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Software Interface Design for Location Tracing Using WI-FI Access Points

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Abstract*—Several times the simulation environment is required to show the results of the research work. Writing program to crunch the raw data is required, for potpourri applications. One can use the programming style and approach presented here as a case study to solve and create user interface for particular problem. The real time data processing is done and tracing of the location of the mobile user, device and/or objects is performed. Similarly, the offline mode can be useful to show demonstration for several purposes. The timer based application is created and the nearest reference point is used to calculate the current position of the movable device or object. The distance formula is used in the current situation, from the values received from the WI-FI access points. The Human computer Interface is developed for the problem in the consideration for location detection using the WI-FI access points in 802.11b.

Keywords*— Simulation Environment, IEEE 802.11b, location detection, mobile user, Human Computer Interface.

I. INTRODUCTION

Recent advancements in the mobile computing efficiently made the access of the location aware applications in the hand-held devices and mobile phones. Either the Global Positioning System(GPS) showing the navigations to the travelling mobile device holder, or the limited range applications like the Wireless Fidelity (Wi-Fi) available in the mobile phones support the user for several purposes. The Long Term Evolution (LTE) providing the high speed beyond the two mbps, in the Fourth Generation (4G) of the mobiles.

The Open Source Linux based Android making the significant contribution in the life of the human beings. The limited range location aware applications up to 200 meters can be made efficiently with the use of WI-FI access points. The location aware applications making the use of the GPS system is found as more energy consumption method, however the battery life is limited in the mobile devices.

The Location-aware computing using the wireless applications are interesting, research area that exploits the possibilities of modern communication technology. Location-aware devices can be located or can locate themselves; by location services. Location-aware computing has great potential areas such personal security, navigation, tourism, and entertainment. The location awareness is not only useful to tracing the human being location, and crime detection but also useful for locating the artificial robots.

The increase in the number of access points can possibly provide the accurate location of mobile user either using laptop, mobile phone or tablets. The location of the user with respect to the position of the WI-FI access point can be available with the distance formula. The IEEE 802.11b based methodology for the location tracing is interesting. We have created the graphical user interface and provided "what you see is what you get" (WUSIWYG) method of simulation. The Google Play Services are available in the android, but need the Internet connection to the use the GPS service for the effective location tracing.

The mobility of the user during the mobile communication technologies either in the any of the telecommunication generations through the first to fourth needs hand-off techniques such as inter system or intra-system, hand-off in Soft or hard hand-off techniques can be done. The updates of the Home Location Register (HLR) and Visitors Location Register (VLR), consumes the energy i.e. battery of the mobile handset or the tablet. The location aware applications highly use the energy and degrade the battery life.

It will be interesting to find out position of the mobile user, in the three dimensional space. e.g. person in one room perhaps on the floor, or in air, or near to ceiling, in the upper section of the room. This research work focuses on the finding out the location of the user in the particular geographical area.

The work takes the measurement of the reference points from the work done by the B. R. Jadhavar & T. R. Sontakke et. al, [8] where the D-Link wireless access point having IEEE802.11b wireless network frequency of 2.4 GHz testing area with wall partitions. The walls between the transmitter and receiver and the indoor Propagation model has been developed for these two buildings based on number of floors between transmitter and receiver which relate signal strength log of distance. The models are based on exponential path loss versus distance relationship. The measurement has been done with the 82 different locations. Experiment is carried out using Laptop as a receiver and D- Link wireless router as a transmitter. The inSSIDer software is used which gives signal strength at particular location. The studies reported here is useful in modelling a first-order prediction of distance dependent mean signal strength level, and also in

understanding the spectral power requirements inside a building. This work contributes in the field of Human Computer Interface, which is important for the Design phase of Software Development Life Cycle. Here, Graphical User Interface designed will be responsive, consistent and memorable to the user for its day to day research work of the research scholar. The scaling of the actual physical area on the "Form" is required several type of the work.

