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Recent Trends in GIS, GPS and RS: A Review

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Abstract:

A geographic information system [GIS], is a system which provides spatial data entry, management, and retrieval, analysis, and visualization of different aspects in a particular application. To enhance the capabilities of GIS system and increase the geographic range of coverage generally satellite communication is used. GIS is roughly synonymous with geoinformatics and part of the broader geospatial field, which also includes GPS, remote sensing. The Global Positioning System [GPS] is also a satellite and ground-based radionavigation system. GPS technology provides an indispensable tool for management of most of natural resourcesand enables the user to determine very accurate locations on the surface of the Earth. The most popular application of GPS is navigation systems fitted in modern vehicles and in smart phones. Remote sensing [RS] is used to gather information above and below the surface of the earth or an ocean from a distant platform, usually a satellite.In RS receiving sensors are installed on satellites that detect and record the reflected or emitted energy from earths surface. This sensed data is used for mapping and spatial analysis.The GIS, GPS and RS are closely related to each other and use the communication enabled devices and satellites for their operationand can cover geographically entire earth planet and are being used for wide range of applications.Present paper takes the review of recent trends in these systems and explores their wide application areas.

Keywords:*spatial data, geoinformatics, geospatial field, radionavigation, satellite*

A Geographic Information System [GIS] is a complex methodology designed to capture, store, manipulate, analyse, manage, and present all types of geographic data with the help of electronic communication devices. A GIS is a system which provides spatial data entry, management, and retrieval, analysis, and visualization of different aspects in a particular application. The implementation of a GIS is often driven by geographic area under implementation, purpose, or application requirements. Generally, a GIS implementation requires use of high-speed advanced computers, communication devices and soft wares to run these devices. To enhance the capabilities of GIS system and increase the geographic range of coverage generally satellite communication is used. GIS is a type of database containing geographic data (that is, descriptions of phenomena for which location is relevant), combined with software tools for managing, analysing, and visualizing those data.GIS is roughly synonymous with geoinformatics and part of the broader geospatial field, which also includes GPS, remote sensing, etc. Geographic information science, the academic discipline that studies these systems and their underlying geographic principles.Geographic information systems are utilized in multiple technologies, processes, techniques, and methods. They are attached to various operations and numerous applications, that relate toengineering, planning, management, transport/ logistics, insurance, telecommunications, and businesses. For this reason, GIS and location intelligence applications are at the foundation of location-enabled services, that rely on geographic analysis and visualization.

GIS provides the capability to relate previously unrelated information, through the use of location as the "key index variable". Locations and extents that are found in the Earth's spacetime, can be recorded through the date and time of occurrence, along with x, y, and z coordinates, representing, longitude (x), latitude (y), and elevation (z). All Earth-based, spatial–temporal, location, and extent references, should be relatable to one another, and ultimately, to a "real" physical location or extent.GIS uses space-time location as the key index variable for all other information. Just as a relational database containing text or numbers can relate many different tables using common key index variables, GIS can relate otherwise unrelated information by using location as the key index variable. The key is the location and/or extent in space-time.Any variable that can be located spatially, and temporally, can be referenced using a GIS. These GIS coordinates may represent other quantified systems of temporo-spatial reference. Some examples are highway mile-marker, building address, street intersection, entrance gate, water depth sounding, POS. Units applied to recorded temporal-spatial data can vary widely, but all Earth-based spatial–temporal location and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent in space–time domain.Related by accurate spatial information, an incredible variety of real-world and projected past or future data can be analysed, interpreted, and represented.This key characteristic of GIS has begun to open new avenues of scientific inquiry into behaviours and patterns of real-world information that previously had not been systematically correlated.

The Global Positioning System (GPS)is a satellite and ground-based radionavigation and locational system owned by the United States Government. which maintains and controls it and makes it freely accessible to anyone with a GPS receiver. It is one of the global navigation satellite systems (GNSS) that provides geolocation and time information to a GPS receiver anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites.GPS enables the user to determine very accurate locations on the surface of the Earth.Obstacles such as mountains and buildings can block the relatively weak GPS signals.GPS technology has provided an indispensable tool for management of most of natural resources. Although GPS is a complex and very advanced technology, user interfaces have been developed to make it very accessible to the non-technical user. Simple and inexpensive GPS units are available with accuracies of 10 to 20 meters, and more sophisticated precision agriculture systems can obtain centimetres level accuracies. The most popular application is navigation systems fitted in modern vehicles and in smart phones. Navigation is a field of study that focuses on the process of monitoring and controlling the movement of a craft or vehicle from one place to another. The field of navigation includes four general categories: land navigation, marine navigation, aeronautic navigation, and space navigation. It is also the term of art used for the specialized knowledge used by navigators to perform navigation tasks. All navigational techniques involve locating the navigator's position compared to known locations or patterns.

