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Radio Based Location Detection

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***Abstract*—**Various techniques has been employed to find location such as GPS, GLONASS, Galileo and Beidou(compass).This paper currently deals with finding location using the existing FM signals that operates between 88-108 MHz . Thelocation can be determined based on the received signal strength of nearby existing FM stations by mapping the signal strength values using trilateration concept. Thus providing security to users data and maintains eco-friendly environment at zero installation cost as this technology already existing FM stations operating in commercial FM band 88-108 MHZ. Along with the signal strength based trilateration it also finds azimuthal angle of the transmitter by employing directional antenna like Yagi-Uda antenna at the receiver side.

Keywords- location; existing FM signals; received signal strength; trilateration; security; eco-friendly; direction; privacy; zero installation cost.

I. INTRODUCTION

Radio Based Location Detection is device which provides location without using GPS satellites and mobile data by that way cost of launching and maintaining satellites is avoided instead this RLOD device will give a eco-friendly environment by reducing power radiated from satellite communication meant for GPS, GLONASS and other such satellite constellation based location detection techniques. It is based on radio signals in the environment which are generated by the FM broadcasters this means it does not requires setting of new towers. The idea behind this is that signal gradually decreases as the distance increases that is signal strength will be maximum near transmitter and it is degrading when the receiver moves away from transmitter. This device measures signal strength in particular channel corresponding to FM transmitting stations of at least two FM transmitting stations. And by comparing received signal strength with pre-loaded database of signal strength from data sheet, which is collected from FM stations. This technique provides X, Y co-ordinates which corresponds to latitude and longitudinal location of receiver that is by making circles representing signal strength and finding out converging point. Then, along with the obtained latitudinal and longitudinal values, direction of transmitter found using some directional antennas in order to get more precise information about location. Thus this makes possible to get location with single tower in an eco-friendly and cost effective manner.

II. RELATED WORK

Location detection has been widely used for variety of application. For commercial location detection, techniques like Global Positioning System (GPS) Global Navigation Satellite System (GLONASS), Galileo navigation system and Beidou been commonly used which makes use of minimum three satellites for giving the approximate location. For precise location trhey need nearly 6 or above in the vicinity .on the other hand, Global Positioning System (GPS) Global Navigation Satellite System (GLONASS), Galileo navigation system and Beidou which are the major constellations of satellites belonging to USA, Russia, non-American European countries respectively for finding location throughout the world, while the users are using those above mentioned technologies employed device, there might be chance that our locational information can be spied by them which possess treat to privacy of those users, RLOD avoid such interventions.

All satellite based location detection techniques provides location detection at cost increased lot of Electro-magnetic emission, while RLOD will provide location based on already existing FM signal broadcasters. So, RLOD requires zero installation cost.In multifunctional devices like smartphone where you require high speed internet connectivity in addition to GPS data to provide location which is not possible in remote locations where there is greater need to find location.

III.ADVANTAGES OF USING FM SIGNALS

The advantages of using FM signals are as follows:-
1. It provides greater coverage levels since the signal range is in megahertz and thus travel to longer distance.
2. It can penetrates through office buildings, walls and metallic structures.
3. It consumes less power than other location techniques.
4. It is present almost everywhere thus providing signals continuously.
5. It undergoes less fading effect.

IV.TECHNIQUES TO BE EMPLOYED

The technique that will going to use is that trilateration technique. Trilateration technique make use of the values from three transmitters. From each values a circle is drawn about that radius and the intersection point gives the location of receiver.

In the fig. 1 Ap1, Ap2, Ap3 are the three FM stations and based on the signal strength circle has been drawn with radius r1, r2, r3.

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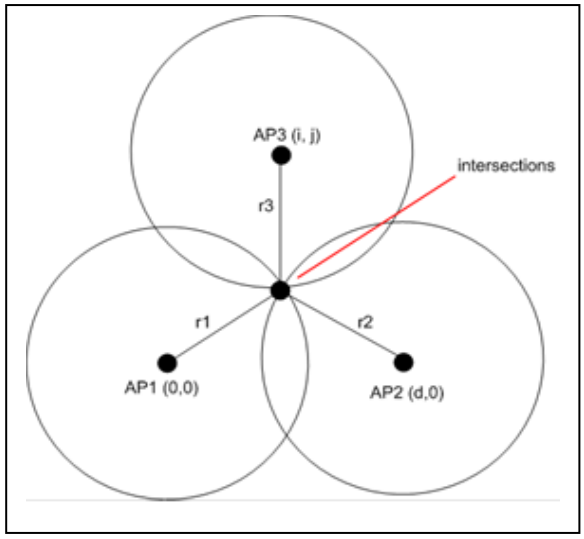

