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Indoor Tracking of Area Using Wi-Fi Routers on a Smartphone

Rutujit Diwate, Prof. D. N.Rewadkar

M.E. Student, Department of Computer Engineering, RMD Sinhgad School of Engineering, Savitribai Phule, Pune University, Pune, India

Professor, Department of Computer Engineering, RMD Sinhgad School of Engineering, Savitribai Phule, Pune University, Pune, India

ABSTRACT: Wireless location finding is one of the key technologies for wireless sensor networks. GPS is the technology used but it can be used for the outdoor location. When we deal with the indoor locations GPS does not work. Indoor locations include buildings like supermarkets, big malls, parking, universities, and locations under the same roof. In these areas the accuracy of the GPS location is greatly reduced. Location showed on the map in not correct when the GPS is used under the indoor environments. But for the indoor localization it requires the higher accuracy sp GPS is not feasible for the current view. And also when the GPS is used in the mobile device it consumes a lot of the mobile battery to run the application which causes the drainage of the mobile battery within some hours. So to find out the accurate location for indoor environment we use the RSSIbased trilateral localization algorithm. The algorithm has the low cost and the algorithm does not require any additional hardware support and moreover the algorithm is easy to understand. The algorithm consumes very less battery as compared to the battery consumption of the GPS. Because of these this algorithm has become the mainstream localization algorithm in the wireless sensor networks. With the development of the wireless sensor networks and the smart devices the WIFI access points are also increasing. The mobile smart devices detects three or more known WIFI hotspots positions. And using the values from the WIFI routers it calculates the current location of the mobile device. In this paper we have proposed a system so that we can find out the exact location of the mobile device under the indoor environment and can navigate to the destination using the navigation function and also can enable the low consumption of the smart mobile battery for the tracking purpose.

KEYWORDS: Indoor Localization Algorithm, RSSI-based WIFI Access Point, Smart Phones, Android, Accelerometer Sensor, Orientation sensors.

I. INTRODUCTION

The communications is currently the major driving force of the development of several indoor location services for wide range of applications such as those in commercial, agriculture, medical, and the military uses. Various wireless technologies can be employed for indoor positioning applications. Some systems make use of an existing wireless network infrastructure such as Wi-Fi. More flexible and efficient systems employ IEEE 802.15.4 Wireless Sensor Networks (WSNs) due to the advantages in term of low power consumption, light weight and low cost.

Existing indoor localization systems[4][5][8] can be classified into three types based on the structure of service areas. These include the indoor localization systems for two-dimensional service areas, three-dimensional service areas, and multi-story building. Most of existing systems are designed for usages in two-dimensional areas where the position of target object is specified by a coordinate (x, y). The second type of the indoor positioning system considers a three-dimensional space in a small service area, such as in a room. The state of the object location is derived in the form of coordinate (x, y, z). Lastly, the positioning systems designed for the indoor multi-story building need to specify not only coordinate (x, y) in two-dimensional plane but also the floor where the object is Located.

Compared with outdoor localization, the difficulty of indoor localization lies in that indoor maps pay more attention to small areas, large-scale, high precision and subtly display of the internal elements.

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Along with the rapid development of wireless net- works and smart phones, the number of WIFI access points increase dramatically and most WIFI access[7] points locations are fixed. This phenomenon suggests a new direction for indoor localization research in wireless sensor network. Existing wireless localization algorithms require either special hardware support or complex computing, which consuming valuable battery resources greatly, especially comes to smart phones or sensors[1]. The contribution of this paper is that it proposed a new algorithm which increases theindoor localization[5] accuracy without any additional hardware support or increasing the computational complexity.

II. RELATED WORK

A. *GPS(Global Positioning System)*

GPS is used for the location tracking in the outdoor environment. The Global Positioning System (GPS)[11] is worldwide radio-navigation system which is formed from the constellation of 24 satellites and their ground stations. The GPS is mainly funded and controlled by the U.S Department of Defense that is (DOD). The system was designed for the operation of the U. S. defence. But nowadays, there are also many civil users of GPS across the whole world. The civil users have permission to use the Standard Positioning Service without any kind of charge or restrictions.

