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SATELLITE IMAGE OF LANDSAT

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Abstract-Landsat satellite imagery has been a critical resource for Earth observation since its first launch in 1972, providing valuable data for monitoring and managing Earth's natural resources. The Landsat program, managed by NASA and the U.S. Geological Survey (USGS), offers high-resolution images of Earth's surface, helping to track changes in land use, vegetation, urban expansion, water resources, and environmental health. The data captured by Landsat satellites plays a crucial role in diverse fields such as agriculture, forestry, urban planning, disaster management, climate change studies, and environmental monitoring. Landsat satellites orbit the Earth at an altitude of approximately 705 km, capturing multispectral images across a wide range of wavelengths, including visible, infrared, and thermal bands. These images are highly useful for analyzing various physical and environmental conditions, providing insights into land cover classification, vegetation health, and changes in the Earth's surface over time. The data collected by Landsat sensors, such as the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS), are made available to the public through the USGS Earth Explorer platform and are widely used by researchers, policymakers, and businesses around the world.

The temporal resolution of Landsat imagery, with periodic revisits every 16 days, allows for consistent monitoring of land changes over time. This temporal aspect is particularly useful for detecting long-term trends such as urbanization, deforestation, and the impacts of climate change. By comparing images taken at different times, analysts can assess the rate of change in land cover, identify areas of environmental degradation, and evaluate the effectiveness of conservation efforts or urban planning strategies.In recent years, the integration of Landsat data with other remote sensing technologies, such as high-resolution commercial satellites and drones, has further enhanced its utility. Advanced image processing techniques, including machine learning and artificial intelligence, have improved the accuracy of land cover classification and change detection. These advancements have made Landsat a vital tool for global environmental monitoring and decision-making. Landsat satellite imagery provides invaluable data for understanding and managing Earth's ecosystems, natural resources, and urban environments. Its continued use and accessibility are essential for addressing global challenges such as climate change, resource depletion, and sustainable development. With ongoing advancements in remote sensing technology and data analytics, Landsat will remain a cornerstone of Earth observation for decades to come.

1. Introduction

Landsat satellite imagery has played a pivotal role in the field of Earth observation for over five decades, providing invaluable insights into the dynamic changes occurring on the Earth's surface. Since its inception in 1972, the Landsat program, managed by NASA and the U.S. Geological Survey (USGS), has been one of the longest-running Earth observation satellite programs. Landsat satellites capture high-resolution multispectral images of the Earth, which have become indispensable tools for scientific research, environmental monitoring, resource management, and policy decision-making. The Landsat program continues to provide vital data to monitor land use changes, urban growth, agricultural practices, deforestation, water resources, and the effects of climate change on the planet.Landsat satellites orbit the Earth at an altitude of approximately 705 km, with the ability to capture images of the Earth's surface across several spectral bands, including visible, near-infrared, shortwave infrared, and thermal infrared. These bands enable detailed observations of the Earth's surface features, such as vegetation, water bodies, built environments, and soil types. The satellite's ability to capture images across multiple wavelengths allows for a comprehensive understanding of land cover, land use, and environmental conditions. Each Landsat mission is equipped with advanced sensors, including the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS), which provide multispectral data with varying levels of spatial resolution—ranging from 15 meters to 100 meters.

The Landsat program's long history and consistent imagery have made it an invaluable resource for monitoring Earth's changes over time. One of the key features of Landsat satellites is their periodic revisit cycle, with the satellites capturing new images of the same locations approximately every 16 days. This high temporal resolution allows for the detection of changes on the Earth's surface, such as urban expansion, deforestation, agricultural trends, and the effects of natural disasters. The ability to track these changes is critical for understanding the impacts of human activity on the environment and for making informed decisions related to conservation, land management, and climate change mitigation.

In addition to its scientific applications, Landsat imagery is used in a wide range of sectors, including agriculture, forestry, disaster management, urban planning, and environmental protection. The accessibility of Landsat data, freely available through platforms like the USGS Earth Explorer, has democratized the use of satellite imagery, enabling researchers, policymakers, and businesses to harness the power of remote sensing for various applications. Landsat satellite imagery has revolutionized our ability to monitor and manage Earth's resources, contributing to better environmental stewardship and sustainable development. As technology continues to evolve, the Landsat program remains at the forefront of Earth observation, providing a rich historical record of the planet's surface and helping address some of the world's most pressing environmental challenges.

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2. Literature Survey

The use of satellite imagery, particularly from the Landsat program, has significantly advanced our understanding of Earth's surface and contributed to various applications in environmental monitoring, land management, urban planning, and disaster response. Several studies have utilized Landsat data to examine changes in land cover, monitor natural resources, and assess environmental conditions. This literature survey presents an overview of key research and advancements in the field of Landsat-based Earth observation.

