will means more hardware required over large networks. Lastly, its power consumption makes mobile devices unfeasible.

IEEE 802.11b is a very robust protocol, which allows a very long range without compromising the speed. 802.11b can peak up to 11 Mbps and its coverage can stretch up to 500 meters, it is also energy saving because it consumes less power due to its low frequency. It has also a WI-FI certification, which ensures full compatibilities between different equipments and vendors. Unfortunately, lack of speed means inability to support multimedia like movies and sound.

IEEE 802.11g is an extension of 802.11b, it is a ‘hybrid’ of 802.11a and 802.11b in terms of capabilities. This protocol have the advantages of 802.11a as it can obtain a maximum transfer rate of at 54 Mbps, but the realistic throughput will be around 7 – 16 Mbps. Like 802.11b, it consumes little power, has lower cost and longer range.

IEEE 802.11g is fully backward compatible with 802.11b, thus it is poised to overtake 802.11b in the near future. It is not possible to replace 802.11b immediately as it is the mainstream of all wireless network products. But as more consumers demand multimedia for their networks, it is inevitable that 802.11g overtakes 802.11b’s position.

2.2. LOCATION DETECTION METHODS

The main challenge in this research project is to calculate the user’s location accurately and to provide relevant information for the client based on his/her position. However, it is virtually impossible to obtain an accurate position of the users due to signal attenuation and interference from the surrounding. The positions of the users are usually blurred inaccurate data. Different locations will house different furniture or different building clusters, thus attenuation and inaccuracy will change from place to place. There is ongoing research to provide an ‘acceptably accurate’ formula to discover the location of users [6].

2.2.1. LAND LOC

Landmark-based user location system (Land Loc) [18] is a recent idea by Microsoft research, the motivation came from the common short-coming of Infrared devices, Wireless networks and GPS. They include costly deployment and implementation, dependency of infrastructure and potential violation of privacy and selective availability (e.g. U.S. military can choose to degrade accuracy of the GPS location estimate available to users globally).

This approach is inspired by the way people find their ways around when they are in an unfamiliar place, People uses landmarks and crossroads as a point of reference to obtain important information. Land Loc offers lower cost of deployment, no dependence on infrastructures and maintains privacy. However, it faces several challenges like finding a method to construct a topographical model efficiently, storing and querying the topographical model on the user’s mobile device.

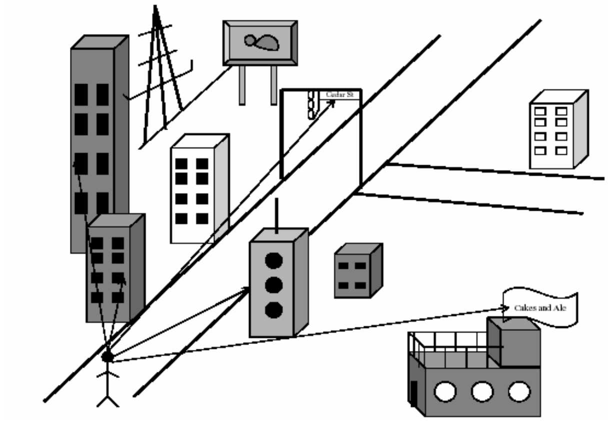

Figure 2. An Urban scenario showing Land Loc in operation. From his present location, the user is able to see two buildings on the left, the one with circular windows on the right, the restaurant on the far right, and the traffic intersection straight ahead. [27]

2.2.2. NEAREST BASE STATION

Nearest Base Station method is a crude way of implementing a location detection system, this is developed in an environment where the segmented areas are large and precise location is not required. This is implemented using wireless networking technology. A 'sniffer' is placed in every desired area or segment. The system will assume that the user is in the vicinity of the sniffer that registers the strongest signal.

A good example will be in a large departmental shop, where administrator might just want to know which department a user is in. This method is easy to implement and no training points are required [1], it is straightforward but it provides a generic estimation. The main disadvantage towards this approach will be that the efficiency is very low, n number of listeners can only provide n number of context.

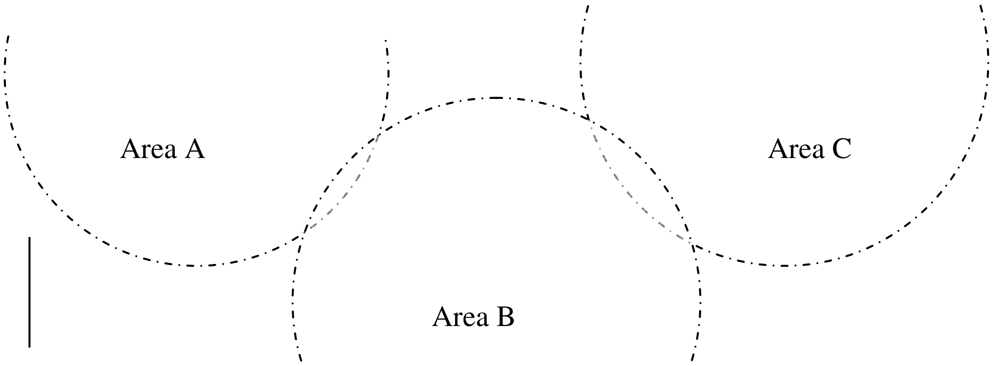

Figure 3. Ex ample of Nearest Base Station method

2.2.3. ACTIVE BADGE SYSTEM

The Active Badge System [13] was an early and significant contribution to the field of location-aware systems. This system works by having users to wear a 'badge' that emits a unique signal every 10 to 15 seconds. These signals are captured by sensors place strategically at known positions. A master station, which is connected to the network, will poll sensors for 'sightings' and compute the information into location very accurately.

As IR technology has been exploited commercially, the cost of producing emitters is not high. The size of the emitters (or badge) is also small and lightweight, thus it is not much of a 'burden' to the user carrying it. Active badge does have several drawbacks though, they can be summarised into the following:

- Poor scalability due to limited range of IR.
- High installation and maintenance cost due to amount of equipment.
- Poor performance in presence of direct sunlight.