GPS[8] tracking is a method of working out exactly where something is. A GPS tracking system, for example, may be placed in a vehicle, or may be on a cell phone, or on special GPS devices[11], which can either be a fixed or portable unit. The working of the GPS is by providing information on exact location. It can also track the movement of the vehicle and person. So, for example, a GPS tracking system can be used by a company to monitor the path or route and progress of a delivery truck, and can be used by parents for checking on the location of their child, or even to monitor high-valued assets in transit. A GPS tracking uses the Global Navigation Satellite System (GNSS) network[11]. This network incorporates a range of satellites which use microwave signals. These are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS tracking system potentially gives both real-time and the historic navigation data on any kind of journey.

GPS provides special satellite signals, these are then processed by a receiver. These GPS receivers track the exact location and also compute velocity and time. The positions can be computed in three-dimensional views with the help of four GPS satellite signals. The Space Segment of the GPS consists of 27 Earth-orbiting GPS satellites. There are total 24 operational and 3 extra (in case one fails) satellites that move round the Earth each 12 hours and send radio signals from space that are received by the GPS receiver.

The control of the Positioning System consists of the different tracking stations located across the globe. These stations help in tracking signals from the GPS satellites which are continuously orbiting the earth. transmit The microwave carrier signals are transmitted by the Space vehicles. The users of the Positioning Systems have GPS receivers that convert these satellite signals so that one can estimate the actual position, velocity and time.

A passive GPS tracking system will monitor location and then will store its data on journeys based on certain types of events. So, for example, the GPS system of this kind can log the data of the locations where the vehicle has travelled the past 12 hour. The data stored on this kind of GPS tracking system is usually stored in internal memory or on a memory card, and then can be downloaded to a computer at a later date for analysis. In some cases the data can be sent automatically for wireless download at predetermined points or can be requested at specific points during the journey.

An active GPS tracking system[9] is also known as a real-time system because this method automatically sends the information on the GPS system to a system in real-time as it happens. These systems is a better option for commercial purposes like fleet tracking or monitoring of people, such as children or elderly, as it allows a caregiver to know exactly where loved ones are, whether they are on time and whether they are where they are supposed to be during a journey. This is also useful for monitoring the employees as they carry out their work and als of the streamlining internal processes and procedures for delivery fleets.

The GPS satellite gives the accurate position of the device. The which is mounted in the Car. This device is in turn which is connected to the local GSM service provider via a GSM network as it has SIM card present in it thus the GPS parameters which the device has are send to the tracking server which has a Static IP address via a GPRS network.

The tracking server consists of a Socket listener application running in the background which listens at a particular port. The GPS parameters received by the port listener[11] are given to the Parser and converter for proper conversions and this data is stored in the database. These values from the database are fetched and are manipulated to get the reports in proper format.

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Fig1: Working of the GPS

But the basic drawback of the system is that the GPS signal does not work in the indoor environment. These signals cannot be used for the tracking purpose in the indoor area because the signal strength is very poor in those area.

B. Fingerprinting

Indoor pedestrian tracking[11] which extends location-based services to indoor environments. Typical indoor positioning system employs positioning model using WI-Fifingerprints[9]. These approaches have practical results in terms of accuracy and coverage and require an indoor map. The indoor map is typically not available to the average user and involves significant training costs. A practical indoor pedestrian tracking approach should consider the indoor environment without a retrained database or floor plan. Using the fingerprinting technique[9] the indoor plan of the floor[9] can be constructed using the smartphones[3] it uses inertial[2] sensors, an observation model using Wi-Fi signals, and a Bayesian estimation for floor-plan construction.

Fingerprinting is a two-phase approach to localize a device based on radio frequency signals. In the first phase, also called pre-deployment or offline, data is collected which is then used in the second phase, called real-time, to localize a device. Wi-Fi Compass requires an algorithm, which is able to localize a user without a pre-deployment phase. As a result, Fingerprinting is not a feasible approach for indoor localization.

III. INDOOR TRACKING

A. Technologies for Indoor Localization

There are many wireless localization technologies and solutions. The commonly used localization techniques include infrared, ultrasonic, radio frequency signal, Bluetooth, and Ultra-Wideband, WIFI but they are not suitable for indoor localization.[6] Infrared is only suit-able for short-distance transmission, and could easily be influenced by fluorescent lamp or the light in the room, there are limitations on the localization accuracy; ultra-sonic, Bluetooth and Ultra-Wideband require special equipment, the cost is too high, hence they are not widely used; RF signal does not have communication capability, and is not easy to be integrated into other systems.

