Rough Work

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B1.2 assess the impact on society and the environment of a technology that applies concepts related to

Kinematics (e.g., photo radar helps prevent vehicular accidents and reduces fuel consumption associated

With excessive speeding)

Sample issue:

B1.2.1 The use of the global positioning system (GPS) increases accuracy in mapping, surveying,

Navigation, monitoring earthquakes, and tracking the movement of oil spills and forest fires, among other

Benefits. However, its extensive use raises concerns about privacy and human rights.

What is GPS?

The global positioning system (GPS) is a navigation system owned by the utility of the United States of America (but is open-source and free for users to use). It consists of a network of 24 satellites in orbit around the earth (placed by the US Department of Defense). This system was originally intended for military applications, but was made usable by civilians in the 1980s. The beauty of the GPS system is that it works anywhere in the world, 24 hours a day/7 days a week, and there are no charges to use or setup. It consists of three segments: the space segment, control segment, and user segment. The GPS is maintained by the US Air Force; which also develops and operates the space and control segments.

How Does GPS Work?

The 24 satellites circle the earth twice a day in a very precise orbit and transmit signals of information to earth the form of radio waves. The receivers on earth take this information from the satellites and use triangulation and trigonometry to calculate the user's exact location in three dimensions. It compares the time a signal was transmitted by the satellite with the time it was received; this time difference tells the gps receiver how far away the satellite is using kinematic equations. This process repeated by more satellites, the distance measurements can be used to determine the user's position and display it on the unit's electronic map. This information and kinematic equations used can also determine the estimated time of arrival (ETA), speed, distance, etc. This information is very useful for mapping, surveying, and for civilians using it during driving for directions (i.e. Google Maps).

Simple Step-By-Step

1. The GPS satellites emit and broadcast radio signals which provides their location, precise time (t1), and status from on-board atomic clocks (which are the most accurate types of clocks created).

2. The broadcasted radio signals by the satellites travel through space (vacuum) at the speed of light (c), which is more than 299, 792 km/second.

3. The GPS receiver receives the radio signals, and notes their exact time of arrival (t2). These are used to calculate its distance from each satellite in view. To calculate this distance from a satellite, the GPS device uses kinematic algorithms such as the following formula: distance = rate x time, where rate is (c) and time is how long the signal travelled through space. Also, the signal's travel time is the difference between the time broadcast by the satellite (t1) and the time the signal is received (t2).

4. The device requires at least four satellites to know its distance. It can use geometry to determine its location on Earth in three dimensions.

Note: The GPS Master Control Station tracks the satellites using a global monitoring system (which keeps the satellites in their precise orbit) and manages their health every day. Antennas on the ground around the world send data updates and operational commands to the 24 satellites. The US Air Force launches new satellites to replace aging ones when needed (these new satellites, which are rarely replaced, offer upgraded accuracy and reliability.

Applications of GPS

The GPS is very important in our modern lives. It has led to the development and infrastructure of hundreds of applications. GPS is now in many technologies, such as cell phones, ATM's, computers, etc. It is free, open, and dependable.

GPS is very essential to people and markets requiring precise time synchronization; some wireless systems cannot operate without it. It boosts productivity across many markets including the farming, construction, mining, surveying, package delivery, and logistical supply chain management. Markets that depend heavily on GPS are major communications networks, banking systems, financial markets, and power grids.

GPS also saves lives by preventing accidents, helping in search and rescue missions, speeding the delivery of emergency services and disaster relief, etc. It also improves scientific processes in weather forecasting, earthquake monitoring, and environmental protection. It will also enhance flight safety and route picking (taking into consideration traffic, whether, etc.).

Lastly, it is essential in military operations and national security. Modern vehicles have GPS integrated into many facets and features.

Surveying and Mapping

"The most effective way to achieve a robust and globally consistent continental reference system is through the technology of the Global Positioning System (GPS). The explosive growth of GPS applications and the economics of GPS make it the technique of choice for sustainable geodetic operations within Africa."

Claude Boucher, Former Secretary General, International Association of Geodesy (IAG)

The surveying and mapping community were one of the first to adopt and use GPS because the reliability and accuracy increased their productivity greatly. It has now become a vital and important part of the fields. When used by professionals, GPS provides the highest accuracy (compared to conventional methods), and is much faster; reducing the work, employees, equipment, etc. in the fields.

