AN INTERNATIONAL AWARD-WINNING INSTITUTION FOR SUSTAINABILITY

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
GOMBAK, 53100, KUALA LUMPUR, MALAYSIA

KULLIYYAH OF ENGINEERING
SEMESTER 2, 2021/2022

MCTE 4344
SECTION 1
REMOTE SENSING & TELEMETRY

ASSIGNMENT

History & Future: Remote Sensing & Telemetry in Malaysia (Agency, Industry and R&D)

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1. HISTORY OF REMOTE SENSING & TELEMETRY

The history of remote sensing begins with photography. The origin of other types of remote sensing can be traced to World War II, with the development of radar, sonar, and thermal infrared detection systems. Since the 1960s, sensors have been designed to operate in virtually all the electromagnetic spectrum. Evelyn Pruitt, a geographer with the U.S. Office of Naval Research, was the first to coin the term 'remote sensing'. It was a need to define the emerging imaging capabilities of multispectral cameras, infrared films, and nonphotographic scanners that prompted Pruitt to come up with a name for this new field of study.

The original telemetry systems were termed supervisory because they were used to monitor electric power distribution. In the first such system, installed in Chicago in 1912, telephone lines were used for transmitting data on the operation of several electric-power plants to a central office. Such systems spread to other fields besides power networks and underwent extensive improvements, culminating in the introduction in 1960 of the so-called interrogation-reply principle, a highly automated arrangement in which the transmitter-receiver facility at the measuring point automatically transmits needed data only on being signalled to do so. The technique is applied extensively throughout the world in such fields as oil-pipeline monitor-control systems and oceanography, in which a network of buoys transmits information on demand to a master station.

1.1 Agency

The requirement for high quality remote sensing data is skyrocketing with the surge in the application of remote sensing techniques and with a huge number of research carried out each day. Every remote sensing analysis revolves around the term “Data” with specified resolution, location, sensor and above all it should be “Free of Cost”. Here is a list of some of the top agencies providing remote sensing data free of cost:

- <u>GLOVIS</u>
  The USGS Global Visualization Viewer (GloVis) is one of the quick and easy online search and order tool for selected satellite and aerial data, especially for beginners.

- <u>NASA Earth Observation (NEO)</u>
  NASA Earth Observation has more than 50 datasets on atmosphere, land, Ocean, energy, environment and much more on a daily, weekly, and monthly frequency. The datasets are available in the form of JPEG, PNG, Google Earth and GeoTIFF.

- <u>USGS Earth Explorer</u>
  USGS Earth Explorer will stay the best portal for fetching Remote sensing data for a variety of reasons. Specially, a wide array of satellite and aerial images, a wide range of search criteria and the sequential arrangements of satellite imagery make the Earth Explorer a pro in terms of downloading imageries. USGS grants you full access to NASA’s Land Data Products and Services such as Hyperion’ s hyperspectral data, disperse Radar data and MODIS & AVHRR land surface reflectance.

- ESA's Sentinel data
  The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) provides complete, free and open access to Sentinel-1, Sentinel-2 and Sentinel-3 user products, starting from the In-Orbit Commissioning Review (IOCR). The ESA's sentinel data is chasing the USGS Earth Explorer with more bands and crisper resolution.

- NASA Earth Data
  With the retirement of the Reverb data search and discovery system on 1 January 2018, Earth data Search will be the primary means for searching and discovering NASA Earth observing data. The result will be faster data searches and more relevant search results for EOSDIS data users. Earth data Search uses Client's natural language processing-enabled search tool to quickly narrow down to relevant collections as shown in the tutorial. Similar to NASA Reverb, Earth Data communicates with a plethora of satellites such as NASA DC, GPS satellites, SMAP, JASON, METEOSAT, ALOS, TRMM, Aura, Aqua and much more.

- NOAA Class
  NOAA (National Oceanic and Atmospheric Administration) Class has a distinct online data library system, a pool of free top quality and valuable geographic data sets which set them apart. The Comprehensive Large Array- data Stewardship System (CLASS) is really in a class of its own with abundance of data accumulated from other rich and viable sources such as the US Department of Defense (DoD) Polar-orbiting Operational Environmental Satellite (POES) , Environmental Satellite (GOES) , NOAA's Geostationary, Operational), and other derived data. However, when compared to USGS, NOAA Class is still amateurish.

- NOAA Digital Coast
  If Coastal data is the only requirement, there is no better portal to reach than NOAA's Digital Coast. Simply define the choice of interest and select from the range of free satellite imagery dataset such as infrared, radar and true colour composite to download. Apart from the coastal data you shall as well get imagery, land cover, elevation, socio-economic and benthic data.

- IPPMUS Terra
  IPUMS Terra integrates population census data from around the world with global environmental data, allowing users to obtain customized datasets that incorporate data from multiple sources in a single coherent structure. The country specific data can be obtained from Terraclip featuring MODIS data.