The GPS does not require the user to transmit any data, and it operates independently of any telephonic or Internet reception. though these technologies one can enhance the usefulness of the GPS positioning information. The GPS provides critical positioning capabilities to military, civil, and commercial users around the world. the latitude of a place on Earth is its angular distance north or south of the equator. Latitude is usually expressed in degrees ranging from 0° at the Equator to 90° at the North and South poles. The latitude of the North Pole is 90° N, and the latitude of the South Pole is 90° S.Like latitude, the longitude of a place on Earth is the angular distance east or west of the prime meridian or Greenwich meridian. Longitude is usually expressed in degreesranging from 0° at the Greenwich meridian to 180° east and west. The latitude is a geographic coordinate that specifies the north–south position of a point on the Earth's surface. Latitude is an angle which ranges from 0° at the Equator to 90° (North or South) at the poles. Lines of constant latitude, or parallels, run east–west as circles parallel to the equator. Latitude is used together with longitude to specify the precise location of features on the surface of the Earth. Longitude is a geographic coordinate that specifies the east–west position of a point on the Earth's surface, or the surface of a celestial body. It is an angular measurement, usually expressed in degrees and denoted by the Greek letter lambda (λ). Meridians (lines running from pole to pole) connect points with the same longitude.

The GPS is a space-based radio-navigation system consisting of a constellation of satellites broadcasting navigation signals and a network of ground stations and satellite control stations used for monitoring and control. Currently 31 GPS satellites orbit the Earth at an altitude of approximately 17,703Km providing users with accurate information on position, velocity, and time anywhere in the world and in all weather conditions.Satellite Navigation is based on a global network of satellites that transmit radio signals from medium earth orbit. Users of Satellite Navigation are most familiar with the 31 Global Positioning System (GPS) satellites developed and operated by the United States. All providersof GPS have offered free use of their respective systems to the international community. All providers have developed International Civil Aviation Organization (ICAO) Standards and Recommended Practices to support use of these constellations for aviation. The basic GPS service provides users with approximately 7.0-meter accuracy, 95% of the time, anywhere on or near the surface of the earth. To accomplish this, each of the 31 satellites emits signals that enable receivers through a combination of signals from at least four satellites, to determine their location and time. GPS satellites carry atomic clocks that provide extremely accurate time. The time information is placed in the codes broadcast by the satellite so that a receiver can continuously determine the time the signal was broadcast. The signal contains data that a receiver uses to compute the locations of the satellites and to make other adjustments needed for accurate positioning. The receiver uses the time difference between the time of signal reception and the broadcast time to compute the distance, or range, from the receiver to the satellite. The receiver must account for propagation delays or decreases in the signal's speed caused by the ionosphere and the troposphere. With information about the ranges to three satellites and the location of the satellite when the signal was sent, the receiver can compute its own three-dimensional position. An atomic clock synchronized to GPS is required in order to compute ranges from these three signals. However, by taking a measurement from a fourth satellite, the receiver avoids the need for an atomic clock. Thus, the receiver uses four satellites to compute latitude, longitude, altitude, and time.

A satellite navigation device, GPS receiveror simply a GPS. This device can receive information from GNSS satellites and then calculate the device's geographical position. Using suitable software, the device may display the position on a map, and it may offer routing directions. Using satellite information and installedsoftware's, a GPS device can be used as an automobile navigation system. Navigation devices can indicate, the roads or paths available, traffic congestion and alternative routes,roads or paths that might be taken to get to the destination, if some roads are busy the best route to take. The location of food, banks, hotels, fuel, airports or other places of interests and the shortest route between the two locations. A GPS navigation system is a GPS receiver and audio/video (AV) components designed for a specific purpose such as a car-based or hand-held device or a smartphone app.The GPS technology has become common in cars, boats, cell phones, mobile devices, and even personal heads-up display (HUD) glasses. GPS technology works in almost any condition and is accurate to within 3-15 meters, depending on the number of signals received, the spread of satellites in the sky and the technologies used in the receiver.