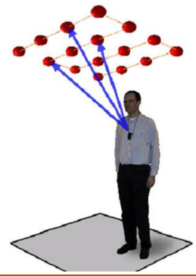

Figure 4. Example of a user wearing a active badge captured by 3 sensors, these information will be sent to a server which will triangulate the user's position.
http://www.uk.research.att.com/bat/

2.2.4. RADAR SYSTEM

The RADAR System is a wireless networking system developed by Microsoft Research [10], the first generation of RADAR systems simply consists of three or more base stations listening to users' signal strength. These strength data are gathered and converted into distance with a fixed formula i.e.

$$P_r = P_t\lambda^2/ (4\pi d)^2 \text{ [5]}$$

With the distance obtained, location of users can be computed via triangulation. Due to the uncertainty in the type of infrastructures, there could be a different amount of interference in different surroundings. This will make 'standard calibration' almost impossible if an accurate reading is to be maintained. Several new strategies have been developed and are adopted to provide more accurate readings in different environments. The most prominent improvement to this problem is the 'training' strategy. The idea is to create a training network at different times [1]. This can be obtained by having pre-measurements of several locations and inputted into the system at different time of the day. This system will then recognise a particular pattern of reading if it appears again. The only disadvantage about training is that systems need to be retrained in every new environment [1]. This can be tedious if no proper method of retraining is pre planned.

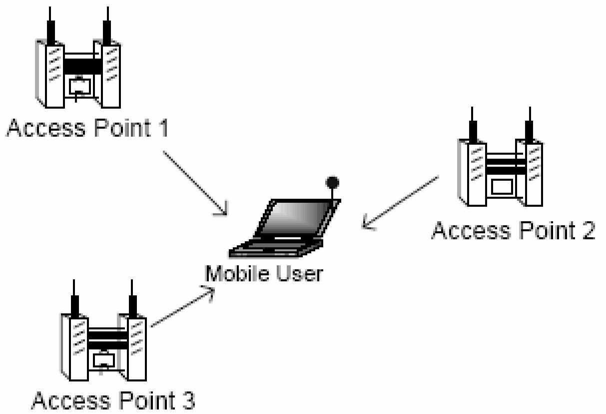

Figure 5. RADAR Systems, 3 APs triangulates their distances to detect mobile user's location. [11]

2.2.5. COMPETITION WITH HAMMING NETWORKS

There were some research [15] on location detection using neural networks - multi layered perceptron by University of Trento, Italy, and we proposed that an adaptation of the hamming networks is a good alternative to the previous approach. Hamming networks was designed explicitly to solve binary pattern recognition problems. It works with the use of hamming distance with each neurons competes with each other against every input, neurons are actually weights which consist of sample signal readings representing a particular context.

This implementation is easy and clear to understand because the rule is simple, the neuron with the least hamming distance wins. Hamming networks consists of 2 layers to calculate the winner neuron (weight), the input will entered into the feed forward layer to obtain the hamming distance for all weights. The results from the feed forward layer will then be forwarded to the recursive layer to be filtered, it is this layer where the neuron with the least hamming distance will survive and win.

2.2.5.1. FEED FORWARD LAYER

The feed forward layer performs a correlation, or inner product, between each of the prototype patterns and the input pattern. This layer by performing dot product will obtain the most similar in terms of characteristic.

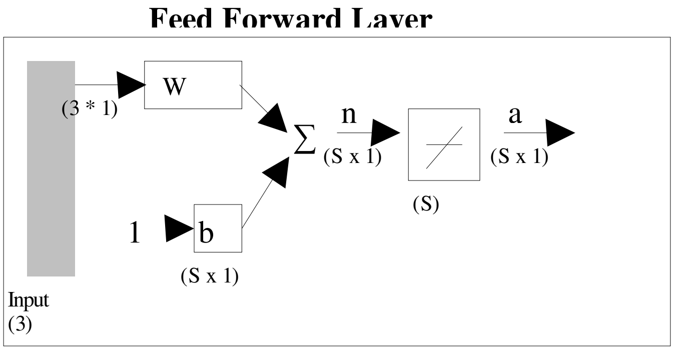

Figure 6. Feed forward layer of Hamming network [16]

Input = sniffed values of the 3 wireless sniffer.
W = Weight of each neuron of size S
b = Because it is Linear and Input size is 3, So it is [3;3]
n = Result to be passed into the Transfer Function
S = vector size
a = output

2.2.5.2. RECURRENT LAYER

The recurrent layer is known as a “competitive” layer. The neurons in this layer are initialized with the outputs of the feed forward layer, which indicate the correlation between the prototype patterns and the input vector. Then the neurons compete with each other to determine a winner. After the competition, only one neuron will have a non zero output. The winning neuron indicates which category of input was represented to the network.

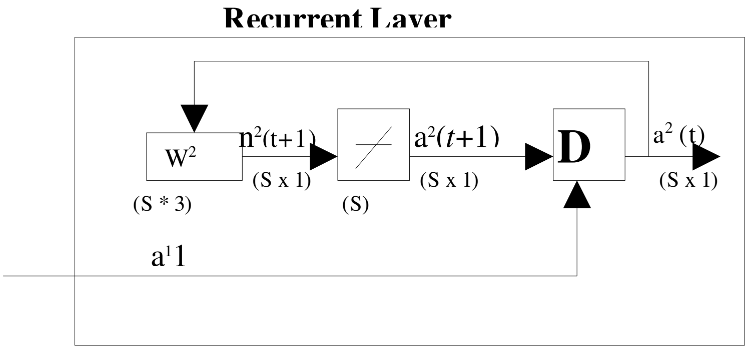

Figure 7. Recurrent layer of Hamming network [16]

A^1 = Input from Feed Forward Layer
A^2 = Input from Self recursion iteration
S = vector size
W^2 = The weight. 1 -ϵ
-ϵ 1 Where ϵ = 1/ (S-1)
N = Result to be passed into the Transfer Function
D = Decision if next iteration is required.