II. BACKGROUND

The review of the paper from technical angle and some human computer interaction has been done, explained in the below section. Selvaperumal et. al, The nearest neighbour beacon nodes can be detected. The distance based localization in the presence of beacon nodes is done. [3]

The location based personalizes mobile service (LBS) useful in emergency for coverage, deployment, routing, location service, target tracking and rescue operations. The GPS is available with no subscription fees. The mobile phone supporting J2ME based application is developed which sent the users current location using Short Message Service (SMS) plus sharing location with friends and family and views them on maps. [4]

Finding the human mobility in cost effective way is necessary, the General Packet Radio Service (GPRS) and GPS is useful in several ways. The GPRS packet can be sent to track the location of the mobile. The IMEI number is useful to track the mobile user uniquely and the use of the database for the information preservation [6][2].

The vehicle security mechanism based on the GSM and GPS is done with the use of SMS sent to the micro controller and vehicle engine should not be started. The theft prevention and tracking is possible, with the use of this system. [7]

The emerging mobile devices and hand held devices use the online business accessible in the Internet domain, with casual sales and purchase. The location enabled services for betterment and benefit of the customer are illustrated in reference [5].

The location based information system on the android operating system with the availability of the sensitive information in several applications like security, traffic patterns, travel guides and availability of data at the real time is required [9].

Triangulation, scene analysis and proximity are the location estimation schemes. Inventory management and asset tracking are the areas need the location tracking perhaps use of RFID and supporting wireless indoor positioning system is possible. The choice of the techniques can be done on the basis of accuracy, precision, complexity, scalability, robustness, and cost [10].

The architectural design of the indoor location prediction system using multiple wireless signals available freely in public or office spaces. There are applications like indoor robot localization which requires as precise localization as possible. There are methods like multiple wireless sources, effects of human body heats or mobility of the users for the location detection and prediction. [11]

III. METHODOLOGY

Here Visual Basic 6 is used, having the different units of the measurement on the "Form/ Window" as a graphical user interface component. The problem domain is here to map actual area to the simulation environment. We have used the line control to draw the boundaries of the experimental area. The mapping is important to show the navigation and movement of the user in the test bed. The run-time drawing on the form area perhps need to set the "Auto Redraw" property of the form as "True".

The tracing of the four different mobile users is done and the strength of the signal in the decibel has been recorded in the text file. The signal strength is considered as the referencing point for the next un-know user mobility values. The database of these values is encoded in the program written by us. There are reference points i.e. red colour points are in the layout shown in the figure. There are 82 points reference points, measured and stored in the separate file. The timer based program is written and the nearest reference point is calculated using the distance formula. However the exact position of the mobile is not shown but the nearest point is calculated. The expected goal is the location should be in one compartment at least. However, the locations of the moving object nearer to the wall needs the decibel values matching in the systematic way.

The green colours points are shown in the Figure 2 are current location of the mobile user. The three round of the reference traces are denoted by three mobile users denoted as the "Test1", "Test2" and "Test3". The values are stored in the simple text files. The values are stored previously have been matched and calculated to find the current location of the user. The text files consisting of the MAC (Medium Access Control/ Physical) address of the WI-FI access points, strength of the signals etc. The accuracy of the signal is not detected from the surface of the floor and from the air dynamics of the mobile user. Physically, the mobile user having laptop holding in hands, at the half height of body.

The values have been received from four access points and all are stored in the "logfile.gpx". We have created the graphical user interface (GUI), as shown in Figure 2, and software program is developed to read these values from "logfile.gpx". The fetched values are stored in the database, and accordingly the calculations done.

In the "learning" phase of our algorithms we have calculated the signal strength from all the four access points. We have created a database with (X, Y, Aval, Bval, Cval, Dval). These values have been used to detect the position of the mobile host, in the dynamic environment. More number of access points and values receiving from them could certainly improve the accuracy in the location tracing. However, this puts additional cost to the user.

In the "testing" phase, we are getting the values, with the interval of at every second. At particular second, we are receiving the values from four access points. To find the actual position of the user, real time we have synchronized our timer. The timers in VB having the accuracy up to milliseconds, as the 1000^{th} part of the second. From the computer graphics point of view we have converted the first quadrant values (bottom left corner starting of (0,0) position) has been

converted so that the GUI should match with the available actual test bed. The form in the VB6 having the scale mode units as pixel, point, twips, centimeter, character, inch and millimeter. The different units can be useful for the several accuracy levels in the different precision levels of the problem domain.

