Location Based Services

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Abstract

Recent advances in wireless mobile communications, positioning techniques and GIS have led to evolution of a whole host of services providing information of interest to a mobile user relating surrounding area. Such services are called Location based services (LBS). These services include information on location of nearby restaurants, theatres, banks etc., driver guidance, vehicle tracking systems and emergency services. These value added services provide great convenience to a user and a revenue stream to the mobile service providers.

This paper presents positioning and LBS techniques. Various location based services have been indicated. Trends in LBS have been discussed.

Keywords : *Global Positioning System, Mobile Communication Location Based Services*

Introduction

Modern wireless technology enables to find location of a mobile user and communicate information of interest to him relating to surrounding area. Such communication services are called Location Based Services (LBS). Recent advances in mobile communications, positioning techniques and GIS have led to evolution of a whole host of location based services. A user can access GIS based information through his mobile handset, PDA or a laptop through SMS, MMS or the Internet.

Location based services include provision of current information on location of nearby restaurants, hotels, theatres, banks etc., traffic conditions, weather report; navigation guidance for a driver to any location from his current position, fleet tracking, emergency dispatch, roadside assistance and target marketing. These value added services provide great convenience to a user; enhance productivity and efficiency of a mobile professional and generate a revenue stream for mobile service providers.

Positioning

Foremost requirement for LBS is to identify the position of the mobile user. Position of a mobile device may be fed manually by the user or determined by triangulation of signals from various satellites such as GPS or from cell sites of a terrestrial cellular network. Automatic position determination techniques are discussed below.

Global Positioning System (GPS)

GPS is a global positioning system comprising 24 satellites in a medium earth orbit. A GPS receiver on a mobile device can locate three or more of these satellites, compute the distance to each, and figure out location of the mobile through trilateration. GPS is the most accurate and popular positioning system. It provides a position accuracy of around ten metres. A clear line of sight to at least four GPS satellites is necessary for high accuracy. Mobile phone sets with inbuilt GPS receiver are now available.

Mobile cellular Systems

Cell of origin

Position of a mobile terminal is known from the serving base station identity. Accuracy naturally depends on cell size. GSM cell radius may extend from 1 to 10 kms.. This method does not require any modification or extra investment in the network or handset. More accurate position can be found by the following methods.

Time of arrival

Position of a mobile set can be known by finding the difference in time of arrival at various base stations. This requires synchronization of base station clocks and location measuring units at the base stations. Position of a mobile set can be located by triangulation of base station signals. However it requires extra equipment at base stations and enhancement in position accuracy is not commensurate with the expenses required.

Angle of arrival

Angle of arrival from handset to different base

stations is used for triangulation in this case. Reflections from various structures reduce accuracy.

Enhanced Observed Time Difference

This technique requires placing of location measurement units as an add-on to the cellular network at multiple sites. Enhancement to Handset software is also required. In this method difference in time of arrival is measured at the handset. GPS is not required in the handset. In this method accuracy may be around 100 metres.

Fig. 1 indicates main elements in a GSM based LBS Network. A request for a LBS form a mobile phone is passed on through base station, base station controller (BSC), Mobile Switching Centre (MSC) and LBS gateway to a LBS provider. LBS provider finds position of the mobile phone through Gateway Mobile Location Centre (GMLC). Requested LBS information is obtained from application and content providers and passed on to the mobile phone in the reverse direction. Security is ensured by requirement of authentication of user profile and authorization for getting position information.
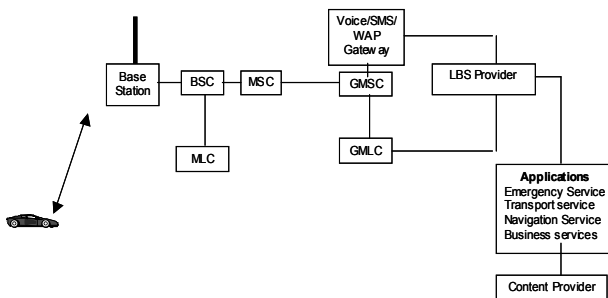

Fig.1 GSM Location Based Services Network Architecture

Wi-Fi RFID

RF ID (Radio Frequency Identification) tags are small microchips that can be attached to consumer goods, inventory, livestock, vehicles and other objects to track their movements. Passive RF ID tags can transmit data only if activated by a radio signal from an exciter (reader). Transmitted information from the RF tag is captured and sent to a central database. Passive tags can be used for a very short distance.

