iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.44422

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Review of Advanced Image Processing Techniques: Digital Elevation Model

Jayashree Rajesh Prasad[1], Apurv Vidhate[2], Durva Patiyat[3], Krutika Patil[4]
[1, 2, 3, 4]*Department of Computer Science and Engineering, School Of Engineering, MIT Art, Design and Technology University, Pune, Maharashtra - 412201*

Abstract: This paper gives an in depth insight into the current as well as the previous systems or techniques that have been used in order to perform advanced image processing.
These systems or techniques have been implemented or tested in the areas of Germany, The United States of America, India, China, Indonesia and many more. The review aims to explore challenges and opportunities in the field computational and image processing areas of the industry.
Keywords: Advanced Image Processing, DEM, DSM, DTM, Satellite Image Processing

I. INTRODUCTION

Today, Advanced Image processing techniques have come a far way from what they were a few decades ago. With the advancement in technology and faster computers and methodologies it has become easier to compute and process larger and complex applications.
Advanced Image Processing is quite a tedious process. Some systems may have come up with a solution by looking into a specific category of image processing but they do have a few drawbacks. Over the years many algorithms have surfaced from TIN, Adaptive TIN, The Mahalanobis Classifier, Neural Networks and so on.

II. EVOLUTION OF ADVANCED IMAGE PROCESSING

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The existing advanced image processing systems are classified into three types.:

A. Digital Elevation Model (DEM)

A Digital Elevation Model (DEM) is a digital representation of the bare ground topographic surface or terrain. DEMs are used often in geographic information systems, and are the most common basis for digitally-produced relief maps.

B. Digital Surface Model (DSM)

A Digital Surface Model (DSM) is an elevation model that captures both the environment's natural and artificial features.

C. Digital Terrain Model (DTM)

Digital Terrain Model or DTM in short, is one of the three advanced image processing models that helps enable a better understanding of satellite or remotely sensed images.
DTM is a 3-Dimensional model near-replica of the bare earth that consists of all the topographic features such as the depth, height, length and so on.
Over the years, many researchers and scientists have with the help of Digital Surface and Digital Elevation Models generated techniques to help build the Digital Terrain Model, which is by far the most successful feat in the area of research.
Earliest notable attempt on tackling DTM was made in the year 2002, by M.A. Rajabi, J.A.R. Blais (14), a Classifier that would take into account the technique of stereo measurements on the remotely sensed images using the Shape For Shading method to derive geometric information about the objects in the images.

Table. 1. Image processing methods over the years.

Sr .	Year	Method
1	1995-2000	Drainage Enforcement Approach
2	2000-2005	A Feed-Forward Back-Propagation Network
3	2005-2010	Interpolating Method
4	2010-2015	Four Closest Neighbors (FCN) Algorithm
5	2015-2020	Interferometric Synthetic Aperture Radar

A few attempts were made in the year 2016 which made the use of neural networks, both Convolutional Neural Networks (CNN) and Artificial Neural Networks (ANN) (17,18). In the Convolutional Neural Networks method (17) the team had labeled the satellite image into five categories, vegetation, ground, road/parking/railroad, building and water. The choices for the architecture parameters of a single-layered CNN were evaluated and used for classification. A combination of four CNNs with varying contextual size that ran in parallel achieved the best classification accuracy of 94.49%. In the artificial neural network (18) method the network classified image points into the classes "ground", "man-made objects", "vegetation" and "water". This enabled the proposed method to use different approaches to achieve the dsm for different areas. The generated dtm contained varying terrain, which was better than the robust hierarchical interpolation (4,5,9) method, for highly vegetated areas and steep hillsides.
In 2021, there are two more techniques used with Neural Networks namely, Generative Adversarial Networks (GANs) (21) and Triangulated Irregular Network (TIN) (9,19,22). Each of which help in the terrain generation of the created Digital Surface Models or the Remotely Sensed Images. GANs were used for the height map construction and 3D Model construction (21). Whereas, TIN was used to create the classification of points on the surface (9,19,22).