Figure 1 shows the sequence of the steps performed for the simulation work. Figure 2 shows the GUI for the layout of the physical setup and location of the access points used for finding out the location of the mobile user. The origin (0,0) of the graphical window is usually at the top-left corner, considered as the fourth quadrant of the two dimensional Cartesian system. We have not considered the exact location of the user in the air medium, considering the 3D space. One can easily guess that, the strength of the signal near to the Access point A is better than the strength of the signal from far away point C. For more accuracy in the signal can be calculated with more number of access points. For the implementation part, we have preferred the file handling because the database oriented transactions of reading and writing (disk access) is slower as compared to the file handling.

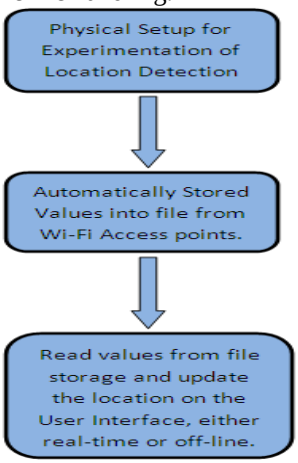

Fig 1: Flow Chart of the work done for creation of the simulation environment.

The program wrote to read the sequential file, with extension .gpx. The file is consisting of the signal strength of four wi-fi access points. The unique values have been identified using the MAC (Physical) addresses. The two dimensional array have been used to store the signal strength values. While reading the MAC addresses [1C:7E:E5:5A:B5:63], [1C:7E:E5:5A:BE:DE], [00:A1:B0:F0:06:3E], and [84:C9:B2:2B:A7:5A], the string comparison function is used. The file is also consisting of received signal strength (RSS), which is useful for the further calculation, for finding out the location of the user. The distance formula is transformed as following equation 1

Diff_A(p, q) = Sqr(((Test_A(p) - a(q)) ^ 2) + ((Test_B(p) - b(q)) ^ 2) + ((Test_C(p) - C(q)) ^ 2) + ((Test_D(p) - D(q)) ^ 2))
.....Eq. (1)

We first reading out the minimum value from each 82 available points. There are totally 484 points, for every sample file this may change i.e. 484 is not fixed, but 82 points are fixed, for this particular case. In our physical set-up, the classrooms, laboratory, and passage parts were available. The A, B, C and D are the access points shown here, and the red points drawn are the reference points, which are the nearest points of the moving laptop. The radio buttons controls shown are fetching the files and tracing the path accordingly. All the Visual Basic coding is not possible to write here, but few part is presented here.

