HARİTA MÜHENDİSLİĞİ

Editör: Prof.Dr. İbrahim YILMAZ

yaz

yayınları

HARİTA MÜHENDİSLİĞİ

Editör

Prof. Dr. İbrahim YILMAZ

yaz yayınları

2024

yaz
yayınları

HARİTA MÜHENDİSLİĞİ

Editör: Prof. Dr. İbrahim YILMAZ

E_ISBN 978-625-6104-63-1

Ekim 2024 – Afyonkarahisar

Dizgi/Mizanpaj: YAZ Yayınları

Kapak Tasarım: YAZ Yayınları

YAZ Yayınları. Yayıncı Sertifika No: 73086

M.İhtisas OSB Mah. 4A Cad. No:3/3
İscehisar/AFYONKARAHİSAR

www.yazyayinlari.com

yazyayinlari@gmail.com

info@yazyayinlari.com

İÇİNDEKİLER

Fingerprint and Face Recognition with Photogrammetry Techniques 1
Abdullah VARLIK, Özşen ÇORUMLUOĞLU

İHA Teknolojisinin Heyelan İzleme ve Analizinde Kullanımı: Yüksek Çözünürlüklü Haritalama ve Deformasyon Analizi..25
Nehir UYAR

FINGERPRINT AND FACE RECOGNITION WITH PHOTOGRAMMETRY TECHNIQUES[1]

Abdullah VARLIK[2]

Özşen ÇORUMLUOĞLU[3]

1. INTRODUCTION

Photogrammetry is a significant scientific discipline with applications across numerous fields, including architecture, archaeology, industry, medicine, and cartography. The advent of digital photogrammetry and advancements in computer technology have expanded the scope and impact of photogrammetry in recent years.

The term "biometrics" is used to describe computer-controlled, automatic systems that have been developed with the purpose of measuring physical and behavioral characteristics of individuals, with the objective of identifying them by recognizing these characteristics. The functioning of biometric systems is analogous to the processes employed by the human brain in recognizing individuals and distinguishing them from others. These systems operate on the basis of recognizing physiological characteristics that are unique to the individual, which serve to prove their identity, that they cannot change, and that distinguish them from others. Biometrics is defined as the measurement,

---

[1] This study was derived from the Phd thesis prepared by Abdullah VARLIK under the supervision of Prof. Dr. Özşen Çorumluoğlu

[2] Assist. Prof., Necmettin Erbakan University, Engineering Faculty, avarlik@erbakan.edu.tr, ORCID: 0000-0003-2072-3313.

[3] Prof., İzmir Kâtip Çelebi University, Engineering Faculty, ORCID: 0000-0002-7876-6589.

analysis, and interpretation of biological data (Nanvati et al.2002). Digital photogrammetry and biometrics are closely related in terms of the techniques they employ. Consequently, digital photogrammetric techniques can be utilized in person and identity recognition.

A multi-biometric system is defined as a system created by combining two or more biometric techniques. It has been postulated that such systems may be designed to be more secure than those created using a single biometric technology (Jain et al.,2004). In order to achieve this objective, a system capable of performing both fingerprint and face matching has been the subject of investigation.

2. FINGERPRINT MATCHING

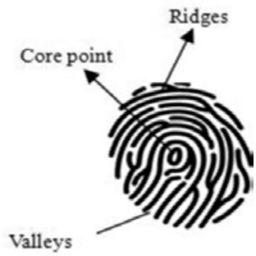
2.1.Fingerprint

The term "fingerprint" is used to describe the visible protrusions on the fingertip skin. These protrusions, which are part of the outer skin, are known as papillae or lines. Upon closer examination, it becomes evident that fingerprints are formed by the combination of numerous lines in various shapes. In the absence of significant trauma, the configuration of lines in a fingerprint remains consistent throughout an individual's lifespan. Each fingerprint exhibits a distinctive set of characteristics that remain unaltered over time. These immutable and distinctive features have rendered fingerprints a valuable tool in forensic identification.

The presence of fingerprints can be discerned through the application of gentle pressure to the fingertips. The surface of the fingertips is characterized by a complex topography comprising numerous ridges and valleys. A ridge is defined as a single curved segment, while a valley is the area between two adjacent ridges.