Active RFID tags can communicate in WLAN protocol. These tags can be used for indoor and outdoor tracking and telemetry operations. Range and coverage area can be extended using multiple exciters and Wi-Fi access points. Tags transmission can be initiated and detected by tag exciters located at suitable points. Tag exciters detect presence of tags and pass on the data received from the tags to a Wi-

Fi access point (Fig. 2). Data from RF tags is processed in a control centre for inventory management.
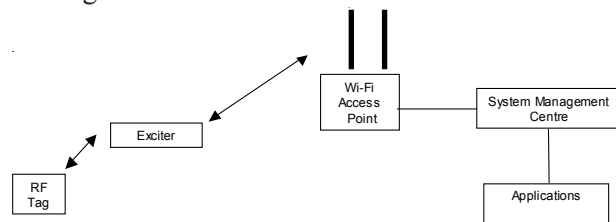

Fig. 2 Wi-Fi RD Network

Position with high accuracy can be detected directly by multiple Wi-Fi access points also using time difference of arrival and signal strength algorithms. Wi-Fi networks have a small coverage area and are in use in applications such as healthcare, manufacturing, asset location, process automation and theft prevention.

Mobile devices

For LBS generally three types of mobile devices are in use: personal digital assistant (PDA), stand a lone PND (Personal Navigation Device) and ubiquitous cell phone. Multifunctional smartphones combining voice, video camera, email, Internet, computing, diary and GPS assisted LBS are becoming increasingly popular.

Location Based Services

Emergency services

In an emergency such as in case of an accident or crime, assistance can be quickly provided if a victim can be located. In USA FCC regulations (E-911 or Enhanced 911) stipulate that call-back number and position of a mobile user calling emergency number 911 should be known within 50 to 300 metres in most cases. In Europe EU Regulations recommend several features for emergency calls E112. These are not yet mandatory.

Crime reporting and control can be very effective if interaction between citizens and Police through mobile devices and Internet is facilitated through a crime management system comprising emergency call number, position identification link, GIS information and police crime data base.

Personalised Services

Location of restaurants, petrol pumps, theatres, ATM, banks etc., local weather, local news, local traffic, locating a friend and advertising are some of the examples of personalized LBS.

Business Services

These services may include sales force/ marketing automation, mobile workforce management, service dispatch, field service, automatic vehicle location /fleet management, asset tracking, travel services, location based real estate search, wireless call centre tracking and location based billing. In a shopping complex, zones of radio signals could be set up that send sale information and other announcements to a consumer's wireless device.

Vehicle tracking Systems

Vehicle tracking and fleet management systems may offer following features:

- Vehicle positioning and monitoring
- Automated arrival and departure time record
- Driver and vehicle performance monitoring
- Tamper detection alerts
- Company Server or web server hosting for fleet management

These management features ensure fleet safety, security, productivity, efficiency and overall economy of operation.

Position of a vehicle may be known from any of the methods discussed above. Position information may be sent to a fleet management or dispatch centre by cell phone, SMS or Internet**.** Current location of a vehicle is displayed on a high resolution display map for fleet management. Directions to the driver can be given over a reverse communication link.

Omnitracs System of Qualcomm is an example of satellite based vehicle tracking system. It utilizes low orbit Globalstar mobile communication satellites and, optionally GPS. Data from a vehicle is sent through a satellite to a Satellite Network Operation centre and from there to a fleet Management Centre. Information may be hosted in a server based at the fleet Management Centre or can be accessed through a standard browser and web based system.