III. APPLICATIONS

Advanced Image Processing on Satellite or remotely sensed images brings with them a variety of applications, some of which are listed below:

1) Extracting terrain parameters for geomorphology (5)
2) Modeling water flow for hydrology or mass movement (for example avalanches and landslides) (5,6)
3) Modeling soils wetness with Cartographic Depth to Water Indexes (DTW-index)
4) Creation of relief maps (5)
5) Rendering of 3D visualizations.
6) 3D flight planning and TERCOM
7) Rectification of aerial photography satellite imagery
8) Reduction (terrain correction) of gravity measurements (gravimetry, physical geodesy)
9) Terrain analysis in geomorphology and physical geography (5)
10) Geographic Information Systems(GIS) (1)
11) Engineering and infrastructure design (3,5)
12) Satellite navigation(for example GPS and GLONASS)
13) Flight simulation
14) Precision forestry
15) Surface analysis
16) Intelligent transportation systems(ITS)
17) Auto safety/ Advanced Driver Assistance Systems(ADAS)

These are just a minuscule amount of applications that we have listed here. Advanced Image Processing has been a guiding light to many organisations and governments to help them to expand and develop in their infrastructure, farming, prevention from natural disasters and much more.

IV. ANALYSIS

Throughout the years we have seen methods increasing in complexity and providing with it more information to get a better and clear Image. In 2005, Interpolation (4,5,9) was the very first method which was used to generate DEMs. Interpolation (4,5,9) played a huge role in what we see today in the modern image processing tools. Interpolation works by estimating values at unknown sites using known data.

For example, if you needed to know the temperature at noon but only had data between 11 a.m. and 1 p.m, you might use linear interpolation to approximate the value. If you had an extra measurement at 11:30 a.m., you might observe that the majority of the temperature rise happened before noon, and you could run a quadratic interpolation with this new data point. The more temperature measurements you have which are close to noon, the more sophisticated your interpolation algorithm can be. Image interpolation operates in two directions, attempting to approximate the colour and intensity of a pixel as closely as possible using the values of nearby pixels. In contrast to air temperature changes and the ideal gradient described above, pixel values can shift dramatically from one area to the next. As with the temperature example, the more information you have about the pixels around you, the better your interpolation will be.

As a result, the more you stretch an image, the worse the results get, since interpolation can never add detail to an image that isn't already there. As you see from the chart below the most popular of these has been Interpolation, Neural Networks and TIN (4,5,9,17,18,19,22). Each of these methods have a different approach to achieving the final Digital Image. A special mention of Agisoft (2,11,12) which has become a boom in recent years which has enabled people to create their own versions of the algorithm.

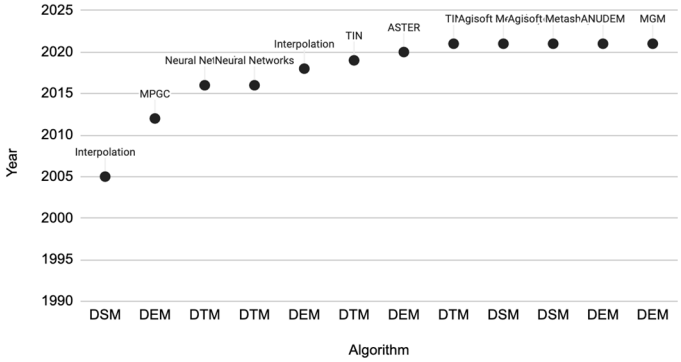


Fig.1. Graph of Year VS Algorithm

Moving on to the various data sources from which the data is acquired during these experiments. According to our research into these projects and research papers, we have concluded that IKONOS and SPOT are the most used satellite data sources. Cartosat, Worldview and Vricon are also widely accepted data satellite sources. Infact Worldview has a variety of versions and each with a different purpose to cater to the variety of problems that require specific imagery. Although IKONOS was decommissioned it is still widely used today and is a big contributor to the research conducted today and before. Though GeoEye-1 was not popular, it is a recently launched satellite and is capable of acquiring image data at 0.50-meter panchromatic (B&W) and 1.84-meter multispectral resolution. It also features a revisit time of fewer than three days, as well as the ability to locate an object within just three meters of its physical location.