2.2.5.3. ADAPTING HAMMING NETWORKS

Because hamming network's view of differences between 2 vectors are judged in terms of characteristic by performing a dot product. It is not the intended distance of signal input calculation, thus it is important that we 'tweak' the strategy a bit to obtain the Euclidean distance instead.
Thus the formula of the *feed forward layer*:

$$\mathbf{a = WP + b}$$

will be adapted to become

$$\mathbf{a = ||W\text{-}P|| + b}$$

where W is input. This formulation is quite similar to a more advanced neural networking method, Learning Vector Quantization.

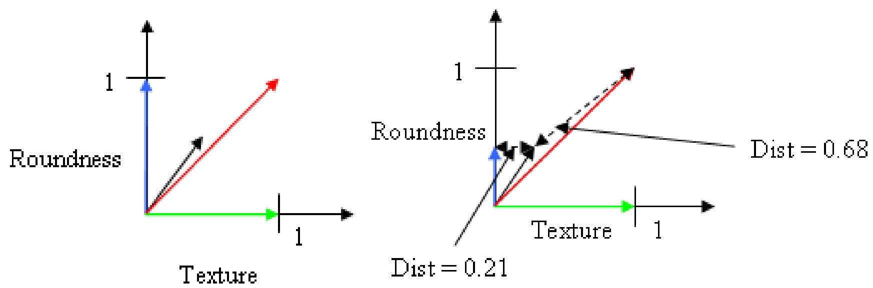

Figure 8. Dot product and Euclidean distance

Because Euclidean distance is used for calculation, the *recurrent layer* can be removed, as the distance need not perform normalisation therefore shortening the whole process. Thus this strategy is very easy to implement, especially if you are interested in offering services to clusters of area. It is extremely useful for a small – medium environment where training points (Context) are little and manageable.

3. LOCATION BASED SERVICES

Wireless Location Services fall into five broad categories:

1. Location-based Commerce,
2. Location-based Information Services,
3. Navigation Services,
4. Tracking Services and
5. Emergency Services.

3.1. LOCATION-BASED COMMERCE

Location-Based Commerce is triggered by end-users entering a specific geographical area. The most interesting opportunities in this field are position-driven advertising and promotion. Mobile subscribers can be proactively notified of the availability of specific services or special offers within a predefined radius of their current position. For example, a mobile Restaurant guide could provide a current menu to nearby consumers.

Location-based commerce will present a major opportunity to the retail sector (including restaurants, cinemas and stores) to dynamically manage demand via tightly targeted promotions and advertising to nearby consumers.

3.2. LOCATION-BASED INFORMATION SERVICES

Location-Based Information Services include all of those that respond to consumers' information needs, which related to where they are, and how they are getting there. Mobile positioning is required to automatically determining which location-dependent services are relevant. These services include traffic monitoring, mapping, and local information.

3.2.1. CONTEXT AWARE APPLICATIONS

There are already similar systems implemented elsewhere, they provide a model for us to study. This chapter will attempt to look into these systems and learn from their difficulty, a comparison with our proposed research project will also be made.

Cyberguide [4] is a system with similar goals of this research, but their method of implementation is different. Cyberguide's goal is to create a system where users will be able to access various services depending on where he/she is, this is achieved by using a combination of active-badge system (indoor) and Global Positioning System (outdoor) to obtain the user's location.

The combination of active badge and GPS for Cyberguide made its readings very accurate and reliable only if the environment is right. But it was found in chapter 3.2 that there are several drawbacks in this prototype, users are required to have excess equipments (sensors and badges). The accuracy of indoor readings via active badge system is also subjected to light sources and line of sight. Lastly, the accuracy of outdoor reading is subjected to urban canyons blocking satellite coverage.

A context-aware system was also recently implemented in a Mexico hospital [8], this is a robust system that fulfils the main goals of a context-aware system. The systems make use of mobile devices like Personal Digital Assistants (PDAs), and it allow users to utilise relevant services within his/her environment. In order to fulfil context awareness, this system also adopted the RADAR concept. Users are triangulated by at least 3 access points; these access points receive the user's signals and convert the strength of the signals to distance. With a trained electronic map, RADAR is able to calculate the user's location by triangulation. This successful implementation shows one of the many services context aware wireless systems can provide. Although it is an indoor RADAR system, it has also produced great accuracy and robustness.

The System has ultimately created an environment where doctors, nurses and patients can easily use services provided by this system. Doctors can now record patient's condition and the nearest nurse will be informed electronically to tend to that patient, these are just two out of hundreds of potential services that are now made possible by this context aware mobile communication.

3.3. NAVIGATION SERVICES

Navigation services guide end-users from predefined start points to destinations. Start points and destination addresses can be defined by user input, by wireless positioning technologies or from service providers' databases.

Driving directions are provided as turn-by-turn instructions, with maps of each turn and of the complete route. A list of point coordinates along the route will enable the requesting user to perform some spatial analysis. Routing maps are automatically centred on a route or a single manoeuvre (turn); however, the area of interest might represent only a small percentage of the delivered map.

These navigation services could provide drivers with voice- and GPS-enabled turn-by-turn guidance triggered by their actual position. They are also able to dynamically track drivers' location and re-route them in case of a wrong turning.

3.4. TRACKING SERVICES

Tracking services include both corporate and consumer applications regarding the location of a third party. Examples include a range of services from "Where is my child?" to "Where is my sales force?"

A delivery routing application could assist a transportation company to perform pickups and deliveries and with a fleet of trucks. At the start of each day or shift, trucks are loaded and the drivers are sent out with a list of scheduled pickups and deliveries. At varying times during the day, important pickups and deliveries are added, and drivers can receive amended route instructions when they check in after each stop. The application

1. Finds the addresses of all scheduled pickups and deliveries,
2. Performs spatial analysis to allocate the pickups and deliveries among the available trucks
3. Generates an optimal route with driving directions and maps for each driver,
4. As additional pickup and delivery orders are received, locate the most appropriate driver and modify the remainder of his route
5. Generate a revised optimal route with driving directions and maps for drivers affected by the changes.