Recent trends

Mobile Cellular services are witnessing a phenomenal growth worldwide, particularly in the developing countries at present. Third Generation (3G) cellular services are now being introduced in many countries. 3G will offer much higher data rates as compared to second generation GSM or CDMA networks. While initial 2G GSM data rate was 9.6 kbps and CDMA 14.4 kbps, 3G systems offer 384 kbps with full mobility and 2 Mbps with limited mobility. There are many intermediate versions of cellular technology, so called 2.5G like GPRS, EDGE (GSM) and cdma2000 which offer varying rates up to 384 kbps. Latest versions of 3G WCDMA and CDMA2000 systems offer data rates even higher than 2Mbps.

Wireless LAN/ MAN networks like Wi-Fi and WiMax provide data rates in the range 11 to 150 MHz. Next generation 4G already under development will provide much higher data rates with full IP connectivity. IP connectivity will facilitate integration of multimedia convergence services. More efficient, faster and user friendly multimedia location based services with built-in GPS and navigation software in mobile devices are becoming a reality with high data rate cellular networks.

About Author
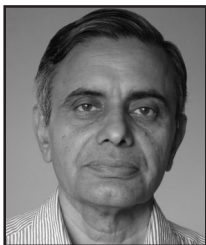
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He was an Executive Director in the Asia-Pacific Satellite Communications Council (APSCC) during 1998-2002. After retirement from the DoT in 2002, he was a consultant in the Directorate of Information Technology, Govt. of Maharashtra. At present he is a consultant for the VSAT based e-governance Network of the Govt. of Maldives. He is a Senior Member, IEEE and a Fellow, IETE.

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Resource Management and Geo-informatics

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Introduction

India is a vast country having natural resources in abundance. Natural resource monitoring and management is a challenge to the Society. It is well accepted fact that mapping is not possible without taking the help of photogrammetry, satellite data. Conventional methods of information gathering and analysis are not able to cope with the requirements of natural resources monitoring and management. The highly dynamic temporal changes in case of flood, forest fires, urban land use can only be reliably mapped and analyzed through satellite image processing. Digital terrain modeling and GIS alone permit complete automatic and integrated analysis free from bias and error. It is universally accepted that photogrammetry and Remote Sensing are the modern approach to information gathering for analysis monitoring and planning. Conventional methods of information gathering and analysis are manual, labour intensive, subject, time consuming, expensive and unreliable and so had to be done away with.

India with varied climatic conditions is bestowed with a varied forest flora and fauna. It is mainly because the country spreads from 6° N to 39° N latitude and heights vary from sea level to 8500 meters. The rainfall varies from 10 cms to 1170 cms in the country and temperature from -20° C to 52° C. Every region has its endemic flora and fauna. Loss of forest over in India is an accepted fact This has resulted in erratic rainfall, heavy soil erosion, floods, pollution, and loss of important flora & fauna. The synoptic coverage of satellite provide real time information on regional and global scale which must be exploited to its fullest potential to have a new world order free from starvation and human miseries.

Resource Management

The following resources are available with us and should be managed in such a way so as to get te maximum benefit out of them

(i) Water Resources

- Surface Water

- Ground Water

- Marine Resources

(ii) Land Resources

- Geology and minerals

- Agriculture

- Soil

- Land use/ Land cover

- Urban Planning

- Forestry

We must also look into the following aspects of the environment and through GIS contain/ manage the following hazards:

- Draught

- Cyclone

- Flood

- Earthquake

- Snow avalanches/ landslide

- Ecologically Fragile Zones

India is primarily an agricultural country. Its major area is utilized for agriculture Hence:

(i) Agricultural resources potential has to be tapped.

(ii) The crop health is to be managed

(iii) The damage to the crop is to be reduced/ minimized.

(iv) GIS also helps us in identification of crop.

GIS is also extensively used for exploration purposes which helps us in;

(i) Oil/ Gas potential assessment.