- LANCE
  The Land, Atmosphere Near real-time Capability for EOS (LANCE) supports application users interested in monitoring a wide variety of natural and man-made phenomena. Near Real-Time (NRT) data and imagery from the AIRS, AMSR2, MISR, MLS, MODIS, OMI and VIIRS instruments are available much quicker

than routine processing allows. Most data products are available within 3 hours from satellite observation. NRT imagery are generally available 3-5 hours after observation.

- VITO Vision

  The VITO Vision provides coarse vegetation data from PROBA-V, SPOT-Vegetation and METOP. These coarse resolution satellites carves out vegetation patterns of the Earth's surface. The easy-to-use interface and delivers free low resolution satellite data. This type of data is a good for large-scale applications that doesn't need the finer details.

1.2 Industry

Remote sensing is the art and science of making measurements of the earth using sensors on airplanes or satellites. These sensors collect data in the form of images and provide specialized capabilities for manipulating, analysing, and visualizing those images. Remote sensed imagery is integrated within a geographic information system (GIS). A GIS is a computer-based tool for mapping and analysing feature events on earth. GIS technology integrates common database operations, such as query and statistical analysis, with maps. GIS manages location-based information and provides tools for display and analysis of various statistics, including population characteristics, economic development opportunities, and vegetation types. GIS allows you to link databases and maps to create dynamic displays. Additionally, it provides tools to visualize, query, and overlay those databases in ways not possible with traditional spreadsheets. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.

Geographic Information Science can bring together large amounts of geospatial data to help professionals make strategic decisions. Widespread GIS technology has led to a growing number of examples of GIS in business. Some of the best GIS projects may be those that utilize technology to improve community infrastructure and public health, but these complex information systems can also be used to save time, money and energy for companies and their facilities. Innovative professionals in virtually any industry can take advantage of GIS technology. Here are six popular examples of industries that use GIS:

- Supply Chain Management

  Over recent years, the processes for bringing products and services to the public have evolved immensely due to changing customer preferences and the rapid growth of ecommerce. Today, the ability to track shipments and inventory can make the supply chain more efficient, saving money for businesses that use GIS.

  One example is the delivery of produce to supermarkets around the world. Agricultural products are picked on small farms and then distributed to grocers in many locations, often crossing state and national boundaries. The produce must arrive in top condition, ripe but not spoiled.

GIS technology can tell agricultural and supply chain professionals when fruits or vegetables left the field, what routes they travelled and their quality upon arrival. If produce shows up at the supermarket looking unappetizing, workers can retrace the items' path to identify problem areas and improve the odds that future deliveries will arrive in better condition.

- Insurance

Insurance companies rely on accurate predictions to determine risk. A wide range of factors come into play, but in nearly all insurance sectors, location is a strong indicator of risk. Certain regions are more prone to earthquakes, hurricanes, floods or other natural disasters, and social factors – like a propensity toward crime – tend to cluster in specific areas as well.

With improved predictions, insurance companies can set coverage rates more appropriately. GIS software allows professional to map risk levels based on information such as:

- Historic records, which could highlight the likelihood of an occurrence like a hurricane
- Demographics, which might give insight into whether people are likely to be involved in a car accident
- Local geography, which could indicate the possibility of an event such as a landslide

- Forestry and Timber

Forestry is a complex field that analyses conditions in wooded areas to determine how to best utilize land, preserve ecosystems or efficiently plan harvests. When poor forest management results in over-utilization, GIS aids in re-establishing plant species. Afforestation and tree species regeneration programs are most effective if foresters accurately determine what land plots will allow tree species to thrive. GIS technologies can map out important details like annual rainfall, minimum and maximum temperatures, the length and severity of the dry season and more.

GIS systems also collect data that is relevant to the preservation of ecosystems, like the species found in an area and how populations are changing over time. Recording accurate, up-to-date information helps forest preservation professionals identify positive or negative patterns.

Foresters are beginning to use GIS to support responsible timber harvesting. Tracking data like soil type and condition, roads, forest type and more can all support a cost-benefit analysis. By monitoring losses due to pests, foresters promote economically sound harvesting practices.

- Urban Planning

Planning a city takes more strategy than simply identifying vacant lots and constructing buildings in them. The placement of business, governmental, public and residential structures impact the quality of life of citizens who live there.

As modern cities grow, planners have less space to work with when they need to add a building or a road or replace aging infrastructure. Developers also must account for the impact they may have on animal and plant life. To responsibly accommodate a community's citizens while minimizing harm to existing historic structures or natural spaces, urban planners rely heavily on GIS technology.

Planners can also review spatial information to determine the most efficient way to introduce alternative energy resources to a city. GIS mapping may help identify the best places to build out wind or solar farms, or install renewable energy infrastructure on a smaller scale, like in underutilized parking lots.