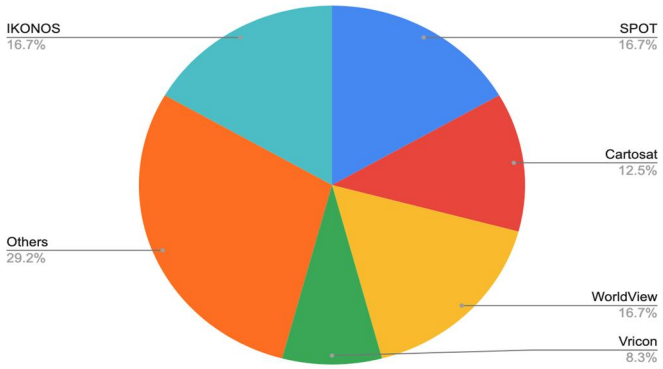


Fig. 2. Pie-Chart for various data sources from which the data is acquired

Image processing has been known to have changed data processing techniques in the last decade with remote drone aircrafts and satellites being able to get images which were transmitted and analysed remotely. It is a wide concept, it can be used in each and every field from leaf detection to human disease detection.

The advanced image processing techniques and methods in regards to topography have been researched throughout the world. However, in some areas around the world, these data are not so readily available and records can be either difficult to access, incomplete or low quality. Few of the leading countries to have extensively researched on this topic are Germany, USA, India and China, which make up around 50% of the total countries of origin of various authors and researchers.

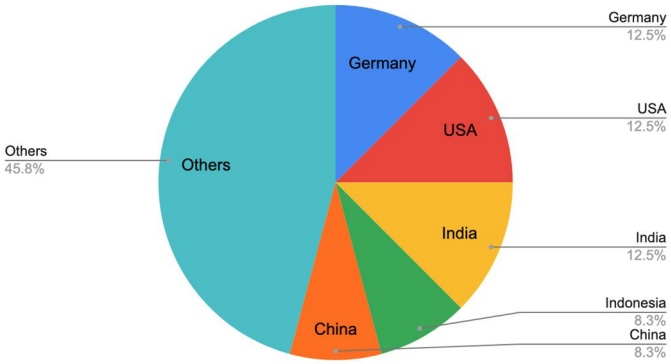


Fig. 3. Pie Chart Representing the various countries of the authors

The amount of research data nowadays is vast and readily available. The internet has played a significant role in providing authentic and detailed information, in the form of research papers published by various authors all around the world. Few of the sites that have a surplus collection of scholarly articles and research papers are Research Gate, MDPI. Apart from online sites, we can also derive useful information through various Conferences and Journals on similar topics.