(ii) Oil/ Gas Pipelines

(iii) Oil pollution monitoring

(iv) Investigate large Geographic Areas for possible routes

(v) Oil/Gas Companies must survey and monitor existing pipelines and oil wells.

Though India has vast forest areas, it is depleting very fast due to uncontrolled and mindless felling of trees and encroachment into the forest by the natives. This is to be dealt by the Government in a very firm and efficient manner. However, forest resources can be managed through GIS in the following fields:

(ii) Timber Inventory

(ii) Health assessment

(iii) Fire Management

Forest resource provides significant economic value for both.

(a) Domestic Income and

(b) Earning Foreign Exchange

Uncontrolled exploitation of forest resources has both economic and environmental implications. The species identification is being done using high resolution multi-spectrum satellite imagery. Volume and area measurement is also resorted to by species.

Exploration

GIS is also extensively used for exploration uroses which helps us in;

(i) Oil/Gas potential assessment

(ii) Oil/Gas Pipelines

(iii) Oil pollution monitoring

(iv) Investigate large Geographic Areas for possible routes

(v) Oil/Gas Companies must survey and monitor existing pipelines and oil wells.

High-resolution satellite imageries are used to augment survey data while re-surveying existing pipelines. It also helps to determine alignment and map corridor/ route for new pipeline.

GIS In Government

GIS is extensively used by the Government for :

(i) Transportation management

(ii) Urban growth

(iii) Housing shortages

(iv) Utility management

It is also used for laying telecommunication and transmission lines-finding lest route and for their maintenance.

Applications

GIS is used for

Surface water management-using multi-spectral satellite imagery, thereby helping in :

- Selection of dam sites
- Watershed prioritization
- Reservoir storage monitoring
- Catchments area treatment plans
- Irrigation command area monitoring
- Reservoir submergence area study/ rehabilitation studies
- Conjunctive use of surface water and ground water
- Monitoring water logged areas
- Source wise irrigation mapping
- Hydrological land use
- Surface water index
- Inland navigation
- River basin studies across countries/states.

For ground water management, thereby making it easier for :

- Hydrogeomorphological mapping
- (ground water prospect zone mapping)
- Ground water supply investigations
- Urban water supply and ground water resources
- Rural water supply and drinking water supply
- Identification of low fluoride drinking water sources
- Industrial waste disposal site selection
- Irrigated area mapping for g round water draft

estimation.

- Potential zones for artificial groundwater recharge.

For exploiting marine resources in a big way which helps us in :

- Potential coastal aqua-culture zones identification

- Sediment dispersion patterns and Littoral process studies

- Sea surface temperature and chlorophyll content for potential fish catch

- Coastal accretion mapping

- Coastal erosion mapping

- Coastal marine pollution and effect on fish catch

- Harbour and port management through coastal bathymetry

- Coastline changes monitoring

- Oil slick monitoring

The GIS can help in

- Controlling deforestation

- Watershed management

- Disaster relief and assessment

- Flood hazard zonation

- Spatial flood forecasting

- Flood monitoring and damage assessment

- Flood alleviation measures

- Cyclone monitoring and landfall predictions

- Cyclone damage assessment

- Cyclone/wind damage modeling

- Earthquake zonation

- Earthquake damage assessment and isoseismic map preparation

- Tectonic analysis of seismic modeling and earthquake events

- Earthquake damage minimization.

Through GIS we can

- Maintain watershed to minimize disruption of soils and vegetation.

- Promote land use that is conducive to effective watershed management.

- Develop effective monitoring of watersheds.

- Water run-off has economic and survival implications.

- Assess overall condition of watersheds.

- Multispectral and Panchromatic Imagery to evaluate watershed rehabilitation

- Map current land use and monitor Developments

- Model alternative land uses

GIS is very effectively used in Cadastral Mapping. It is a very strong tool with Govt. to expedite rural mapping. IKONIS imagery provides direct extraction of information critical to rural and urban cadastre. IKONOS imagery can further be used as a basis to derive useful information about utilities, environmental quality, demography etc.