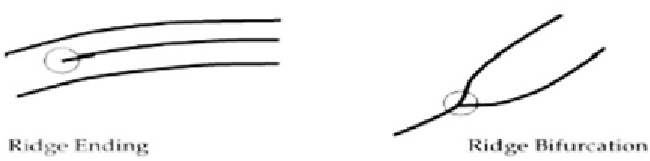
The dermal ridges and valleys contain numerous pores that facilitate respiration, excretion of oils and sweat, and other functions (Maltoni et al., 2003).

Figure 1. Fingerprint



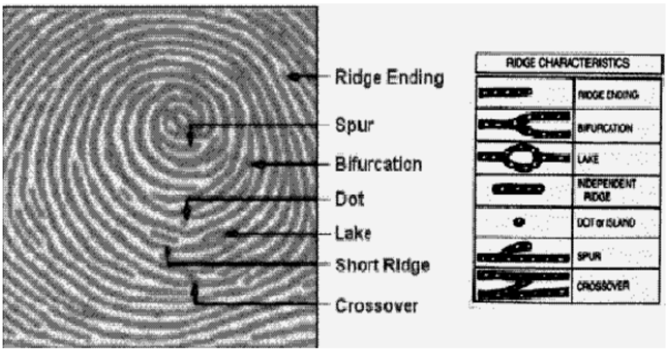
Upon close examination, it becomes evident that some lines in fingerprints exhibit a sudden termination or bifurcation, resulting in the formation of a bifurcation. These distinctive characteristics are referred to as "qualities." These points are designated as line ends and bifurcations, respectively. The primary distinguishing factor of fingerprints is the location and direction of the attributes within the fingerprint. A comparative analysis of fingerprints reveals that, despite their overall structural similarities, they exhibit significant differences when the attributes are considered. These distinctions are so pronounced that studies have determined that the probability of two individuals on Earth having the same fingerprint is one in 64 billion.

Figure 2. Minutiae



The basic shapes in fingerprints are the shapes formed by lines. These are; Ridge ending, Bifurcation, Lake, Independent Ridge, Dot or Island, Spur, Crossover.

Figure 3. Fingerprint Characteristics



There are two types of fingerprints features.

- Core Point; Some lines in fingerprints can curl around themselves and form a lasso. If there is a lasso upwards in the fingerprint, the middlemost fold point of this lasso is called the navel point and this point is accepted as the center point of that fingerprint.
- Delta Point; In fingerprints, there is a delta point formed by a group of lines corresponding to each lasso. Some fingerprints may not have a core point and a delta point.

Figure 4. Examples of fingerprint features (Circle represents a hub dot region; triangle represents a delta dot region)

2.2.Fingerprint Matching Techniques

Two principal methods are employed in the field of fingerprint recognition: filtering (wavelet transform) based and feature based fingerprint recognition.

In fingerprint verification and detection systems, point-based matching algorithms, which are also known as feature point matching algorithms, are typically employed in lieu of pixel or trace-based matching algorithms. These algorithms utilize the distinctive characteristics of lines in fingerprint images, known as feature points, and their interrelationships to facilitate the identification and recognition of individuals (Özkaya 2003).

It is of great consequence that the recognition process be capable of obtaining feature points from the input fingerprint image in a seamless and dependable manner. The efficacy of algorithms for identifying feature points is contingent upon the quality of the input fingerprint image. In general, fingerprint images are of insufficient quality to be processed directly and require image enhancement operations. Image enhancement algorithms apply a series of operations to the input fingerprint image, resulting in a higher-quality image.

In point-based fingerprint matching, the fingerprint image is typically enhanced, traces are extracted using directional histograms or the Fourier transform, feature points are extracted, and feature points are aligned using one of several techniques, including the roving point approach, the nearest neighbor technique, the center point method, and others.