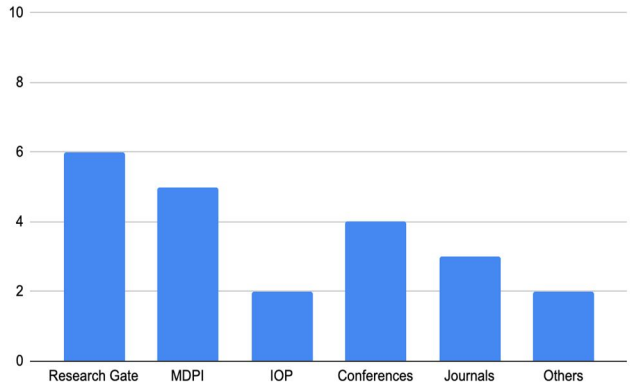


Fig. 4. Chart representing the various publication agencies

V. ACKNOWLEDGEMENTS

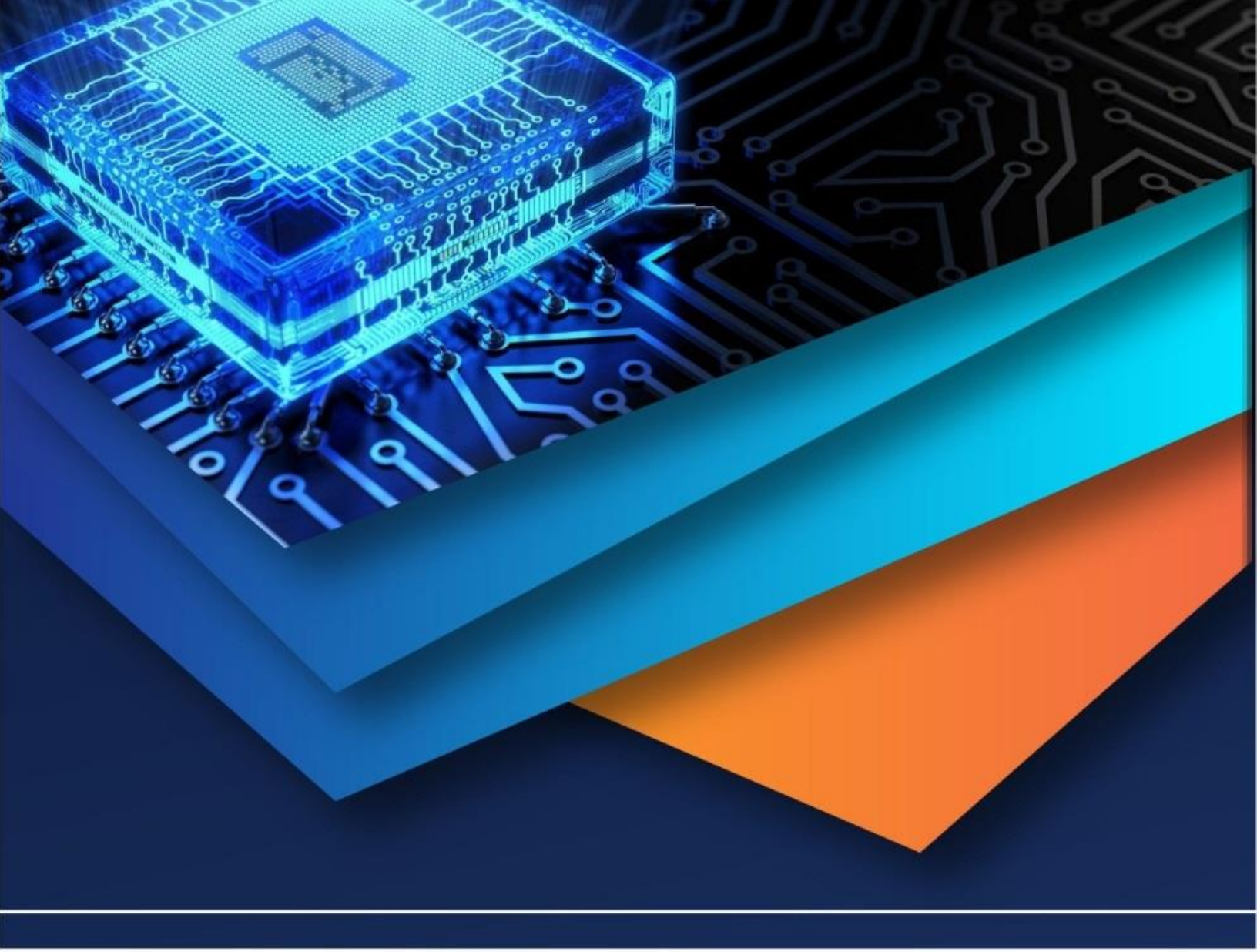
We would like to thank MIT Arts, Design and Technology University and Department of Computer Engineering for providing us the opportunity to present our paper on this topic.

VI. CONCLUSION

With the development of human society, human activities have significantly changed the surface morphology. The appearance of man-made landforms, such as roads, dams, and farmland, has increased the complexity of the topography (3,6,5). Our Research indicates that over the years we have seen massive improvements in the field of Advanced Image Processing and have better, faster, informative and descriptive algorithms and techniques which enable us to understand and develop on satellite and remotely sensed images. To this date we have concluded that the most advanced technology is AGISOFT (2,11,12) as it helps us to create 3D spatial data for GIS applications (1) and for indirect measurements of objects of various scales. IKONOS and SPOT still remain and play a vital role in providing high resolution imagery for such applications.