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But currently there are number of indoor WIFI access points[7] which are offering the services for free. So WIFI is the most used technology.

B. Algorithms for Indoor Localization

Conventional methods for indoor positioning[8] are based on time of arrival,[5] time difference of arrival and angle of arrival of radio signals transmitted by mobile stations. For these methods to accurately estimate the location of a receiver, line-of-sight (LOS) between the transmitter and the receiver has to be ensured. Furthermore, specialized time synchronization hardware is required to be integrated into the existing equipment. These requirements increase the cost of implementation considerably.

But because this algorithm does not require any additional hardware support and has the higher accuracy for the indoor localization[4][6] this is widely accepted and used technique for the indoor localization.

IV. PROPOSED SYSTEM

In the indoor environment with each WIFI routers there are some attributes. In our system we will be using the strength that is the level and the frequency for the calculation of the distance of the mobile from the WIFI routers. But as we are dealing with the accurate location finding and also less consumption of the battery we take the assistance from the mobile sensors. The smart mobile has the number of the sensors embedded within it. But for our system we use the accelerometer and the orientation sensors. We calculate the distance value to plot the mobile device location and to check whether the user is moving to check speed and the path change we take the sensor values.

A. *System Architecture*

This is the general architectural diagram of the system. The system has one web application and one application running on the smart mobile. the smart mobile user first download the map of the indoor environment for which he wants to enable the navigation with login in to the system. The user gets the map on the smart mobile. With the search function user can search for the desired position and can enable the navigation to reach to the destination.

The system takes the assistance from the mobile sensors also for the low battery consumption and for the more accurate location of the smart mobile in indoor location.

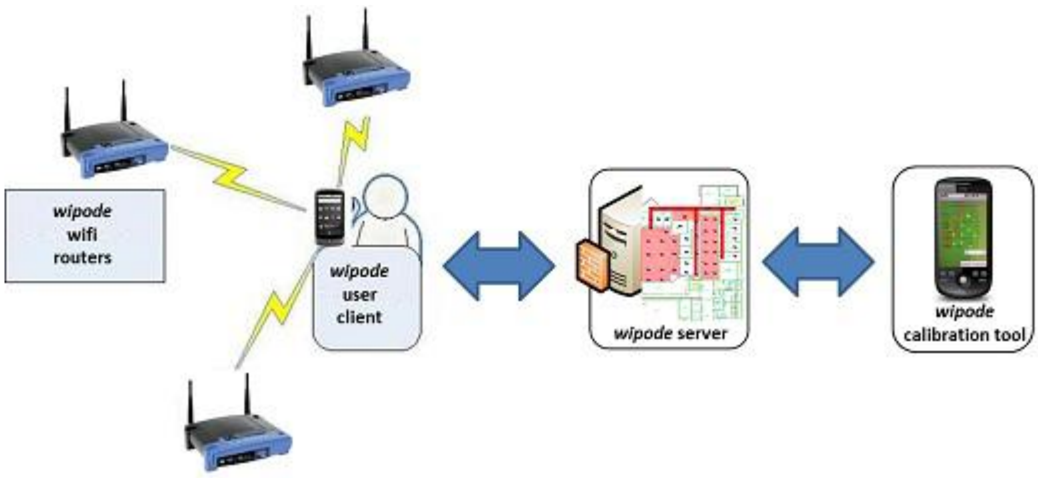

Fig2:General Architecture

In the environment we cant guess the user behaviour the user might be at one position or he can take the turns the speed variation all these behaviour can be pointed out using the accelerometer and the orientation sensors. These sensors sends the location samples to the server and those are plotted on the map and the trajectory is made.