2.3. Minutiae Extraction Stages

The capacity to extract feature points from a fingerprint image in a seamless and dependable manner is of paramount importance for matching. The efficacy of algorithms for identifying feature points is contingent upon the quality of the input fingerprint image. Image enhancement algorithms employ a series of operations to the fingerprint image, resulting in a superior quality image. Enhancing the quality of the input image is crucial for accelerating, optimizing, and ensuring the reliability of the automatic fingerprint recognition system in the matching process, while reducing the margin of error of the system.

2.3.1. Enhancement of Fingerprint Image with Directional Histogram

The directional information of the image is also employed in the processes of fingerprint cleaning and enhancement. During the stage of determining the directional areas, the directions of the fingerprint are sought to be identified with the objective of extracting the feature points on the fingerprint image.

A variety of techniques have been devised to ascertain the orientation area. One such method is the Rao algorithm, which comprises the following stages (Karahan et all., 2003).

- The input image is partitioned into blocks of size W x W (for example, 16 x 16).
- For each point in the image, the Gx and Gy gradient values are calculated by applying the Sobel filter.

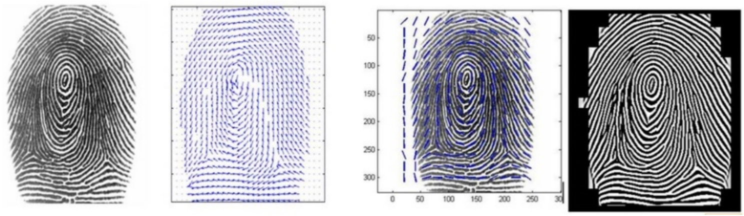
$$G_x = -1.a_1 + 1.a_3 - 2.a_4 + 2.a_6 - 1.a_7 + 1.a_9$$

$$G_y = 1.a_1 + 2.a_2 + 1.a_3 - 1.a_7 - 2.a_8 - 1.a_9 \quad (1)$$

- The local orientation of each block is determined by the solution of equation (2).

$$\theta_o = \frac{1}{2} tan^{-1} \left(\frac{\sum_{i=1}^{W} \sum_{j=1}^{W} 2G_x(i,j)G_y(i,j)}{\sum_{i=1}^{W} \sum_{j=1}^{W} (G_x^2(i,j)G_y^2(i,j))} \right) \quad (2)$$

Figure 5. Fingerprint image with orientation areas determined



- Once the orientation area of the fingerprint image has been identified, the subsequent step is to determine the area of interest. This is achieved by utilizing the local entropy of the image, as outlined in the equation below.

$$E(i,j) = f(i,j) - \sum_i \sum_j f(i,j) * log_2\big(f(i,j)\big) \qquad (3)$$

The energy map illustrates the region within the fingerprint image where the tracks are situated. The region encompassing the track is designated as white, while the surrounding area is assigned a black value. This image is then utilized as a mask in the subsequent stage of processing. Once the orientation of the input image and the area of interest have been established, the subsequent stage is to determine the track.

-A salient characteristic of tracks is that the gray-level values (track density) in the direction transverse to the track tend to reach a local maximum, while the gray-level values of the bifurcations (the bisection of the track) tend to reach a local minimum (Jain 1997). This feature is employed to determine whether a given point in the image represents a track. If the gray-level value at a given point exceeds a specified threshold, T_{iz}, that point is designated as a track.

Once the trace has been removed, the remaining traces must be thinned in order to facilitate the detection of the feature points. The method typically employed for thinning entails the examination of minute fragments from the scanned image. The objective is to identify the outline, or shape, within the bitmap.

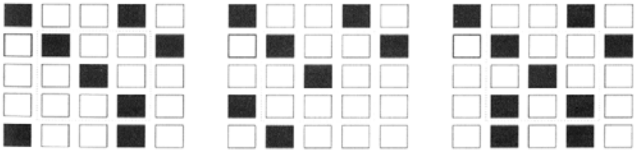
To this end, specific pixels within the bitmap are altered to white, thereby gradually reducing the black tones and facilitating the thinning process. Subsequently, the thinned trace image is refined through the application of the mask derived from the area of interest image.