The application could be enhanced to incorporate real-time online traffic services that alert fleet operators and drivers of traffic conditions, road construction, accidents and unscheduled traffic events. It could add support for weather services to adjust routing and schedules for adverse conditions. The application could issue instant alerts and rerouting in critical situations.

3.5. EVENT-BASED INFORMATION

Event-based information such as the provision of real-time traffic and parking information is extremely valuable in the deployment of location-based services. This information can significantly enhance the quality of driving directions. Real-time parking information is especially valuable for large cities. When business travellers visit a client in a foreign city, it is important to find a parking lot near the client's address where parking is available.

3.6. END-USER ASSISTANCE SERVICES

End-User Assistance services are those designed to support subscribers in difficulty. The main types of assistance service are breakdown and emergency services. For example in the case of a medical emergency this service could locate the nearest medical practice or hospital.

4. IMPLEMENTATION

4.1. OBTAINING OF WIRELESS NETWORK SIGNAL STRENGHTS

Signal strength is the necessity for context awareness; the values are needed to calculate the location of the clients. Signal strengths can be obtain from different devices and technologies, this chapter will look into obtaining signal strength via wireless networks as RADAR systems are derived from this technology.

Wireless network cards will be required to 'sniff' signal packets sent by clients and it will calculate the strength of the packet received. These device drivers are usually provided by operating systems or manufacturer, but default drivers do not always provide this advance feature required as there are some security concerns. Some manufacturers are worried that these sniffing features might be abused by malicious developer. However, this abuse is possible and it is also inevitable. As it is too difficult to prevent any sniffing at all, security should be implemented by clients to ensure privacy.

Windows Driver Development Kits (DDK) [7] is provided by Microsoft for device development, there is a different DDK for each version of Windows Operating System and these comes with subscribed version of MSDN. Because DDK is a licensed product and libraries written with it are not opened sourced, there are several outstanding issues and problems. We will have to write libraries, which can be tedious and time consuming.

The linux-wlan(tm) Project (Linux Wireless Local Area Network) [2] is launched by AbsoluteValue Systems in December of 1996, the goal of this project is to develop a complete, standards based, wireless LAN system using GNU/Linux. Many services can be offered by using Linux-wlan device drivers, programmers can enjoy the convenience of reusing them instead of having to start rewriting everything from scratch. There are a number of open source programs (open source are programs that includes the source code and are free to be edited) written based on these drivers, these programs are robust and can be customised to different requirement easily. Unfortunately, the number of network cards that linux-wlan project supports is limited to some chipsets. At present, only drivers for network cards based on prism chipsets are written by them. This will not pose a problem as the strict network card requirement is applicable only the 'snoopers' and not the client.

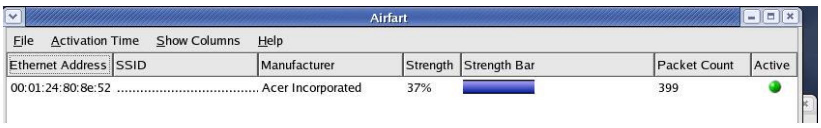

Figure 9. Air Fart sniffing for wireless packages, this program listens to wireless clients and produce useful information like Ethernet address of the client, manufacturer, strength and packet count

4.2. IMPLEMENTATION PROGRAM

The results of chapter 4.3 are obtained from a program written specifically for this paper, it is meant to obtain location information with different strategies presented in the above chapters, making the results simulated not based on 'paper and pen' but actual implementation from a sample program. Because of the complexity of the software due to its ability to test context results with different strategies, this sub topic is dedicated to introduction of the program written.

The follow figures will show how the program work in general and how we obtained the result with test data. The program generally consists of a main GUI, which will display information like Map, listener stations and clients