- Banking

  Banks choose their branch locations very carefully, considering factors like the potential customer base and local crime rates. As the landscape of banking changes due to increased usage of online services and trends in consumers' preferences, financial institutions must make strategic decisions. In some cases, institutions need to close or consolidate branches to boost profitability. The tricky part is knowing which branches to close, especially when some are still performing well.

  Before adopting GIS software, decision makers often viewed branch locations on a physical map taped to a wall, stuck with pins or marked with Sharpies. GIS software makes it much easier for banks to identify locations with lower utilization rates, higher loan default rates or nearby competitors.

  GIS can also be used to map out demographics and see which areas may be most in need of specific products. For example, someplace with high rates of car ownership may have a greater need for auto insurance.

- Health and Human Services

  The field of public health focuses on patterns of disease within communities, directing prevention efforts and efficiently addressing problems as they emerge. Medical professionals have long been aware that location can impact patients' well-being, and modern GIS technology can help health organizations analyse significant trends. Health and human services organizations use software to map cases of a disease, identifying high-risk areas or common origination points.

  The Centres for Disease Control and Prevention utilize GIS technology to manage a wide array of public health issues. For example, a map detailing heart disease death rates from 2011-2013 shows high risk in the Southern U.S. and the state of Nevada. Meanwhile, residents of Minnesota, the Pacific Northwest and Colorado are at much lower risk. With this information, public health professionals might take steps like deploying awareness campaigns about heart disease prevention in the areas where they are most needed.

1.3 Research and Development

The field of remote sensing applications is extremely broad. In order to apply observation data to these fields, it is necessary to conduct a wide range of research activities ranging from fundamental research on the observation of target objects to applied research corresponding to application needs, including combination with other information sources. There is also a need to develop technologies for the storage and processing of data obtained through satellite observation, as well as application technology and systems for data usage. Here is an example of research and development team in remote sensing:

- <u>RESTEC</u>

  RESTEC has continued to conduct research ranging from fundamental research such as studies on the reflective properties of target observation objects, to applied research in the areas of environmental monitoring and management of forests, water resources, the atmosphere, and oceans, food safety and security, disaster prevention, development of information on national land and infrastructure, and other fields of data application. At the same time, it is engaged in the development of calibration technologies such as radiometric and geometric calibration of observation data, the development of ground systems for the reception, processing, and storage of satellite data, as well as the development of software such as data application systems that incorporate the latest trends in technology, including Open GIS Consortium (OGC) and International Organization for Standardization (ISO). In addition, it is engaged in the development of remote sensing equipment. Among their publications are:

  - Mapping of Inundation Depth Estimated from Satellite Data
  - Research on High-Quality Products Using the Himawari Meteorological Satellite
  - Smart Agriculture Using Satellites and Drones
  - Detecting Dangerous Spots in Social Infrastructure in their early stages. Contributing to Ensure a Safe, Secure and Robust Society
  - Using Satellite Data to Vitalize Agriculture and Solve the Problem of Food Shortages
  - Surveying Wider Areas of Global Oceans and Smaller Localized Areas of Ocean
  - Minimizing Flood Damage by Ascertaining the Movement, Spread and Amount of Water
  - Japan's Top Professionals Monitor Forests around the World from Space

2. FUTURE OF REMOTE SENSING & TELEMETRY

New capabilities will surely arise during the next decade. A substantial thrust is doing things faster and cheaper rather than bigger and better. The military is developing new techniques for building reconnaissance satellites that can be launched on short notice as needs arise. The use of non-visible portions of the spectrum (particularly infrared and microwave) will be expanded, the number of active sensors such as lidar and radar will be increased, and the spatial and temporal sampling will be improved.

Particularly important will be new technologies for linking sensors through wireless and traditional means into sensor networks. This will allow the information to be combined so as to support rapid decisions in complex situations. In addition, the output of one or several sensors can be used to trigger observations from others, or even to rapidly reconfigure the other sensors so as to optimize observations of an event.

With the growing demand, novel sensor approaches are also likely to appear. One possibility is "interactive remote sensing," such as farmers genetically "tagging" their crops to enhance the remotely detectable spectral signature for crop distress or optimal harvesting.

Policy efforts are underway to guide this future. In 2003, NOAA spearheaded a global initiative called the Global Earth Observation System of Systems, or GEOSS, now a loose coalition of 66 nations aimed at coordinating much of the world's Earth observing activities. GEOSS is focused on using the resources we have more effectively—a worthy goal. Within the United States, the National Research Council report referred to earlier laid out a "decadal plan" for Earth observation from space, including a set of 17 new missions to be launched during the coming decade.

The competing forces of increased business demand, limited government resources, and advancing technological capability will play out over a decade from now. The rapidly growing consumer needs will introduce a new and somewhat unpredictable factor. The future promises to be bright, but it won't happen on its own. The community of professionals must work diligently to ensure its success.