Remote sensing [RS] is used to gather information about the surface of the earth from a distant platform, usually a satellite. Remote sensors fitted in satellites provide a global perspective and a wealth of data about Earth systems, which enable data-informed decision making based on the current and future state of our planet. This remotely sensed data used for mapping and spatial analysis is collected as reflected electromagnetic radiation, which is processed into a digital image that can be overlaid with other spatial data.Reflected radiation in the infrared part of the electromagnetic spectrum, which is invisible to the human eye, is of particular importance for vegetation studies. For example, chlorophyll strongly absorbs blue (0.48 μm) and red (0.68 μm) wavelength radiation and reflects near-infrared radiation (0.75 to 1.35 μm). Leaf vacuole water absorbs radiation in the infrared region from 1.35 to 2.5 μm. The spectral properties of vegetation in different parts of the spectrum can be interpreted to reveal information about the health and status of crops, rangelands, forests, and other types of vegetation. Remote sensing is used in numerous fields, including geography, land surveying and most Earth science disciplines like hydrology, ecology, meteorology, oceanography, glaciology, and geology.It also has military, intelligence, commercial, economic, planning, and humanitarian applications, among others.

Satellites can be placed in several types of orbits around Earth. The three common classes of orbits are low-Earth orbit (approximately 160 to 2,000 km above Earth), medium-Earth orbit (approximately 2,000 to 35,500 km above Earth), and high-Earth orbit (above 35,500 km above Earth). Satellites orbiting at 35,786 km are at an altitude at which their orbital speed matches the planet's rotation and are in what is called geosynchronous orbit (GSO). In addition, a satellite in GSO directly over the equator will have a geostationary orbit. A geostationary orbit enables a satellite to maintain its position directly over the same place on Earth's surface. Low-Earth orbit is a commonly used orbit since satellites can follow several orbital tracks around the planet. Polar-orbiting satellites, for example, are inclined nearly 90 degrees to the equatorial plane and travel from pole to pole as Earth rotates. This enables sensors aboard the satellite to acquire data for the entire globe rapidly, including the polar regions. Many polar-orbiting satellites are considered Sun-synchronous, meaning that the satellite passes over the same location at the same solar time each cycle. A medium-Earth orbit satellite takes approximately 12 hours to complete an orbit. In 24-hours, the satellite crosses over the same two spots on the equator every day. This orbit is consistent and highly predictable. As a result, this is an orbit used by many telecommunications and GPS satellites. While both geosynchronous and geostationary satellites orbit at 35,786 km above Earth, geosynchronous satellites have orbits that can be tilted above or below the equator. Geostationary satellites, on the other hand, orbit Earth on the same plane as the equator. These satellites capture identical views of Earth with each observation and provide almost continuous coverage of one area.

There are many applications of Remote Sensing. Conventional radar is mostly associated with aerial traffic control, early warning, and certain large-scale meteorological data. Doppler radar is used by local law enforcements' monitoring of speed limits and in enhanced meteorological collection such as wind speed and direction within weather systems in addition to precipitation location and intensity. Laser and radar altimeters on satellites have provided a wide range of data. By measuring the bulges of water caused by gravity, they map features on the seafloor to a resolution of a mile or so. By measuring the height and wavelength of ocean waves, the altimeters measure wind speeds and direction, and surface ocean currents and directions.Ultrasound (acoustic) and radar tide gauges measure sea level, tides and wave direction in coastal and offshore tide gauges. Light detection and ranging (LIDAR) are well known in examples of weapon ranging, laser illuminated homing of projectiles. LIDAR is used to detect and measure the concentration of various chemicals in the atmosphere, while airborne LIDAR can be used to measure the heights of objects and features on the ground more accurately than with radar technology. Vegetation remote sensing is a principal application of LIDAR. Radiometers and photometers are the most common instrument in use, collecting reflected and emitted radiation in a wide range of frequencies. The most common are visible and infrared sensors, followed by microwave, gamma-ray, and rarely, ultraviolet.

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