Figure 5. Cleaning the thinned image using thinning process and area image mask

Each point in the thinned track map is assigned a value of 1 or 0. If we assume that (x,y) represents a point in the thinned track map and N0, N1, ..., N7 represent the eight neighbors around this point, then the following rules apply:

- If Ni = 1, then (x,y) is the end of the track.
- If Ni > 2, then (x,y) is a bifurcations. Subsequently, the x,y coordinates of each identified feature point and the characteristics of the feature point (line termination or bifurcation) are documented.

Figure 6. Sketch representation of feature points (Ridge Ridge ending, Bifurcation)



There may be cuts on the trace map due to noise or other problems. Feature points that are detected due to cuts and do not actually exist are found and deleted. The following rules are taken into account in this process.

- If there are many feature points in a small area, all feature points except the one closest to the region center are deleted.
- If two feature points are very close to each other and there is no trace between them, both feature points are deleted

Figure 7. Minutiae Extraction

Following the completion of the cleaning process, the remaining feature points have been brought as close as possible to reality. At this stage, the x and y coordinates, local trace direction, and feature type (end of line, bifurcations) of each detected feature point are recorded. The four pieces of information, namely the x and y coordinates, local trace direction, and feature type, are utilized by systems that provide security with fingerprints for verification and detection purposes.

Figure 8. Fingerprint that has been cleaned and freed from faulty feature points

2.3.2. Minutiae Matching

In feature point-based matching, in the alignment phase, transformations such as translation, rotation and dimensioning are calculated between the input and the sketch stored in the database, and the input feature points are aligned with the sketch feature points according to the calculated parameters. In the matching phase, the input and sketch feature points are converted to polygons, and a flexible set of matching algorithms are used to match these resulting polygons.

Theoretically, two planar point sets can be aligned exactly with two pairs of corresponding points. In order to achieve a correct alignment between two point meshes, triangle structures are created between the points and all possible opposite triangle edges formed by input feature points and sketch feature points are compared, tested and the most suitable one is selected. The pose transformation between the two point meshes is calculated correctly with the help of the matched triangle structures. This process requires a large amount of fit testing. Therefore, although alignment with mutual point pairs is convenient, it is not practical. If two identical point patterns are perfectly aligned with each other, the corresponding point pairs intersect exactly. In this case, the point mesh matching is determined by counting the number of overlapping pairs, but this is not the case in practice. The algorithm to be used should have the feature to ignore the distortions caused by nonlinear distortions and incorrectly determined feature point locations. Usually, such a flexible matching is done by placing a bounding box around each sketch feature point. This box indicates where the input feature point can be with respect to the sketch feature point. The input feature point is constrained to be within the corresponding feature point. This method does not provide good results in practice because the accumulated global distortions may be quite large, while the local distortions may be small. An adaptive flexible matching algorithm that is capable of eliminating feature point localization errors and nonlinear distortions should be implemented.

Figure 9. Minutiae Matching

X	Y	θ	T
106	26	320	R
153	50	335	R
255	81	215	B

T(ΔX, ΔY , Δθ)?

X	Y	θ	T
215	08	120	R
213	20	145	R
372	46	109	B

2.3.2.1.New Proposed Methods for Minutiae Matching

n order to facilitate a comparative analysis of two fingerprint images, it is necessary to superimpose the images in question. This can be achieved by rotating and translating one fingerprint in order to align it with the position of the other. In order to facilitate a comparison between two sets of points whose rotation, scaling, and translation information are unknown, it is necessary to express both sets in relation to one another.

There are many matching algorithms in the literature. Although the feature-based automatic fingerprint matching method is used extensively in fingerprint recognition, the following deficiencies and problems have been identified with this method.

The algorithm requires that the scale be changed in a certain range with a certain increment. When the scaling sensitivity is increased, the processing time becomes very long. In addition, the same two images can be perceived differently at scaling values smaller than 0.1. Due to the insufficient scaling sensitivity, the same transformation may be seen differently, and the transformation and therefore the matching score may decrease. The center of the image is taken as the reference in the transformations. Therefore, different transformations can be found for different sequential operations such as translation / rotation and rotation / translation. Even if a meaningful point (kernel) in the images is taken as the reference, the result does not change. Because a kernel may not be found in every image. In addition, the reference may change in lossy fingerprints.