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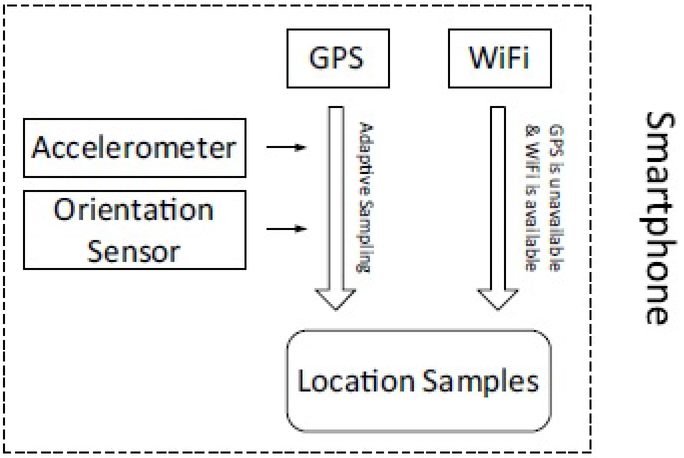

Fig 3 : Sensor data

The mobile sensors[1][3] and the WIFI routers can be user for the indoor localization because of the accuracy and the consumption of the less mobile battery.

B. *Triangulation Algorithm*

Triangulation offers a way to locate yourself in space. This technique was used by the Cartographers in the 1600s to measure things like the height of the cliff, which would be too impractical to measure directly. After the triangulation method evolved into an early navigation system when Dutch mathematician Willebrord Snell discovered three points can be used to locate a point on to the map.

While triangulation method uses angles for locating the points, whereas trilateration uses lateral distances. If we know the positions of three points P1, P2, and P3, as well as our distance from each of the points, r1, r2, and r3; we can look at the overlapping circles formed to estimate where we are relative to the three points.

The technique can be extended to3D, finding the intersecting region of spheres surrounding the points. For the triangulation algorithm the input is from the WIFI routers. It takes the values of the frequency and the strength or the level and calculates the distance using the Free Space Path Length. Then the circle is drawn taking that as radius and for all the routers and the location is determined Following is the figure for the smart mobile device under the indoor environment[5]. The location is found by using the 3 routers.

In the system as the number of the router increases it gives the exact location of the smart mobile. The sensors that is the accelerometer[1] and the orientation sensors[3] they are used to determine the location of the smart mobile when the environment consists of the minimum number of the routers.

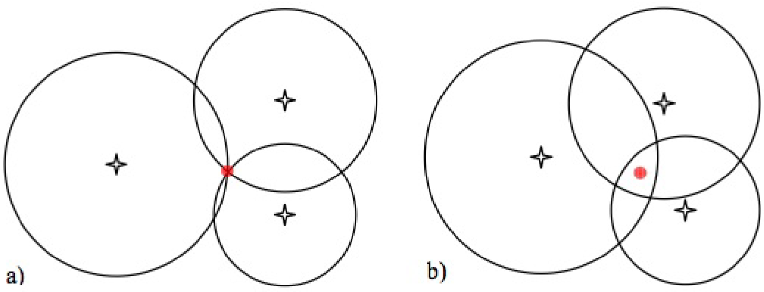

Fig 4: Triangulation for 3 routers

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The following figure shows the trilateration algorithm for the n amount of the points.