2.1 Agency

Remote Sensing Technology Market Research Report assist businesses with the intelligent decision making and better manage marketing of goods which ultimately leads to growth in the business. Remote Sensing Technology Market report involves six major parameters namely market analysis, market definition, market segmentation, key developments in the market, competitive analysis, and research methodology. It shows that the rise in market value is generally attributed to the rising growth of the applicable industries and the subsequent rise in demand of applications. Businesses can attain knowledge about complete background analysis of the industry which includes an assessment of the parental market.

The Global Remote Sensing Technology Market is expected to gain market growth in the forecast period of 2022 to 2029. Data Bridge Market Research analyses that the market is growing with the CAGR of 8.6% in the forecast period of 2022 to 2029 and expected to reach USD 20,090.18 million by 2029. The increasing adoption of Internet of Things (IoT) innovation in the agriculture sector is expected to drive the market growth.

The list below shows the development of the Global Remote Sensing Technology Market:

- In November 2021, Terra Remote Sensing Shocking scenes captured by from companies' long time aircraft service providers, Sierra Helicopters. Company crews are out flying LiDAR in multiple locations with Sierra to assess hazards, damage, and plan the path to recovery. The company enhanced its business portfolio generating more income and profit to it.
- In December 2021, James Webb Space Telescope, built in partnership with Northrop Grumman Corporation, successfully launched from the European Space Agency's (ESA) Spaceport in Kourou, French Guiana aboard an Arianne 5 rocket. Through this company enhanced their brand value for the market and enhanced the customer base.
- In December 2021, Airbus completed its second ocean monitoring satellite sentinel-6B. The satellite was built to measure the distance to the sea surface to an accuracy of a few centimetres. The main purpose of the satellite is to measure the height of the sea surface, variations in sea levels, and analyse and observe ocean currents.
- In January 2022, Northrop Grumman Corporation completed a successful precision strike missile rocket motor static test. The rocket motor test was a necessary requirement to validate the company's motor design for production. The company's investment in digital technologies drives affordability in modern and efficient tactical solid rocket motor production facilities.

IoT in agriculture makes use of remote sensors, robots, drones, and PC imaging to display screen crops and provide information to farmers for efficient management of the farm. Internet of thing (IoT) sensors are used to gather data this is transmitted for the purpose of analysis. Farmers can display the quality of the crop from a systematic dashboard. Among the major competitor agencies in remote sensing are:

- Northrop Grumman,
- The Airborne Sensing Corporation,
- ITT INC.,
- Leica Geosystems AG - Part of Hexagon,
- Lockheed Martin Corporation.,
- Honeywell International Inc.,
- Thales Group, Orbital Insight,
- Droplet Measurement Technologies,
- Airbus,
- Farmers Edge Inc.,
- SCANEX Group.,
- Terra Remote Sensing

2.2 Industry

The remote sensing industry in the future will consist of several applications such as:

- Landscape Assessment

- Rural/Urban Change
- Biomass Mapping

- Security
- Geology and Mineral Exploration
- Hydrology
  - Flood Delineation and Mapping
  - Soil Moisture
- Forestry
  - Coastal Protection
  - Biomass Estimation
  - Agroforestry Mapping
  - Burn Delineation
  - Depletion Monitoring
- Healthcare
- Air Quality
- Flood Plain Mapping and Emergency Management
- Agriculture
  - Crop Monitoring & Damage Assessment
  - Crop Type Mapping
- Oceanography

2.3 Research and Development

Due to the explosive developments in sensing, geospatial sensors started to produce an increasing amount of data, and soon Big Data have become a reality. Cloud computing has gained dominance and nearly unlimited processing and storage capacity are offered. Very large computers are also widely available, providing the base for massive processing. It is important to emphasize that the real potential of harnessing data revolution is the capability to extract additional information that has not been feasible in the past. Here is an example of research and development team in remote sensing:

- <u>EROS</u>

  EROS has been an integral part of earth-observation science since the launch of the first Landsat satellite in 1972 and is renowned for its experience and proficiency in remote sensing technology. They have been providing technical expertise and services to the USGS and its partners across government, industry, and academia for decades, with a particular emphasis on the capability. Among their publications are:
  - System characterization report on Planet SkySat
  - System characterization report on the Satellogic NewSat multispectral sensor
  - ECCOE Landsat quarterly Calibration and Validation report — Quarter 2, 2021
  - System characterization of Earth observation sensors
  - System characterization report on the WorldView-3 Imager
  - System characterization report on the Gaofen-1

- System characterization report on the German Aerospace Center (DLR) Earth Sensing Imaging Spectrometer (DESIS)
- Landsat 8 thermal infrared sensor scene select mechanism open loop operations