The rotation angle is calculated by taking the difference between the angles of the feature points in the images, so the accuracy of the point angles is very important. However, due to the noises that occur in the images during the acquisition and digitization of fingerprints and the problems in the binary image acquisition and thinning stages, it is difficult to find the angles of the end and bifurcation points with sufficient precision. As a result, the rotation angle cannot be determined correctly. Although the point angles are determined as an angle range or region rather than as a single value, the rotation angle cannot be found accurately and the same for every point in the image.

In order to circumvent the aforementioned adverse scenarios, an alternative methodology has been implemented. A novel methodology has been devised for the purpose of fingerprint matching. The developed method is a local matching approach based on the Affine transformation.

In the field of photogrammetry, the Affine transformation, which is a two-dimensional transformation, is employed in the transition from image coordinates to model coordinates and from model coordinates to terrain coordinates. While similarity transformations are typically employed in geodesy, their use in photogrammetry and cartography is somewhat distinct. It is notable that when materials such as film and paper are deformed, the distortions along both axes are not identical. In this instance, the Affine transformation is the optimal choice. The distortions observed in the fingerprint exhibit a distinctive environmental signature. The distortions in the fingerprint typically originate from a specific point and subsequently propagate in an outward direction. Accordingly, the potential benefits of the Affine transformation were evaluated.

In the affine transformation, the shape is geometrically distorted after the transformation. The angles change, but the lines are still correct and the parallelism does not change. In order to find the affine transformation parameters, at least three common points are needed in both images, if there are more than three points, these parameters are calculated by balancing according to the Least Squares method. The main difference of the affine transformation from the similarity transformation is that the scale factors in both axis directions are different.

In the affine transformation; the transformation of any line is still correct. Parallel directions are still parallel after the transformation. The ratio of two line segments on a line to each other is the same after the transformation. It is not an angle-preserving transformation. The angles change after the transformation. The scale is the same for each line, the scale changes with the direction. The areas of geometric shapes change by a fixed amount after the transformation, this fixed amount is equal to the determinant of the transformation matrix (Yaşayan 1978).

In order to calculate the transformation parameters in a balanced way, the common points in both coordinate systems are reduced to the center of gravity. The advantage of working with coordinates reduced to the center of gravity is that it allows working with smaller numbers.

$$X_2=a_0+a_1 X_1+a_2 Y_1 = X_2^0 +m \cos\Phi X_1 - n \sin\Psi Y_1$$

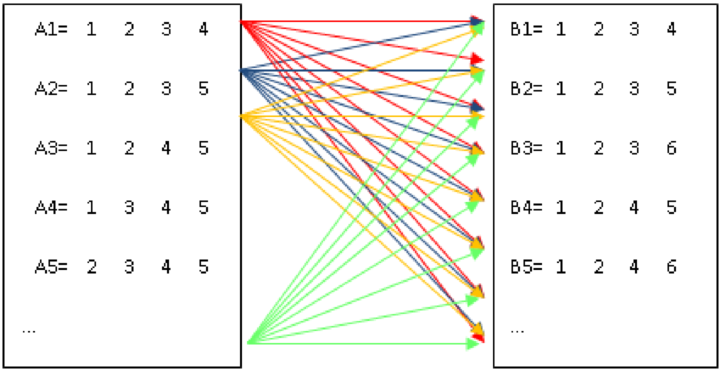
$$Y_2=b_0+b_1 X_1+b_2 Y_1=Y_2^0+m\sin\Phi X_1 - n\cos\Psi Y_1 \qquad (4)$$

These equations contain six unknowns: X_2^0 , Y_2^0 are two translations (initial differences between systems), **Φ and Ψ** are two rotations, m and n are two scale coefficients. In case of more than three points, the transformation coefficients are calculated according to the least squares method.

The method developed within the scope of the study was created based on the principle of finding four common points in both systems.

In the event that both fingerprint images belong to the same individual, there are sufficient common points between the identified feature point sets. The objective is to identify a minimum of four points from each set and perform the Affine transformation. This will enable the determination of whether the number of common points in both systems is sufficient following the transformation.