GPS is very useful to surveying and mapping fields because it accurately maps/models the whole planet (i.e. mountains, rivers, streets, buildings, utility lines, cars, blockages, etc.). These can be displayed on maps, receivers, and in geographic information systems (GIS) that store, manipulate, and display geographically referenced data. Resources and timely decisions are facilitated using GPS and GIS by many organizations including: government, scientific organizations, commercial operations, etc. GPS and GIS is very valuable and beneficial for these organizations requiring accurate location information about its assets.

GPS is not bound by constraints such as line-of-sight visibility between survey stations; meaning they can be placed at great distances from each other (as long as they have good visual of the sky). GPS is also extremely useful in surveying coasts, waterways, lakes, rivers, ponds, etc. This is because there are few land-based reference points, so GPS and SONAR are used together to detect nautical charts which alert mariners and civilians of changing water depths, underwater hazards, etc. These graphs (which are dated) are also useful to bridge builders (for distance above the water), offshore oil rigs (for hydrographic surveys), etc.

On land, mappers and land surveyors can carry GPS systems very easily because of their small sizes. They can be stored in backpacks, mounts, vehicles, etc. for accurate data collection which is also fast. GPS can also be used for motion studies to build better offices, direct flow of pedestrians or animals, analyse paths, etc. Current survey-grade receivers, to achieve the highest level of accuracy, use two GPS radio frequencies: L1 and L2. The problem is that there is no current civilian signal at L2, so these receivers use a military L2 signal using “codeless” techniques. To combat this issue, the GPS modernization program is adding a dedicated civil signal at L2. These allow for centimeter-level surveying results in real-time!

Space

> “GPS is transforming the way nations operate in space -- from guidance systems for the International Space Station’s return vehicle to the control of communication satellites to entirely new forms of Earth remote sensing. When all is said and done, the power and compass of this new tool will surely surpass what we can imagine now.”
>
> *Dr. Tom Yunck, Jet Propulsion Laboratory, California, USA*

GPS is revolutionizing the space industry, travel, and exploration! Nations and countries are using GPS to operate in space from guidance systems for crewed vehicles, to the management/tracking/control of

communication satellite constellations, to monitoring Earth from space. There are many benefits of using GPS which include:

- Space-qualified GPS units providing high precision orbit determination, and minimum ground control crews for navigation solutions.
- For attitude solutions, you can replace high cost on-board attitude sensors with low-cost multiple GPS antennae and specialized algorithms (i.e. ones used for Google Maps, Google Earth).
- For constellation control, the orbit maintained of large numbers of space vehicles such as telecommunication satellites by providing single point-of-contact to control.
- For timing solutions, you can replace expensive spacecraft atomic clocks with low-cost, precise time GPS receivers.
- For formation flying, GPS can be used for allowing precision satellite formations with minimal intervention from ground crews.
- For virtual platforms, GPS can provide automatic "station-keeping" and relative position services for advanced science tracking maneuvers (such as interferometry).
- For launch vehicle tracking, tracking radars can be augmented or replaced for higher precision, and lower-cost GPS units can be placed for autonomous flight termination and range safety.

https://www.youtube.com/watch?v=_zM79vSnD2M#t=308

Public Safety & Disaster Relief

"The data from the Southern California Integrated GPS Network will allow us to anticipate future earthquakes with more accuracy, as well as to study in much greater detail the fundamental processes of crustal deformation that are the root causes of earthquakes."

Dr. Thomas Jordan, Director Designate, Southern California Earthquake Center

GPS can be used to deliver disaster relief to areas in less time, and more accurately. They can also be used to detect possible dangers in the area (incoming tsunami, wars, etc.). This can save lives and restore infrastructure which was possibly destroyed (i.e. cable lines, hydro-poles, etc.). They can also provide position information for the mapping of disaster regions where ones are not established already. This can become useful for knowing high impact areas, groups who need rescuing, etc. GPS can also be used for the detection of floods, monitoring of seismic precursors, events, etc. Lastly, they can provide positional information about civilians in need/in case of emergency. This is through the civilians' phones, computers, cars, etc. which contain GPS receivers (mostly).

Environment

"Until the advent of GPS tracking, it was practically impossible to record elephant movements with sufficient temporal resolution to give

a full picture of movement patterns. The presence of elephants in Kenya is a key indicator of the health of the environment."