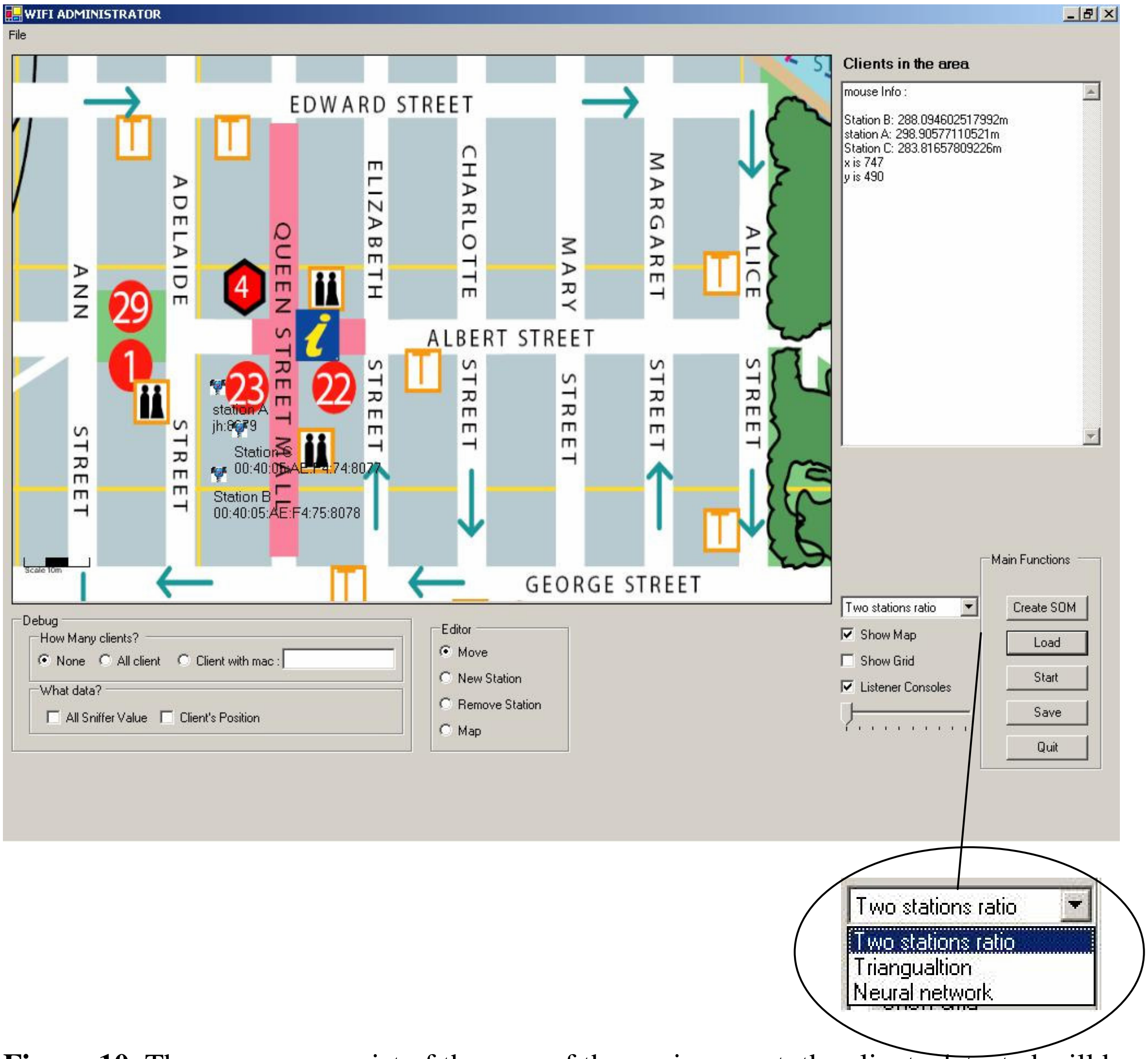

Figure 10. The program consist of the map of the environment, the clients detected will be printed on the right. We can also choose between the methodologies to calculate users' location.