It is also very effective in topographical mapping with support from satellite imagery and digital photogrammetry.

Summary

GIS thus greatly assists to

- Serve as "Ground Truth," or Verification Information.

- Provide Early Warning on Localize Level.

- Assess damage to Infrastructure in disaster situations.

- Speed-up process for early damage assessments.

- Improve information gathering networks.

- Improve timeliness of large scale mapping (localize level).

- Provide rapid monitoring tool of environmental problems.

- Provide visual evidence.

- Potential landslide zones mapping.

- Integrated tribal development.

- Snow melt and run-off prediction.

- Snow and avalanche studies.
- Navigation in iceberg areas
- Drought monitoring and early warning.
- Drought management/ watershed development.
- Optimal land use assessment.
- Crop suitability modeling.

- Monitoring of drought proofing.
- Roads and buildings.
- Infrastructure database mapping.
- Natural resources database development.
- Irrigation command and GIS databases.
- Socio-economic databases linked to natural resources and hazards.

About Author

Brigadier Manoj Tayal acquired his B.E.(Civil) Degree from IIT Roorkee in 1973. He was commissioned into the Indian Army in the Corps of Engineers in June 1975. Thereafter, he did a number Army Courses as a subaltern in an Engineering Regiment.

He was seconded to Survey of India in the year 1977. After doing his basic Survey Engineering Course at Survey Training Institute, Hyderabad, he was posted to an Army Survey Unit at Dehra Dun. Thereafter, he had various experiences in Survey of India units as Dy. Superintending Surveyor & Superintending Surveyor. He did PG Diploma course from ITC, The Netherlands. Thereafter, he was posted to Survey Training Institute at Hyderabad as instructor, where he was heading a unit which was involved in training of Group 'A', 'B', 'C' personnel of Survey of India and also extra departmental and foreign trainees. He did a tenure in Military Survey during "Op Parakram". Thereafter, he was again posted to Survey Training Institute, Hyderabad as Director.

Since 2005 he is heading the Maharashtra & Goa Geo-spatial Data Centre as Additional Surveyor General, located at Pune which is involved in various types of survey work including departmental and project works from extra-departmental organizations.

Role of GPS in Meteorology in Respect of Surface Meteorological Measurement

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Abstract

Accuracy, stability and reliable performance under difficult environmental conditions are key performance requirements for meteorological instrumentation. Instrumentation reliability - both in data quality and sustainability - directly affects data network integrity as well as operating costs. The application of GPS to the meteorological measurements has significantly contributed in achieving the goal. The GPS based satellite-linked Automatic Weather Stations (AWS) have been conceived to provide accurate, reliable, trouble-free and real time meteorological data to the meteorologists for undertaking the complexities of weather. An integrated aviation meteorological system (IAMS) has opened a new era of safe flying as well as flight planning at the airports. This paper highlights the salient features of a GPS-based multipurpose Automatic Weather Station (AWS).

Introduction

India Meteorological Department (IMD) has been maintaining a network of around 1200 surface observatories. This conventional network suffers from perennial problem of communication break down during adverse weather and meteorologists are devoid of valuable data. With the launch of INSAT series of satellites, meteorological data from the remotest corner of India is obtained and scientists could utilise this data for understanding the complexities of weather. During eighties IMD established and operated 100 such Automatic Weather Stations through INSAT-1B and gave valuable experience to Indian scientists in handling and maintaining such unattended systems. To augment the technology, a few state-of-the-art AWS were procured from USA in 1997 and were installed in different parts of India and were co-located with the manned observatories for providing ground truth observations. The performance of AWS was evaluated vis-a-vis data from co-located observatories. The overall accuracy of the data received from AWS network is found to be well within the required limits specified by World Meteorological Organization (WMO).