Fig. 1Intersections of 3 circles

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V. PROPOSED ARCHITECTURE

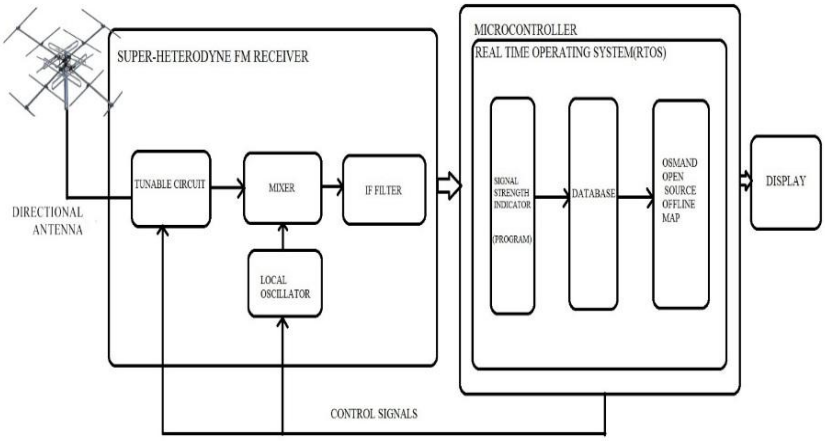

Fig. 2 RLOD-Block diagram.

The above diagram consists of two parts,

i. Receiver part
ii. Processing part

A. Receiver part

The receiver part consists of,

a. Directional antenna
b. Receiver

The Directional antenna will be placed facing different direction like if we use four antennas, each antennas will be facing four directions north, west, south and east or it can be rotated. If a directional Antenna facing a particular direction has higher gain, we can say that transmitter is only in the particular direction.

The directional antenna RLOD uses in YAGI-UDA as it is simple and can be fabricated as PCB based antenna too which can reduce size if RLOD to greater extent making RLOD more portable and low power consuming device.

The receiver which is a super-heterodyne is can able to pass signal of commercial FM band. The receiver here measures the RSSI (Received Signal Strength Indication), which is then send to microcontroller for processing.

Control signals are meant to tune the Receiver circuit to available FM band in that location. This control is provided by microcontroller when user needs know about their location.

B. Processing part

a)Microcontroller: RLOD currently uses ARM based microcontroller which has

i) Better processing speed.
ii)RTOS supportable .

b)Real Time Operating System (RTOS): RLOD currently uses android as Real time Operating System because it has integratable API's and another main resons are it's easy to access database and main reason it is popular in smartphone devices .

i) Database- As for as now we have made datebasse by manually measuring signal strength at different location away from the transmitter, later we will be using data of simulated signal strength as a database, the simulated reading will be based on terrain based values which also considers phenonmenon of reflection, scattering, diffraction and multipath fading. [3]And database using simulation results is agrees with manually calculate value upto 97%.

VI. PROPOSED METHOD

Process of location detection in RLOD starts with finding available FM broadcasters in nearby surrounding. After searching for available FM broadcasting stations in the area where RLOD currently is located, it will then compare the measured signal strength of those available FM broadcasters with pre-computed database of signal strength as mentioned in Section V, by comparing those data we can find radial distance of receiver(RLOD) from the transmitter by having radial distance from the transmitters of two or more stations we can find the intersection of those radial distance using trilateral method as described in section IV, the intersection point gives position of receiver(RLOD). However due to factors like reflection, diffraction, scattering and multipath fading the measured signal strength which should me more or less agrees with theoretical formula for measuring signal strength as in equation 1 and 2 would be deviated from original by a large margin,

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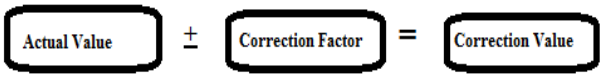
$$P_r(d) = 10\log\left(\frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}\right) \quad \text{dBm} \qquad (1)$$

$$V_{ant} = \sqrt{P_r(d) \times 4R_{ant}} \ \text{mV} \quad (2)$$

This is happens as signal strength varies from according to the differentterrain areas encountered. The one way to reduce this is to analysis of the different terrain and to add terrain correction factor to observed value as shown in figure 3. As there are of lot of propagation model for providing terrain correction factor. We are going to use Long-Rice propagation model as this model considers almost all of noise generating factors like reflection, diffraction, scattering and multipath fading for all channels of FM band.