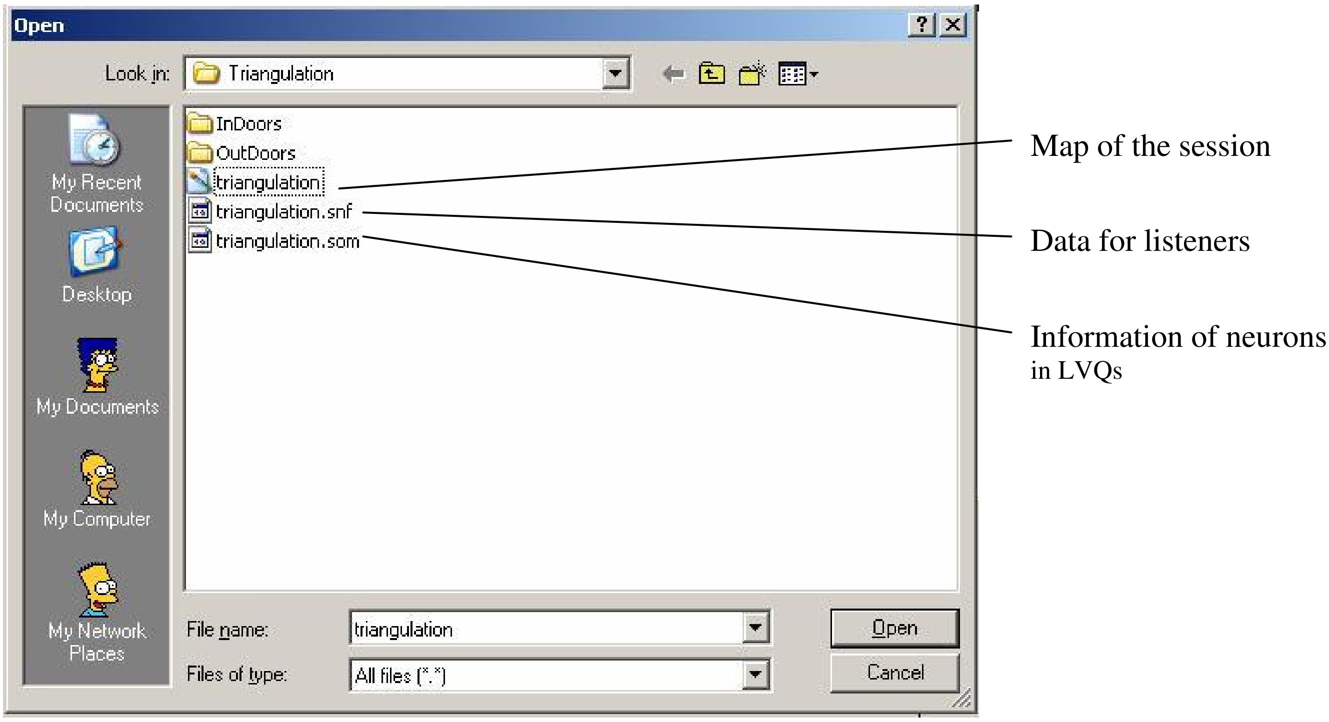

Figure 11. Files created per session

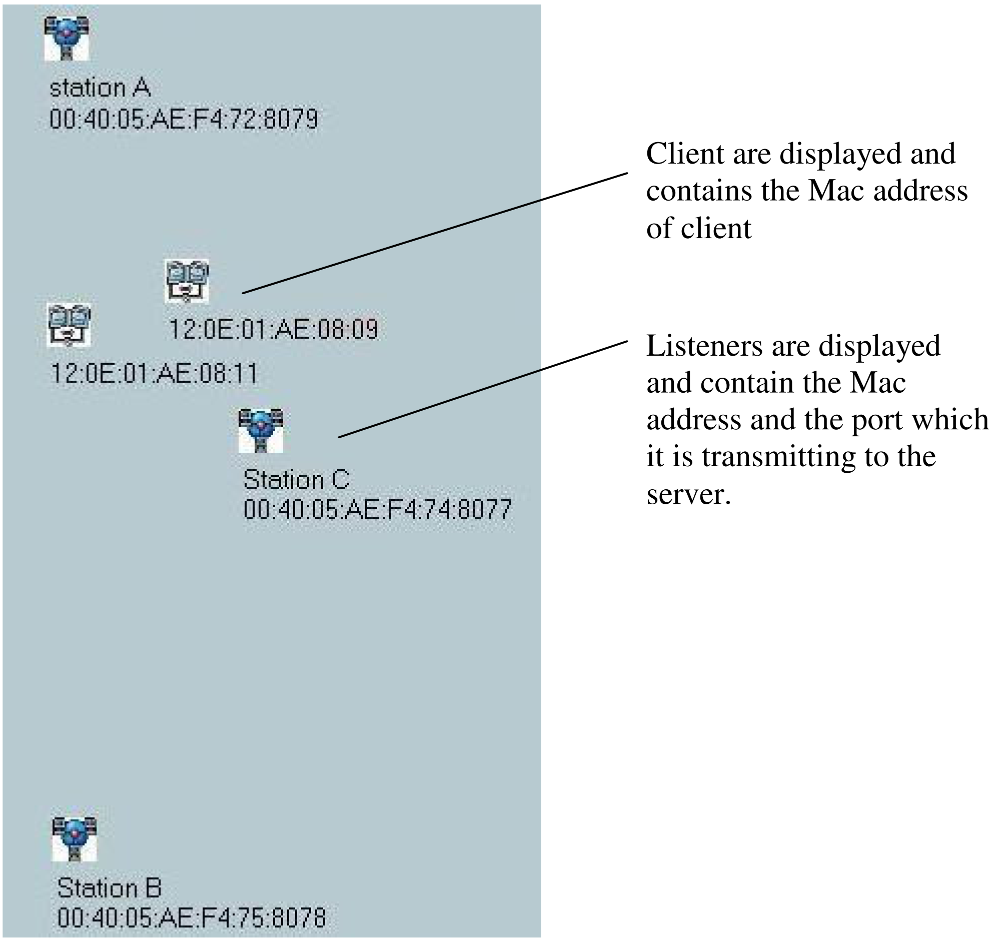

Figure 12. Result which will be displayed

4.3. RESULTS

Tests have been done for different strategies of Location detection; they include linear calculation, Triangulation and Euclidean distances with hamming network. All these strategies are utilised in a single test program, the results are summarised as follow.

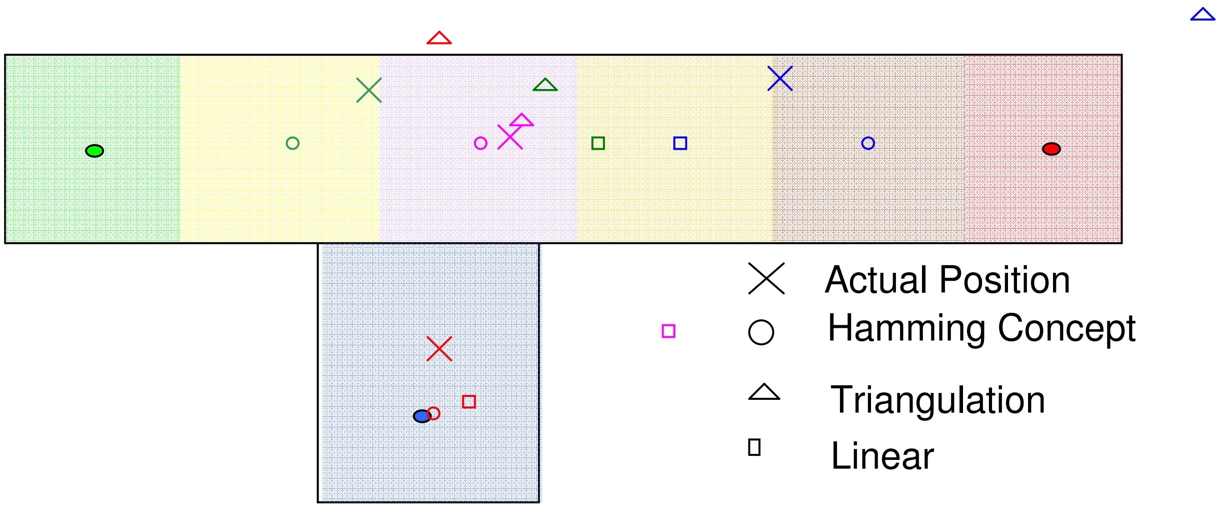

Figure 13. The result

The result shown was not erroneous in under extreme cases where the user stands very near the border, but this might not be the case in the real world. It is possible that the system might read the figures and compute the wrong context because the user is standing so close the neighbouring context, thus a test is made to find out why and how inaccurate is it. The result is very reassuring because it is found that the frequency of error is not too much at all, the system was able to obtain an accurate reading of the user 82.6% of the time. It is very reasonable to allow 17.4% errors when the user is standing so close to the border for now.