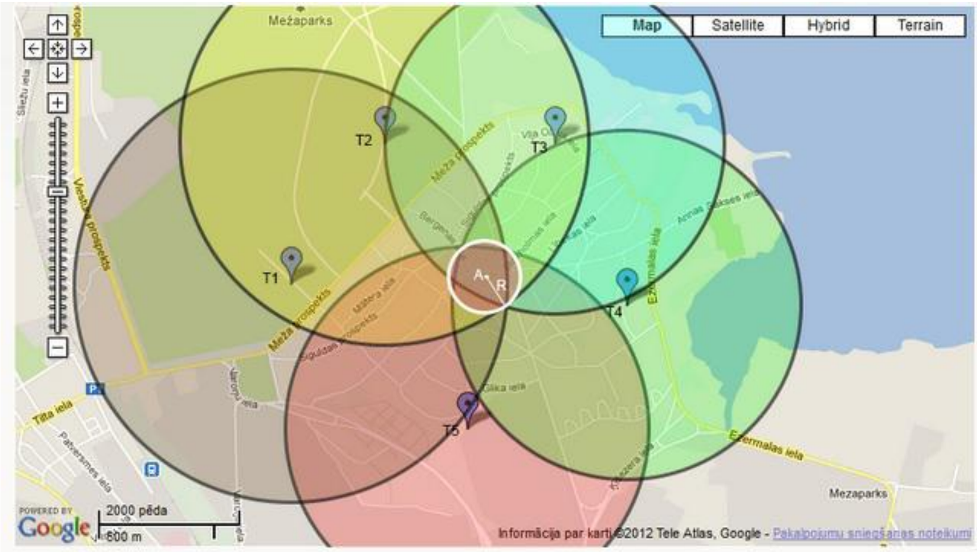

Fig 5: Triangulation for the n routers

V. MATHEMATICAL MODEL

Free-space path loss is proportional to the square of the distance between the transmitter and receiver, and also proportional to the square of the frequency of the radio signal.

$$FSPL(dB) = 10log10((\frac{4\pi}{c}df)^2)$$

$$=20log10(\frac{4\pi}{c}df)$$

$$=20log10(d) + 20log10(f) + 20log10(\frac{4\pi}{c})$$

$$= 20log10(d) + 20log10(f) - 144.55$$

Where the units are as before

For typical radio applications it is common to find f measured in units of MHz and d in Kmsin which the FSPL equation becomes

$$FSPL(dB) = 20log10(d) + 20log10(f) + 32.45$$

For d, f in meters and kilohertz, respectively, the constant becomes -87.55

For d,f in meters and megahertz, respectively, the constant becomes. -27.55

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For d,f in kilometers and megahertz, respectively, the constant becomes 32.45

A. Evaluation of the Location

The experiment was made in an indoor building to check the accuracy of the location. Which was consisting of the 3 floors each floor contains one access point AP[7]. The application calculates the RSSI[6] floor information[9] of the available AP the apply to the triangulation algorithm to find out the location of the smartphone device[3]. Results are shown with the following table and the graph which depicts the variation In the actual and the calculated location.The smartphone is Galaxy S-3 made by the Samsung and operating system is Android 4.1.2

Floor	AP1 RSSI dBm	AP2 RSSI dBm	AP3 RSSI dBm	Mobile Calc. Mean dBm	Actual Dist. m	Calc. Dist. m	Diff. m
1	-87	-74	-50	-84	5	4	1
2	-90	-80	-65	-78	10	12	2
3	-53	-64	-88	-90	15	13.5	1.5

Table: Perceived values table

Floor	Exist AP	Calc. AP	Actual Dist. Bet. Mobile and AP(m)	Calc. Dist. Bet. Mobile and AP(m)	Diff (m)
1	AP1	AP1	7	5	2
2	AP2	AP2	10	12	-2
3	AP3	AP3	15	13	2
1	AP1	AP1	4	4.5	-0.5
2	AP2	AP2	6	8	-2
3	AP3	AP3	7	6	1
1	AP1	AP1	20	17	3
2	AP2	AP2	16	15	1
3	AP3	AP3	18	19	-1

Table: Observed values

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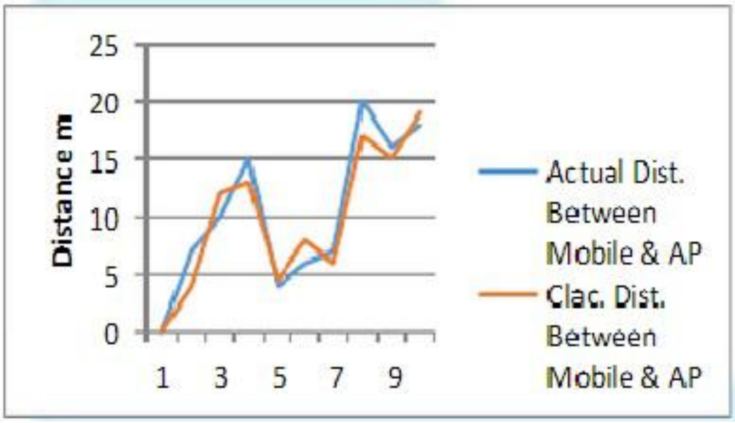

Fig 6: Graph of variation

VI. CONCLUSION AND FUTURE WORK

This paper provides technique for indoor tracking using the WIFI routers. The Smartphone sensors accelerometer and the orientation sensors are also used to find out the accurate location of the smart mobile. These techniques don't require any additional hardware and as the sensors require very less battery consumption than the GPS it can be used to save the battery life. In the future the system can be integrated with the outdoor tracking and positioning to form the complete system which will help the user to enable the tracking for both indoor and outdoor locations.