Insat Aws System

A typical INSAT-AWS system configuration is depicted in Fig.1. INSAT-AWS system consists of field unit, space segment and the ground segment consisting of data receiving, processing and dissemination system. Automatic Weather Station includes sensors, signal conditioning unit, digital system, transmitter and antenna unit. AWS unit is housed in a weather-proof housing.

INSAT DATA COLLECTION SYSTEM
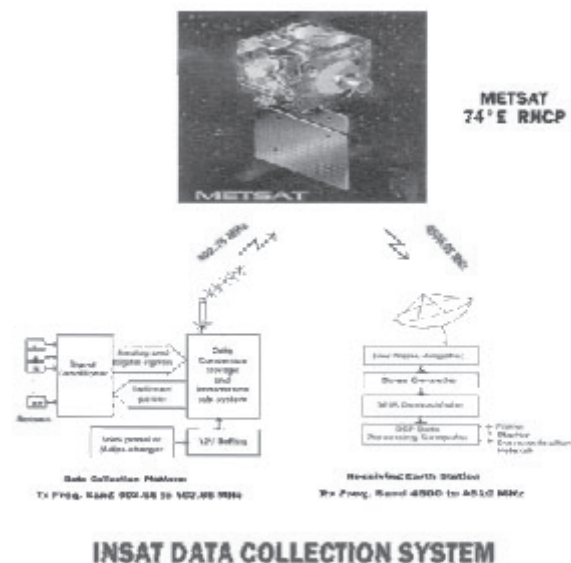
The space segment METSAT (Kalpana-1) consists of UHF receiving antenna for 402.75 MHz, down converter (402.75 MHz to 28 MHz), filter, upconverter, amplifier and transmitting antenna. The receiving earth station at Pune consists of 3.8 meter parabolic dish antenna, low noise amplifier, down converter, Digital Direct Readout Ground Station (DDRGS) and data processing computer.

AWS field stations automatically take environmental observations and transmit weather

data at every full hour UTC at an uplink frequency of 402.75 MHz which is received by METSAT (Kalpana-1). The received signals are downconverted to 28 MHz at the satellite and then amplified and upconverted and transmitted back to Pune receiving earth station at down link frequency of 4506.05 MHz. The dish antenna of the receiving earth station receives the signal transmitted by METSAT and is amplified by low noise amplifier and downconverted to 140.95 MHz by downconverter and fed to DDRGS demodulator. The raw data is processed by the computer and hourly data of the meteorological parameters are made available to the forecasters and other users in real time through Global Telecommunication System (GTS) network of IMD in the prescribed WMO format. It is also used for data validation and comparison. The weather parameters measured are air temperature, wind speed, wind direction, atmospheric pressure, relative humidity and rainfall.

Performance and Data analysis

Presently 55 stations are in the IMD network. 11 AWS stations have been installed in Maharashtra State. A map depicting 125 AWS stations which are being installed is given in Fig. 2.
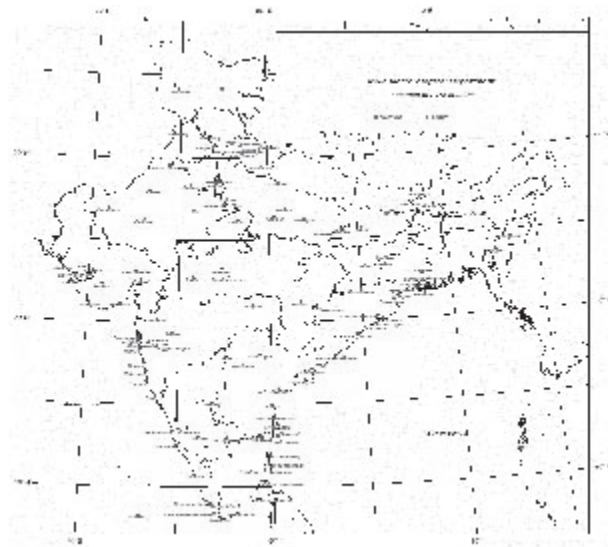