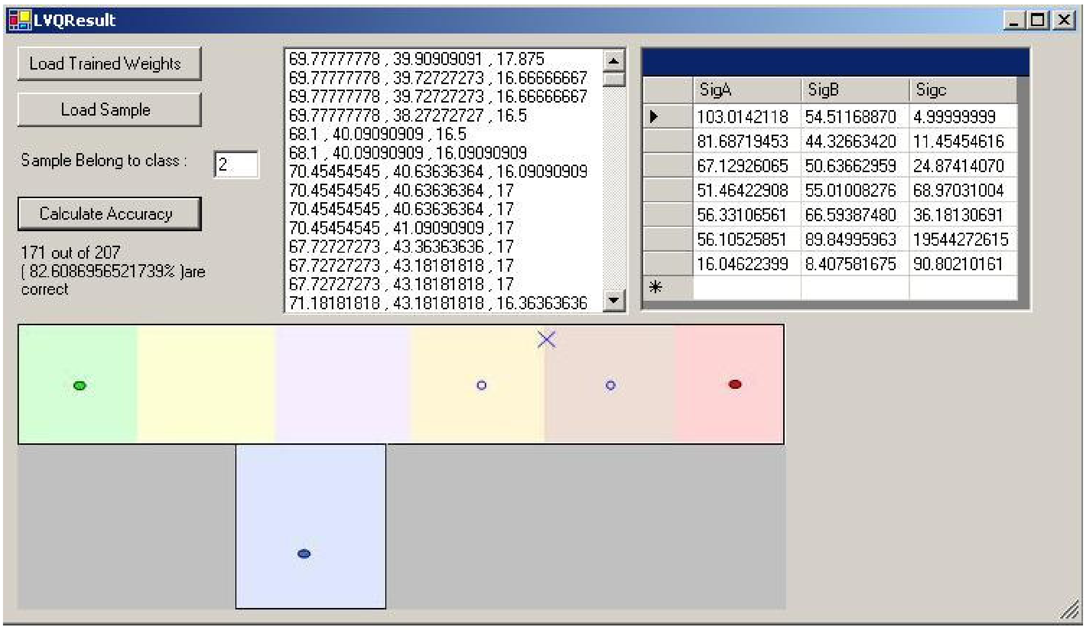

Figure 14. Border testing, the user is placed at the corner of a context.

5. PRIVACY OF LOCATION DATA

Privacy Principles are needed to prevent the misuse of location-aware technology. Fair Information Principles (FIP) for handling personal information have been formulated by many organisations. The OECD (Organisation for Economic Co-operation and Development) formulated its principles in 1980, and these are commonly accepted as a good baseline for proper handling of personal information. For location based services these principles are directly applicable. The intent of the Location Inter-operability Forum (LIF) Privacy Guidelines is to sharpen the OECD principles specifically for location data.

1. Collection limitation: Location data shall only be collected when the location of the target is required to provide a certain service.

2. Consent: Before any location data collection can occur, the informed consent of the controller has to be obtained. Consent may be restricted in several ways, to a single transaction, certain service providers etc. The controller must be able to access and change his or her preferences. It must be possible at all times to withdraw all consents previously given, to opt-out with simple means, free of additional charges and independent of the technology used.

3. Usage and disclosure: The processing and disclosure of location data shall be limited to what consent is given for. Pseudonymity shall be used when the service in question does not need to know the identity being served.

4. Security safeguards: Location data shall be erased when the requested service has been delivered or made (under given consent) aggregate. From this it should be clear that the LIF recommendation is to offer location services in such a way that the controller must be able to give his/her informed consent for collection and disclosure of location data. This consent is referred to as the opt-in principle in this document, in contrast to the opt-out principle, where the controller actively must decline location data from being shared with others.

5.1. LAWFUL ACCESS TO LOCATION INFORMATION

With the authority of law all the mentioned privacy principles may be overruled. The two common cases are emergency calls and lawful intercept. The most common overriding of location privacy is emergency calls. The emergency service provider must be able to retrieve the location of the caller by law in many countries and this is irrespective of any privacy preferences.

5.2. RIGHT TO CONTROL LOCATION DATA DISCLOSURE / USAGE

The cellular subscriber or the mobile terminal user has the right to approve or deny collection and disclosure of location data. The terminal user and the subscriber is not always the same person. For example, the employer who controls the privacy preferences can position an employee that uses a terminal at work. To be clear in terminology a controller is the one that decides on the privacy preferences to be followed by a location service. A target is the individual using the terminal, the one that is being positioned. Normally, the controller is also the subscriber of the target terminal and the privacy rules may be part of the subscription. The requestor is the party that initiates a service request finally leading to the positioning. LCS client presents the actual positioning request to the location service. The controller can authorize another party to configure the privacy preferences. In practice transferring this right may happen in several possible ways. Two common cases are presented below as examples.

5.3. EMPLOYER AND EMPLOYEES

When an employer wants to track the location of his employees by tracking their mobile terminals, the consent of each employee must be acquired separately. This can happen at the time of signing a contract of employment, by clearly stating that by signing the contract the employee agrees to be tracked geographically by the employer. Alternatively a separate contract about tracking can be signed.

The responsibility of acquiring employee consent must also be agreed between the employer and the party providing the location service, like the cellular operator. If the employer is responsible, the operator must have an agreement with the employer removing the responsibility from the operator. On the other hand, if the operator is responsible, there must be an agreement guaranteeing that the employer respects the rules agreed between operator and employee.

Regardless of the means of acquiring an employee's consent the employee must know beforehand that he may be tracked, or otherwise his consent must be asked for separately when the need for tracking arises. It should also be noted that in practice the employee either agrees that he configures his privacy preferences himself so that his employer may track him, or he gives the right to configure his privacy preferences to his employer.

Parents and children, when parents want to track the location of their child the situation may be different than in the employer-employee case. By law, a child is a minor and has parents or legal guardian(s). The questions that arise are: May parent(s) or guardian(s) decide on the right of a child's privacy and can they track a child's location even without her/his knowledge and/or consent. The recommendation is that the parent is the controller. Although tracking might be allowed from a legal point of view, the LIF recommendation is to at least notify the child when he is positioned or to be tracked geographically.

There are two ways of getting the controllers informed consent for collection and disclosure of location data:

1. Permission asked. The authenticated identity of the requesting party is presented in an understandable form to the controller. Additional information like the planned usage, policy on storage and forwarding to third parties and if pseudonymity is offered may also be given. The now informed controller decides whether location data may be collected and disclosed in this specific case. The controller may optionally give permission for a longer period or even permanently.
2. Predefined permission. The controller has beforehand given informed consent for one or several location services. Special care should be taken with written or electronic subscriber agreements where privacy preferences are given together with other service subscriptions. Changing of user preferences must be easy and free of any additional charges.