One of the most common applications of Landsat imagery is land cover and land use classification. Liu et al. (2007) explored the use of Landsat imagery for mapping land cover changes in urban environments. They utilized both spectral information and spatial texture features to classify urban areas, vegetation, and water bodies. Their study showed that Landsat's moderate resolution and multispectral bands were sufficient for accurate land cover classification, making it a powerful tool for urban growth monitoring. Similarly, Chavez et al. (2013) used Landsat data to track deforestation and changes in vegetation cover in tropical regions. Their research demonstrated that Landsat’s temporal resolution and spectral range are particularly effective for monitoring long-term changes in land cover.

Another important application of Landsat data is environmental monitoring, particularly in the study of water resources. Zhang et al. (2017) applied Landsat imagery to monitor changes in water quality and the extent of water bodies, focusing on the effects of drought and climate change in regions like the Great Lakes in the U.S. Their study found that Landsat’s multispectral bands, particularly in the infrared spectrum, could be used to assess water quality by identifying changes in turbidity and vegetation around water bodies. Furthermore, Wang et al. (2016)developed algorithms to detect and monitor urban heat islands using Landsat’s thermal infrared data, helping urban planners assess the impact of urbanization on local climates.

Landsat imagery has also been extensively used in agriculture. Thenkabail et al. (2012) used Landsat data for crop yield prediction, employing vegetation indices like the Normalized Difference Vegetation Index (NDVI) derived from the near-infrared and red bands. Their work showed that Landsat’s high spatial and temporal resolution is particularly beneficial for monitoring crop health and estimating yields on large agricultural plots. Similarly, Jensen (2015)explored the use of Landsat imagery to monitor agricultural land use, providing valuable insights into crop rotation practices, irrigation, and soil health.

Despite its usefulness, Landsat imagery does have limitations, particularly in terms of spatial resolution, which can be challenging for applications requiring fine detail.Roy et al. (2014)

highlighted this limitation and discussed the integration of Landsat data with higher-resolution commercial satellite imagery to improve classification accuracy and land monitoring capabilities.

In recent years, advancements in machine learning and image processing have enhanced the utility of Landsat data. Liu et al. (2018) applied deep learning techniques to classify land cover types and detect land use changes from Landsat imagery, improving classification accuracy and enabling better change detection. This integration of AI and machine learning with Landsat data has opened new possibilities for more automated, efficient, and precise analysis of Earth's surface.

The literature highlights the wide range of applications of Landsat satellite imagery in environmental monitoring, land use analysis, and resource management. While the system has proven to be invaluable in many areas, advancements in image processing and machine learning are expected to continue enhancing its capabilities, making it an even more powerful tool for understanding and managing Earth's resources.