Honorable Dr. Newton Kulundu, Minister for Environment, Natural Resources, and Wildlife, Kenya

Many environmental concerns can be addressed using GPS data and information which has been collected by GIS packages. This gives a comprehensive analysis for environmental concerns in many areas of the world (such as the Amazon deforestation). Using this data collected by the GPS and GIS, environmental patterns and trends can be analysed, and thematic maps can be created easily. The good thing about using GPS for environmental reasons is that the data can be analysed with the primary need for field data transcription into digitized form! Also, because of the more frequent forest fires because of global warming, and oil spills due to more nations and companies taking part in oil exploration/extraction, GPS can allow for more accurate/efficient tracking of these environmental disasters. An example of this is how GPS helped cleanup crews respond to the oil spill in the Gulf of Mexico in 2010. GPS can also assist with water and land data collection for crustal and seismic monitoring which is very precise positional data to be used by scientists. Lastly, GPS receivers can be used to track and monitor endangered species and their patterns for their preservation. This can also create detailed maps for the species!

Roads and Highways

"The promise of GPS technology for increasing safety and security, reducing congestion, and improving efficiency are limitless. Quite simply, GPS has become the enabling technology for transportation."

Jeffrey N. Shane, Former under Secretary for Policy, U.S. Department of Transportation

GPS is used widely on roads and highways by many different parties (i.e. civilians for directions, tracking, maps, etc.). This allows for everyone using transportation to be safer higher mobility. This is also through transportation services (ex. TTC, GO Bus, etc.) who use GPS to have more accurate position determination so that they have greater passenger information (i.e. crowded locations). This information from GPS can also help create better transit systems to suit the needs of its users. It also allows for more effective and productive monitoring so that schedule adherence is ensured. One of the biggest advantages may be that there is better location information with electronic maps for drivers. This allows for in-vehicle navigation systems, such as Google Maps! Lastly, it allows for reduced costs in surveying roads.

Kinematics

Physics is widely used in GPS systems because the system of 24 satellites requires precise algorithms, mathematics, and physics to function. As explained in other categories, GPS uses the following algorithm a lot to calculate this distance from a satellite, the GPS device uses kinematic algorithms such as the following formula: distance = rate x time, where rate is (c) and time is how long

the signal travelled through space. There are many other kinematic formulas used, such as to determine the speed of a car on the highway using GPS. This is done through analysing the location of the car at two specific points of its displacement, and then determining the speed. This is also how the average velocity is determined. Distance can also be taken into consideration so that the estimated ETA can be determined with the current speed and velocity of the car. Kinematics must also be used to launch the satellite into orbit so that it follows a specialized path – otherwise it would not be able to communicate with receivers and other satellites. You would need to take into consideration the projectile motion, vertical and horizontal velocities, terminal velocity, and total time (both for when it will reach orbit, and the time it would take to retrieve if required back to earth). In conclusion, GPS is very physics and kinematics reliant. It is one of the most useful scientific advances of the modern era, as well!

Human Rights

There has been lots of controversy over GPS and human rights by many civilians and nations. This is because many countries use it to spy on others, and other nations. An example of this is Google Earth; when released, it showed all areas of the world, but then nations and companies threatened to sue if it did not censor certain areas. An example is North Korea who threatens other nations over spying conflicts using satellites and GPS. This threatening has also escalated into North Korea threatening countries with nuclear bombs. Although, the benefits of GPS outweigh the disadvantages; it was saved peoples' lives, aided in many different fields, etc.

About

This is a website created as a final summative for the Grade 11 Academic SciTech Physics class – SPH3UR. It is created to educate people about GPS, its functions and uses, and how it relates to kinematics. My topic is listed below:

- http://blog.oscarliang.net/wp-content/uploads/2014/01/GPS-constellation.jpg
- http://dictionary.reference.com/browse/gps?s=t
- http://electronics.howstuffworks.com/gadgets/travel/gps.htm
- http://gridskipper.com/assets/resources/2007/10/what%20google%20wont%20map.jpg
- http://office.microsoft.com/en-ca/excel-help/display-only-the-last-four-digits-of-identification-numbers-HP001143511.aspx
- http://schools.peelschools.org/sec/chinguacousy/SiteCollectionImages/ST%20Logo%202%20colour%5B1%5D.jpg
- http://www.clipconverter.cc/download/EFRGiJ_b/140920788/
- http://www.gps.gov/applications/
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- http://www.physics.org/article-questions.asp?id=55
- http://www.weebly.com/weebly/main.php#
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- https://www.edmodo.com/?language=&auto_selected_lang=true&logout=true
- https://www.youtube.com/watch?v=_zM79vSnD2M#t=308
- https://www.youtube.com/watch?v=1mZT9vaC4vY
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