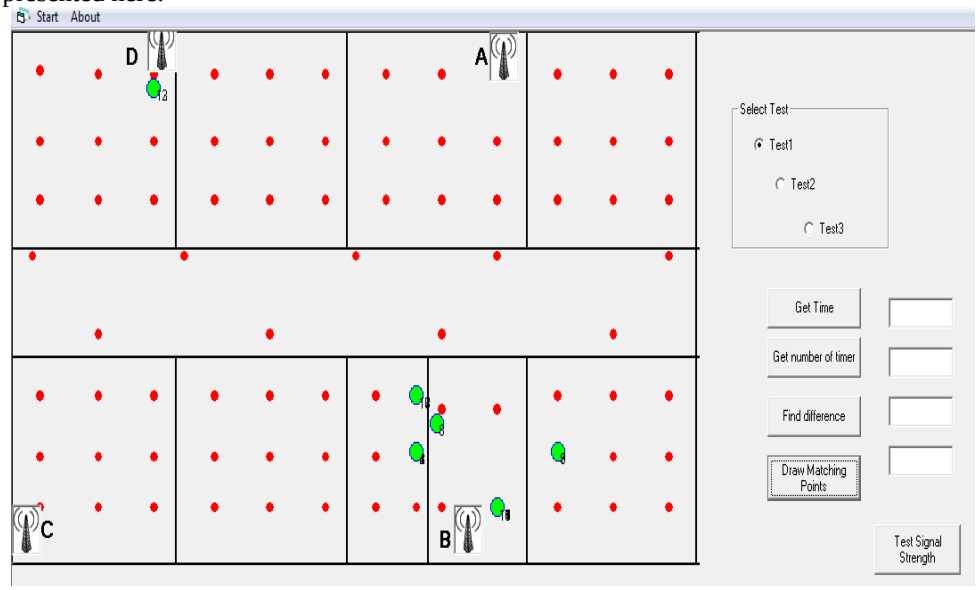

Fig 2: The Graphical Screen, simulating the physical setup Libratory set up


```
While Not EOF(1)
        Input #1, str
            If Left(str, 6) = "<time>" Then
            current_time = str
               If prev_time = Null Then
                  prev_time = current_time
                  Print #10, current_time
               End If
        If prev_time <> current_time Then
            Print #10, current_time
            prev_time = current_time
        End If
        ElseIf str = "[1C:7E:E5:5A:B5:63]" Then
        Print #10, str
        ElseIf str = "[1C:7E:E5:5A:BE:DE]" Then
        Print #10, str
        ElseIf str = "[00:A1:B0:F0:06:3E]" Then
        Print #10, str
        ElseIf str = "[84:C9:B2:2B:A7:5A]" Then
        Print #10, str
        ElseIf Left(str, 6) = "RSSI: " Then
        Print #10, Mid(str, 8, 2)
        End If

Wend
Close #1, #10

        Private Sub Form_Load()
        'Form1.Timer1.Enabled = False
        " X points
        timer_counter = 1
        plotter_counter = 0

        For i = 1 To 82
           Form1.Circle (x(i) * 6, y(i) * 6), 1, RGB(255, 0, 0)
          If i <> 82 Then
           Line (x(i) * 6, y(i) * 6)-(x(i + 1) * 6, y(i + 1) * 6)
           End If
        Next
        End Sub

        Private Sub Timer1_Timer()
           Form1.Circle (x(timer_counter) * 6, y(timer_counter) * 6), 1, RGB(255, 0, 0)
           If timer_counter <= 81 Then
           Line (x(timer_counter) * 6, y(timer_counter) * 6)-(x(timer_counter + 1) * 6, y(timer_counter + 1) * 6)
             timer_counter = timer_counter + 1
           Else
           Timer1.Enabled = False
           End If
           End Sub

        Private Sub Timer2_Timer()
        plotter_counter = plotter_counter + 1
        While Not EOF(13)
           Input #13, x_str
           x_dummy = CInt(x_str)
           Input #13, y_str
           y_dummy = CInt(y_str)
           Form1.FillColor = RGB(0, 255, 0)    Form1.Circle (x_dummy * 6, y_dummy * 6), 2, RGB(0, 0, 255)
           Print plotter_counter

        Wend
        End Sub
```


One can use the Google maps, navigation system (which we have not used here) on the Android based applications to find the location. The MapView control in the Android Framework [1] of the current version KITKAT is useful to write the location aware services.

IV. CONCLUSIONS

The distance formula to calculate the exact position of the moving device is not sufficient due to wall partitions, but need to consider some more considerable factors, otherwise the nearest reference point perhaps wrongly get traced. Hence, necessary analysis and use of the technique should be discovered. The Interface design is necessarily useful for the further work. The HCI technique used here is always useful wherever the machine interface is required to collect and synchronize the data either at real time or off-line situation. To process and show the output by drawing at the real time the file handling is always better for faster calculations and avoid request disk reading writing operations, which consumes the energy. The robotic devices, automation devices, instruments, equipments, sensor based vehicles tracing applications in manufacturing industry requires such a model of human computer interface design.

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Dr. Manoj has been conducted series of national level conferences to motivate the post-graduate students for research. He is also working with the theoretical concepts of grid computing and emerging concepts of "Nvidia-Tesla" General Programming with Graphics Processing Units (GP-GPU). He has been published several papers, co-authored edited chapters, and wrote few articles.