3.Block diagram

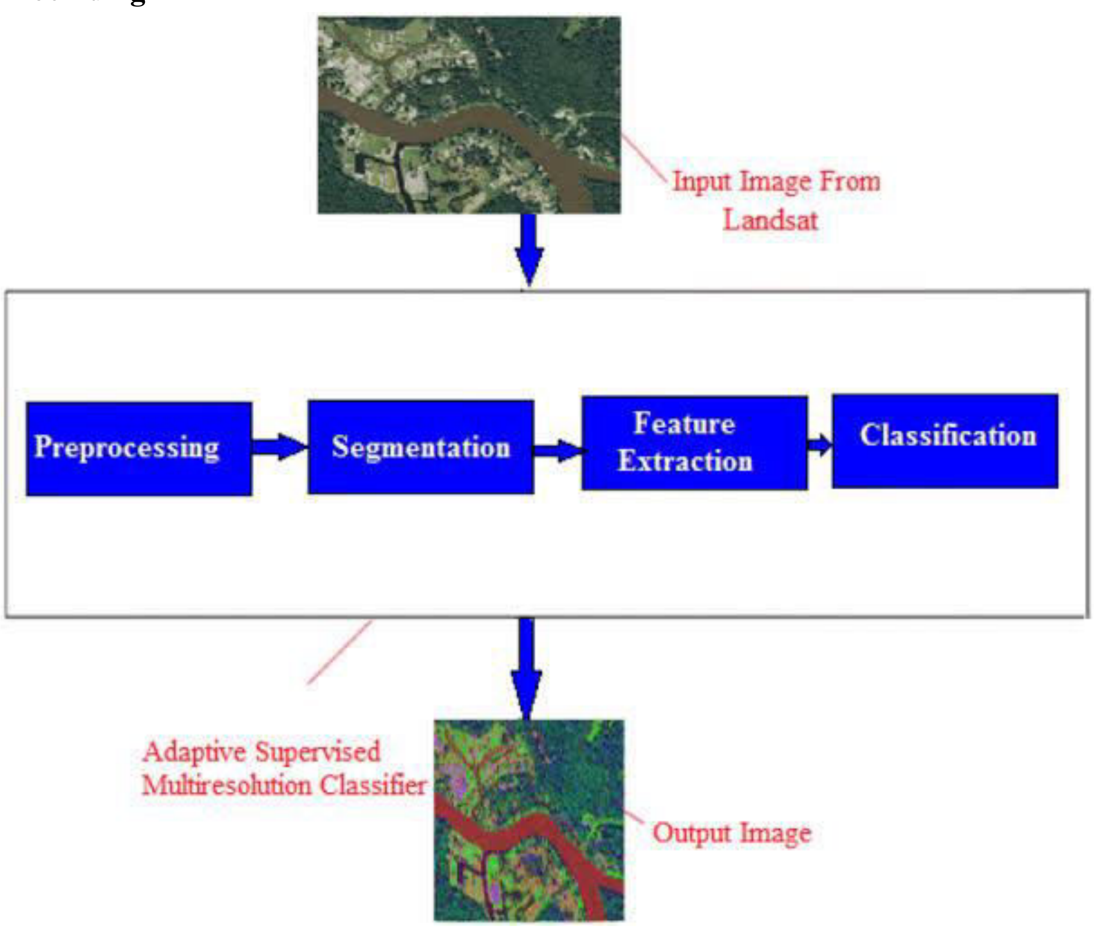

fig.1 block diagram of satellite image on Landsat

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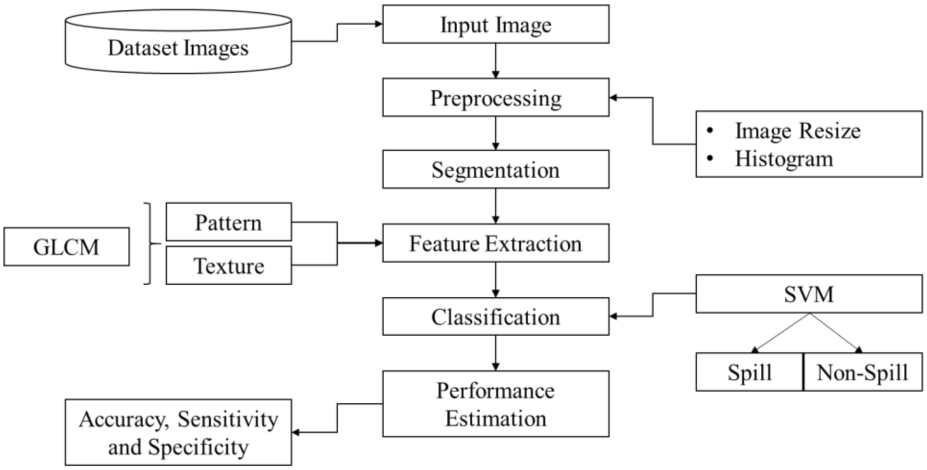

fig.2 Architecture of satellite image on Landsat

Landsat images:-



fig.3 original image fig.4 resized image fig.5 Red channel

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Fig.6 green channel fig.7 blue channel fig.8.segemented image

Fig.9 gray image

4.Conclusion

The Landsat satellite program, with its long history and consistent imagery, remains one of the most valuable tools for Earth observation, offering comprehensive insights into the planet's land cover, environmental changes, and resource management. Since its launch in 1972, Landsat has provided continuous, high-resolution imagery that has been instrumental in tracking changes in urbanization, deforestation, agriculture, water resources, and the impacts of climate change. The multispectral and temporal resolution of Landsat data makes it an essential resource for a wide range of applications, from environmental monitoring to disaster management.The ability to track long-term changes on Earth's surface is one of the primary advantages of Landsat imagery. With a revisit cycle of approximately 16 days, Landsat satellites can capture seasonal and yearly changes in land cover, which is crucial for monitoring phenomena such as urban growth, deforestation, and agricultural development. The integration of multiple spectral bands, including visible, infrared, and thermal infrared, enables detailed analysis of land cover types, vegetation health, and water quality. This capability has made Landsat imagery particularly useful for addressing pressing global challenges, such as monitoring the effects of climate change, managing natural resources, and implementing conservation efforts.

In addition to land use and environmental monitoring, Landsat imagery has shown great promise in areas like agriculture, urban planning, and disaster response. Researchers have used Landsat data to monitor crop health, predict yields, track water stress, and assess urban heat islands. The accessibility of Landsat data through platforms like the USGS Earth Explorer has democratized the use of remote sensing data, enabling a wide range of users, from policymakers and scientists to businesses and local communities, to access and utilize this valuable information for informed decision-making. However, despite its many advantages, Landsat imagery does have limitations, particularly regarding spatial resolution. While the 30-meter resolution of Landsat provides broad coverage, it may not always be sufficient for applications requiring fine detail, such as monitoring small-scale land features or detailed urban planning. Recent advancements in satellite technology, along with the availability of higher-resolution commercial satellites and the integration of machine learning and artificial intelligence, have helped address these challenges and improve the accuracy and utility of Landsat data for various applications. the Landsat program has played a foundational role in Earth observation, offering a wealth of data that continues to drive research, policy decisions, and global environmental monitoring. As technology advances and new analytical tools emerge, Landsat will remain at the forefront of remote sensing, offering vital insights for sustainable development, climate change mitigation, and natural resource management in the years to come. The continued success of the Landsat program highlights the importance of long-term, continuous Earth observation and its critical role in tackling the environmental challenges of the 21st century.

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