REFERENCES

1. Alejandro Correa, Marc Barcelo, Antoni Morell, and Jose Lopez Vicario, Enhanced Inertial-Aided Indoor Tracking System for Wireless Sensor networks: A Review, IEEE SENSORS JOURNAL, VOL. 14, NO. 9, SEPTEMBER 2014.
2. Anthea Wain Sy Au, Chen Feng, Shahrokh Valaee, Senior Member, IEEE, Sophia Reyes, Sameh Sorour, Member, IEEE, Samuel N. Markowitz, Deborah Gold, Keith Gordon, and Moshe Eizenman Indoor Tracking and Navigation Using Received Signal Strength and Compressive Sensing on a Mobile Device, IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 12, NO. 10, OCTOBER 2013
3. Lei Zhang, Student Member, IEEE, Jiangchuan Liu, Senior Member, IEEE, Hongbo Jiang, Member, IEEE, and Yong Guan, Member, IEEE, SensTrack: Energy-Efficient Location Tracking With Smartphone Sensors, IEEE SENSORS JOURNAL
4. Mike Emery, Mieso K. Denko IEEE 802.11 WLAN based Realtime Location Tracking in Indoor and Outdoor Environments, 0840-7789/07/$25.00 2007 IEEE.
5. Mike Emery, Mieso K. Denko, IEEE 802.11 WLAN based Realtime Location Tracking in Indoor and Outdoor Environments, 0840-7789/07/$25.00 IEEE
6. Xiuyan Zhu, Yuan Feng*, RSSI-based Algorithm for Indoor Localization Communications and Network, 2013, 5, 37- 42 doi:10.4236/cn.2013.52B007 Published Online May 2013 (http://www.scirp.org/journal/cn)
7. Ning Chang, Rashid Rashidzadeh, Member, IEEE, and Majid Ahmadi, Fellow, IEEE, Robust Indoor Positioning using Differential Wi-Fi Access Points, IEEE Transactions on Consumer Electronics, Vol. 56, No. 3, August 2010.
8. U. G. Yanying, A. Lo, and I. Niemegeers, A survey of indoor positioning systems for wireless personal networks, IEEE Communications Surveys Tutorials, vol. 11, pp. 1332, Mar. 2009.
9. A. S. Al-Ahmadi, T. A. Rahman, M. R. Kamarudin, M. H. Jamaluddin, and A. I. Omer, Single-phase wireless LAN based multi-floor indoor location determination system, in2011 IEEE 17th Int. Conf. Parallel and Distributed Systems, pp. 10571062.
10. Ruppel, K. M. Stubbe, and U.Z winger, indoor navigation integration platform for firefighting purposes, in 2010Int. Conf. Indoor Positioning and Indoor Navigation, pp. 16.
11. Sameer Darekar, Atul Chikane, Rutujit Diwate, Amol Deshmukh, Prof. Archana Shinde, Tracking System using GPS and GSM: Practical Approach, International Journal of Scientific Engineering Research Volume 3, Issue 5, May-2012 1 ISSN 2229-5518.

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BIOGRAPHY

Rutujit K Diwateis a Research Scholar RMD Sinhgad School of Engineering, University of Pune. He has received B.E. in Information Technology from Information Technology department of Sinhgad Academy of Engineering from University of Pune, Pune (2012). Currently he is pursuing M.E. in Computer Engineering from RMD Sinhgad School of Engineering, Warje, Pune, University of Pune.

Prof. D. N. Rewadkar has received M.E.Computer Technology, from S.R.T.M. University, Nanded. (2000). Currently he is working as an Associate Professor & Head the Department of Computer Engineering, in RMD Sinhgad Technical Institutes Campus, Warje, Pune. He was a Member of Board of Study (BOS) committee of S.R.T. Marathwada University, Nanded for Computer Science & Engineering. His area of interest is Traffic Engineering & Mobile Communication. He has 21 years of teaching experience.