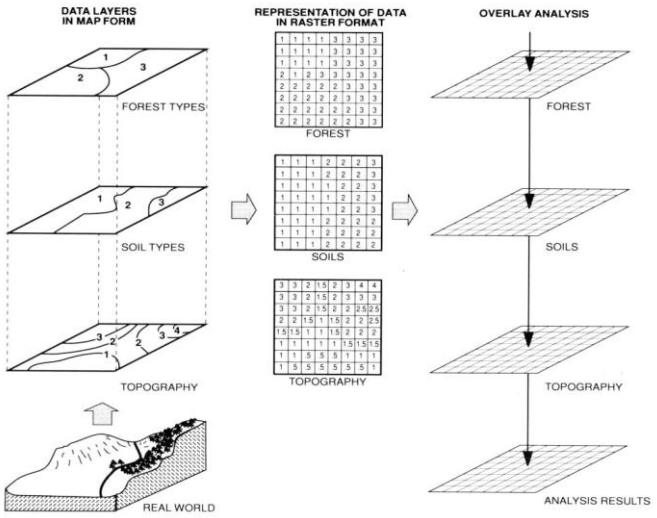


Fig. 3Correction Factor estimation based on terrain using Long Rice model.

As we know where the particular FM station is located we can able to know about its surrounding parameters in order to provide correction values.

After finding the actual signal strength it is been compared with the existing database of FM signal strength in different areas, if the values matched then we can able to show that where receiver is. The accuracy of the detection of location increases as more number of stations located in a particular area it is shown in figure 4.

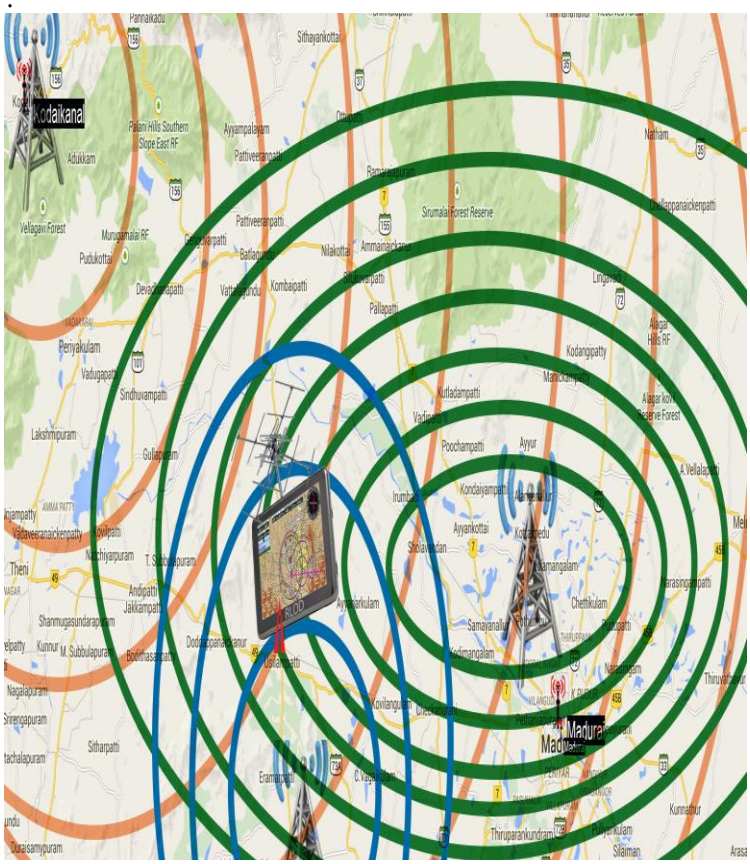


Fig. 4 Three tower based trilateration.

But in some cases like where FM stations are very near to each other and few stations (less than or equal to two) in an area, trilateration can't alone able to provide better results.
So, RLOD uses directivity property of directional antennas at RLOD (receiver) to provide better result. With these added technology to radial length estimation based on signal strength RLOD can able to provide location using a single tower also.