5.4. AUSTRALIAN PRIVACY LAWS

The Privacy Amendment (Private Sector) Act 2000 regulates the way the private sector organizations can collect, use, keep secure and disclose personal information. It gives individuals the right to know what information an organization holds about them and a right to correct that information if it is wrong. Consumers have the right to know why a private sector organization is collecting their personal information, what information it holds about them, how it will use the information and who else will get the information. Except for some special circumstances, consumers can ask to see this information and for the information to be corrected if it is wrong. Consumers can also make a complaint if they think their information is not being handled properly.

6. CONCLUSION

To conclude, this research has been made to study the best method to implement a location detection system that can be easily deployed anywhere for commercial purposes. But before any in-depth studies into the strategies are made, the technologies available to us are studied. Thus this paper has managed to give an impartial view as in the best choice of technology which location detection should be implemented on.

Leaving technologies aside, methodologies play an important role too. This research has reviewed several methodologies in location detection; some of them are picked for comparison and bench marking purposes. Linear method and triangulation are of such examples, the results of these methodologies are important to prove the efficiency of the new proposed strategy.

It is concluded that by adapting neural networking with wireless network as an alternative method for implementation of the system, not only is it able to be, it also allows easy dynamic deployment. This means that there this method saves costs, time and manpower with the benefit of efficiency. Currently, the implemented system could predict the user's context with an accuracy of up to 4 meters, but this can be improved if resources are spend on type of sniffers used and algorithm to obtain training weights and compute the result.

REFERENCES

[1] A. Smailagic, Daniel P. Siewiorek, J. Anhalt, D. Kogan and Tang W., (2001, 1 – 2 May), *Location Sensing and Privacy in a Context Aware Computing Environment*, in Proceedings of Pervasive Computing 2001, Gaithersburg, Maryland.

[2] AbsoluteValue Systems Inc. (2003), *Embedded Linux solutions for WLAN*, Retrieved 15 Dec 2003 from World Wide Web http://www.linux-wlan.com/ issued: 2003.

[3] B. Bing (1999, 17 – 20 Oct), *Measured Performance of the IEEE 802.11 Wireless LAN*, in Proceedings of 24th Conference on Local Computer Networks, Lowell, Massachusetts , pp. 34-42.

[4] Gregory D. Abowd, Christopher G. Atkeson, Jason Hong, Sue Long, Rob Kooper, and Mike Pinkerton (1997, Oct), *Cyberguide: A Mobile Context-aware Tour Guide,* ACM Wireless Networks, v.3, n.5, pp.421-433.

[5] I. Ramani, R. Bharadwaja and P. Venkat Rangan (2003, 6-9 July), *Location Tracking for Media Appliances in Wireless Home Networks*, in Proceedings of International Conference on Multimedia and Expo 2003, Baltimore, MD

[6] Matt Welsh, Research in Wireless Sensor Networks , Retrieved 10 Nov 2003 from World Wide Web: http://www.eecs.harvard.edu/~nawoj/cs299r/, issued : Spring 2004

[7] Microsoft Corporation (2004), *Windows Hardware and Device Central*, Retrieved 15 Dec 2003 from World Wide Web www.microsoft.com/whdc/ddk/ issued: 2004.

[8] Miguel A. Muñoz and Marcela Rodríguez and Jesus Favela and Ana I. Martinez-Garcia and Victor M. González (2003), *Context-Aware Mobile Communication in Hospitals*, IEEE Computer Society, v.36, n.9, pp.38-46, 2003.

[9] P. Aldridge(1997, Aug), The Global Positioning System, Retrieved 18 Dec 2003 from World Wide Web : http://www.aero.org/publications/GPSPRIMER/, issued: July 06, 1999.

[10] P. Bahl and Venkata N. Padmanabhan (2000, Mar 26-30), *RADAR: An In-Building RF-based User Location and Tracking System*, in Proceedings of IEEE Infocom 2000, Tel Aviv, Isreal.

[11] P. Bahl, V. N. Padmanabhan, and A. Balachandran (2000, April). *A Software System for Locating Mobile Users: Design, Evaluation, and Lessons*. Technical report, Microsoft Research, MSR-TR2000 –12 Redmond, WA.

[12] R. Want, A. Hopper, V. Falco and J. Gibbons (1992, January), The Active Badge Location System, ACM Transactions on Information Systems, v.10., n.1, pp.91-102.

[13] R. Want, A. Hopper, V. Falco and J. Gibbons (1992, January), *The Active Badge Location System*, ACM Transactions on Information Systems, v.10., n.1, pp.91-102.

[14] R. Battiti, Thang Le Nhat and A.Villani (2002), *Context Aware computing : A Neural Network*, Technical Report DIT-5, Department of Information Technology , University of Trento.

[15] R. Battiti, Thang Le Nhat and A.Villani (2002), *Context Aware computing : A Neural Network*, Technical Report DIT-5, Department of Information Technology , University of Trento.

[16] Sommerville, I. (2001, August). Software Engineering ; 6th edition, Addison-Wesley Publishing Co, Harlow, Essex UK.

[17] The Net Gear Inc(Feb 2003), *The ABGs of Wireless LAN*, Retrieved 07 Jan 2004 from World Wide Web http://www.netgear.com/pdf_docs/ABGs_of_Wireless_2.03.1.pdf, issued: Feb 2003.

[18] Venkata N. Padmanabhan (2003, Jan), *LandLoc: Landmark-based User Location*, Technical Report, Microsoft Research, MSR-TR-2001-23, Redmond, WA.

[19] Y. Cui and S. Sam Ge (2003, Feb), *Autonomous Vehicle Positioning with GPS in Urban Canyon Environment*, IEEE Transactions on Robotics and Automation, v.19, n.1, pp.15-25.