REFERENCES

[1] Poli, D., Fabio Remondino, and C. Dolci. "Use of satellite imagery for DEM extraction, landscape modeling and GIS applications." International Workshop on Processing and Visualization Using High-Resolution Imagery. Pitsanulok: ISPRS, 2004.
[2] Abidin, Ku Hasna Zainurin Ku Zainol, Mohd Adib Mohammad Razi, and Saifullizan Mohd Bukari. "Analysis the Accuracy of Digital Elevation Model (DEM) for Flood Modelling on Lowland Area." IOP Conference Series: Earth and Environmental Science. Vol. 140. No. 1. IOP Publishing, 2018.
[3] Lakshmi, Subbu Esakkipandian, and Kiran Yarrakula. "Review and critical analysis on digital elevation models." G eofizika 35.2 (2018): 129-157.
[4] Amante, Christopher J. "Estimating coastal digital elevation model uncertainty." Journal of Coastal Research 34.6 (2018): 1382-1397.
[5] Polidori, Laurent, and Mhamad El Hage. "Digital elevation model quality assessment methods: A critical review." Remote sensing 12.21 (2020): 3522.
[6] McClean, Fergus, Richard Dawson, and Chris Kilsby. "Implications of using global digital elevation models for flood risk analysis in cities." Water Resources Research 56.10 (2020): e2020WR028241.
[7] Zhao, Mingwei, et al. "On the topographic entity-oriented digital elevation model construction method for urban area land surface." Frontiers of Earth Science (2021): 1-15.
[8] Bhushan, Shashank, et al. "Automated digital elevation model (DEM) generation from very-high-resolution Planet SkySat triplet stereo and video imagery." ISPRS Journal of Photogrammetry and Remote Sensing 173 (2021): 151-165.
[9] Hoja, Danielle, Peter Reinartz, and Manfred Lehner. "DSM generation from high resolution satellite imagery using additional information contained in existing DSM." Proceedings of the High-Resolution Earth Imaging for Geospatial Information, Hannover, Germany (2005): 17-20.
[10] Zhang, Chunsun, and Clive Fraser. "Generation of digital surface model from high resolution satellite imagery." Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci 37 (2008): 785-790.
[11] El Garouani, Abdelkader, Abdalla Alobeid, and Said El Garouani. "Digital surface model based on aerial image stereo pairs for 3D building." International Journal of Sustainable Built Environment 3.1 (2014): 119-126
[12] Grottoli, Edoardo, et al. "Structure-from-Motion-Derived Digital Surface Models from Historical Aerial Photographs: A New 3D Application for Coastal Dune Monitoring." Remote Sensing 13.1 (2021): 95
[13] Ye, Jiang, et al. "High-Precision Digital Surface Model Extraction from Satellite Stereo Images Fused with ICESat-2 Data." Remote Sensing 14.1 (2022): 142.
[14] Rajabi, M., and R. Blais. "Densification of DTM grid data using single satellite imagery." INTERNATIONAL ARCHIVES OF PHOTOGRAMMETRY REMOTE SENSING AND SPATIAL INFORMATION SCIENCES 34.4 (2002): 482-487.
[15] Straub, Christoph, et al. "Assessment of Cartosat-1 and WorldView-2 stereo imagery in combination with a LiDAR-DTM for timber volume estimation in a highly structured forest in Germany." Forestry 86.4 (2013): 463-473.
[16] Perko, Roland, et al. "ADVANCED DTM GENERATION FROM VERY HIGH RESOLUTION SATELLITE STEREO IMAGES." ISPRS Annals of Photogrammetry, Remote Sensing & Spatial Information Sciences 2 (2015).
[17] Längkvist, Martin, et al. "Classification and segmentation of satellite orthoimagery using convolutional neural networks." Remote Sensing 8.4 (2016): 329.
[18] Tapper, Gustav. "Extraction of DTM from satellite images using neural networks." (2016).
[19] Hirt, Christian. (2016). Digital Terrain Models. Encyclopedia of Geodesy. 10.1007/978-3-319-02370-0_31-1.
[20] Rokhmana, Catur Aries, and Ahmad Ridho Sastra. "DTM generation from aerial photo and Worldview-3 images by using different DSM filtering methods." Sixth Geoinformation Science Symposium. Vol. 11311. International Society for Optics and Photonics, 2019.
[21] Pendyala, G.K.V., Kalluri, H.K., Rao, V.C. (2021). An efficient multi-stage object-based classification to extract urban building footprints from HR satellite images. Traitement du Signal, Vol. 38, No. 1, pp. 191-196. https://doi.org/10.18280/ts.380120
[22] Costa, Miss Jewela, et al. "3D Reconstruction of Satellite Data-Survey."
[23] Bouziani, M., M. Amraoui, and S. Kellouch. "Comparison Assessment of Digital 3d Models Obtained by Drone-Based LIDAR and Drone Imagery." The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences 46 (2021): 113-118.



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