This can be done by rotating the directional antenna, only at a certain particular point of rotation of antenna the gain of the receiver reaches its peak value and by measuring the angle at which the gain is maximum with respect to the compass we will get direction of transmitting antenna, this is shown in Figure 5,

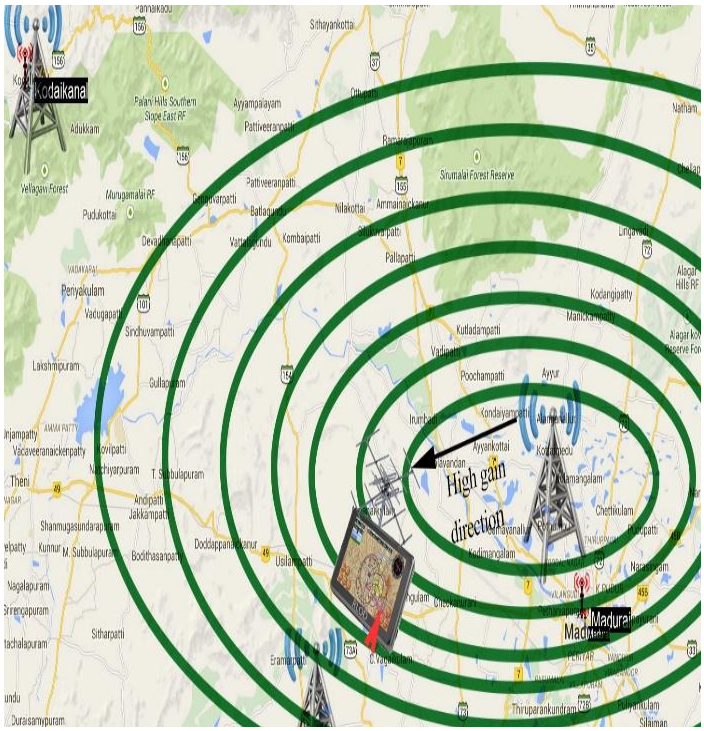


Fig. 5 Location using single tower

If there is more FM stations are available, then more and more precise location can be achieved. Since number of the received signal strength values will be more, more circle and hence intersection of those circle gives the precise location along with directivity as shown in figure 6.

Fig. 6 Location using three towers

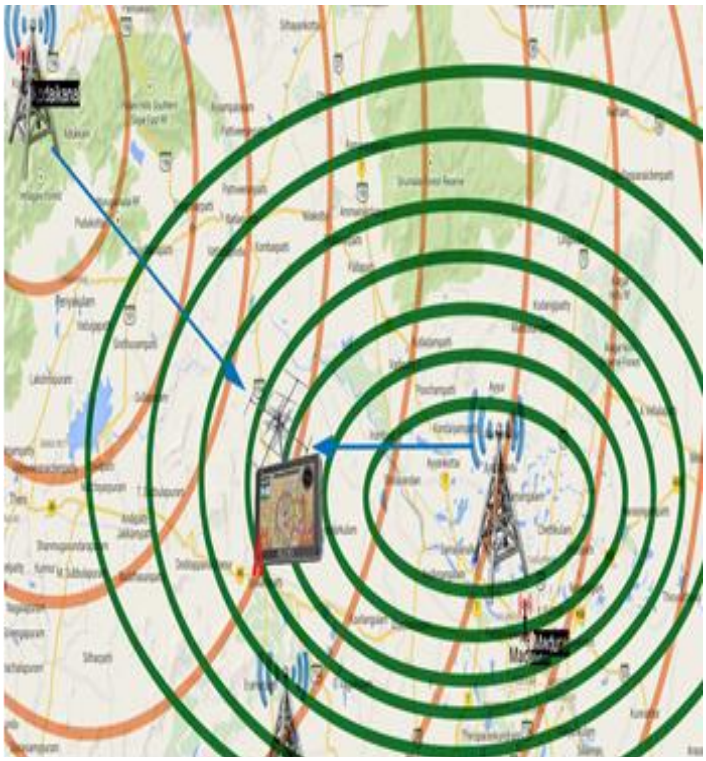


Fig. 7 Location using two towers

VII. CONCLUSION

The location awareness is everyday required technique, the competition between the companies and researches is huge to improve their systems and produce new versions of old systems to keep them up to date, and try to exist new systems Which might spread and cover the marketing.

We have described a method for location finding based on FM radio signal strengths. This method include the wide coverage of FM radio, spanning Indoor and outdoor locations. The system is a low-cost solution in terms of setting up towers as these towers are already acting as FM broadcasting stations.

This technology also reduces danger of spying and providing eco-friendly location detection by reduces the electromagnetic radiations that is been emitted while using satellite constellation based location finding technologies.

VIII. FUTURE WORKS

This work currently limited to location using carrier signal strength of FM broadcasters. Later if we the FM stations can able to provide RDS data in sidebands of main band then even more results can be achieved.

The proposed method serves as a preliminary step that could be integrated in future work where we can improve to a greater extent by taking into account of GSM towers, AM broadcasting stations to provide location with greater precision.

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