Fig. 2

AWS and surface data for 03 UTC and 12 UTC observations for two stations Dwarka and Ratnagiri for the period Jan-Nov 2004 for the meteorological parameters dry bulb temperature, station level pressure and relative humidity has been taken for preparation of scatter diagrams and calculation of correlation coefficient and standard deviation. The results have been analysed and discussed. The

monthly standard deviations for the same meteorological parameters for two stations Dwarka and Ratnagiri for the period Jan-Nov 2004 have been compared for 03 and 12 UTC and graphs have been plotted and analysed (Figs. 2 & 3).
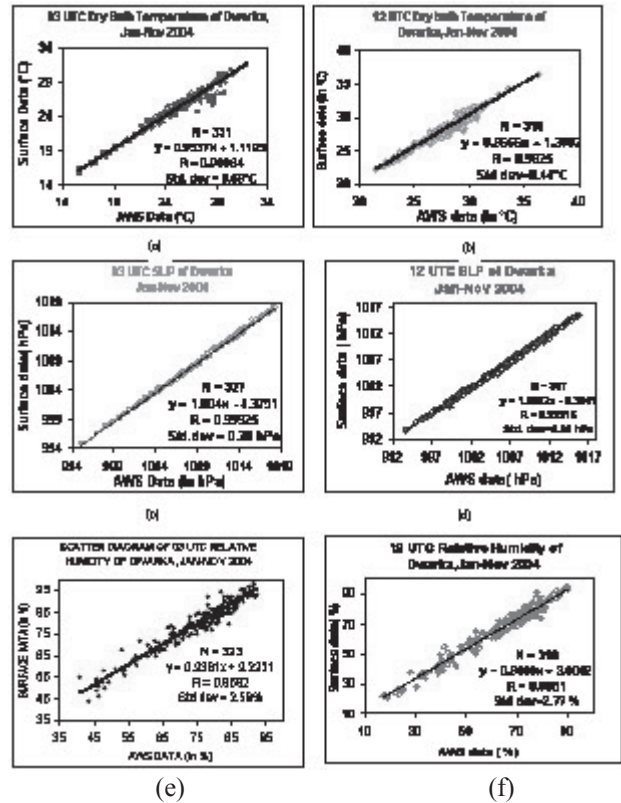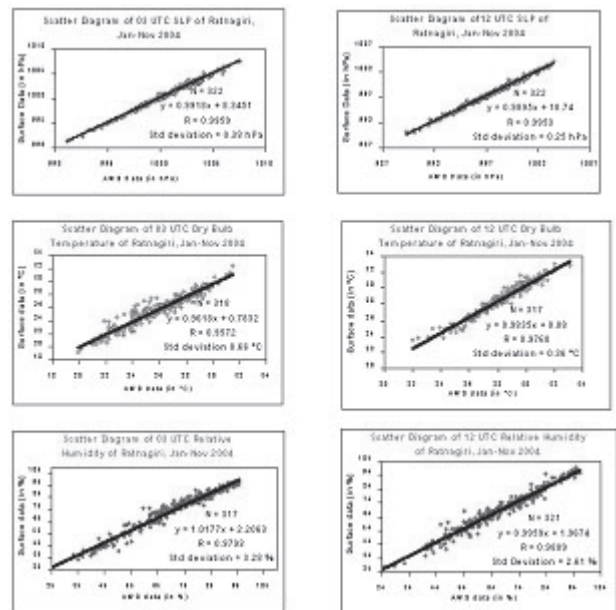

Fig. 2 Scatter diagrams for AWS Dwarka, Jan-Nov 2004

Fig. 3: Scatter diagrams of 03 & 12 UTC of AWS Ratnagiri, Jan-Nov 2004

Conclusion

In view of vast experience and expertise available in operating state-of-the-art GPS synchronised automatic weather observing systems, Government of India has prepared an ambitious plan for installing about 1000 Satellite-linked Automatic Weather Stations and 5000 Automatic Raingauge Stations in different parts of India.

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