Figure 10. Comparison of 4 subsets of point sets A and B

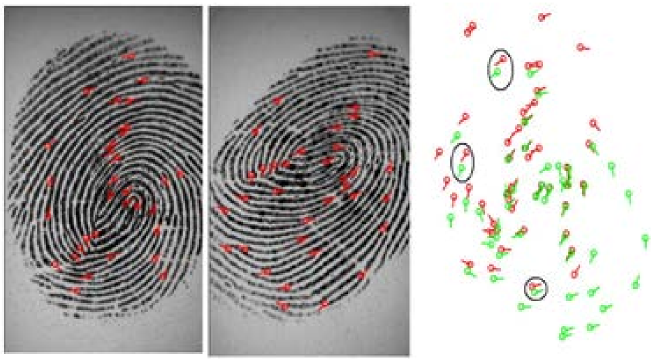


For this purpose, each set of points has four subsets. The number of subsets is the same as the number of four combinations of the number of points. The aim is to compare each of these subsets with the other and perform the Affine transformation between them. When comparing both subsets, it is important how to rank the points that we think are common. First, the midpoints of the points in both sets, Ao and Bo, are found.

$$Xo=(x1+x2+x3+x4)/4, Yo=(y1+y2+y3+y4)/4 \qquad (5)$$

The distances from the midpoint to the other points are calculated (a1, a2, ..., b1, b2, ...,). The points are then ordered from the smallest to the largest according to their distances to the midpoint. Subsequently, the feature values of the sorted points (end of line, bifurcation point) are compared. In the event that the feature values of the compared points are not identical, the process is terminated and alternative point sets are considered. Once the sorting process is complete, the Affine transformation is performed using the sorted points. In the event that the mean square error (mo > 10) in the Affine transformation exceeds 10 pixels, the process is terminated and the comparison process of other sets is initiated. Conversely, if the squared mean error is less than 10 pixels, the process is continued, and the input point set is transformed with the assistance of the identified transformation parameters. Subsequently, the coordinates of the input points are converted to draft point coordinates. Overlapping points are then identified within a 10x10 limiting window. In the event that the feature values of the overlapping points are identical, these points are deemed to be matched. In this manner, the number of matching points is determined. In the event that the number of matched points exceeds 13, it is inferred that the two fingerprint images belong to the same individual. In the event that the number of matching points is less than 13, the match is not accepted and the process is repeated with other subsets. In the event that the number of matching points does not exceed 13 as a consequence of the aforementioned operations, it is postulated that the two fingerprint images in question do not belong to the same individual.

Figure 11. Comparing input points with sketch points



3. FACE MATCHING

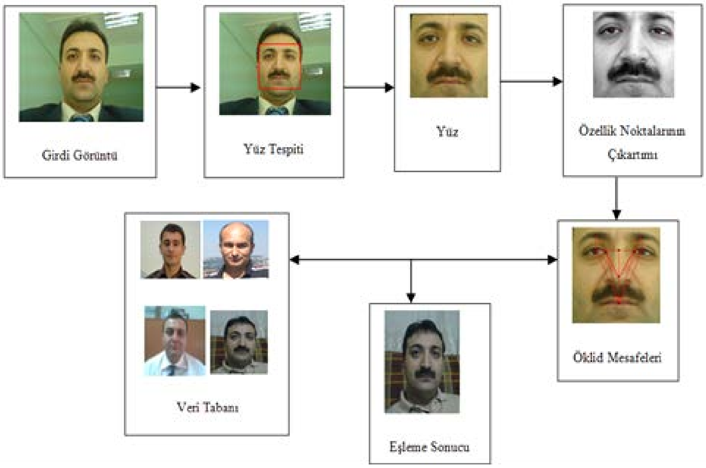
Human beings are distinctive in a multitude of ways, and these defining characteristics facilitate their recognition and identification. The foundation of facial recognition technologies is the extraction of distinctive features associated with a given face from existing image data. The process entails a comparison between two fixed images. Two principal techniques are employed in the construction of facial recognition systems (Ahuja et al., 2002).

- Holistic determinants encompass the entire face.
- In partial determinants, the eyes, lips, and nose are the areas of the face that are examined.

Within the scope of the study, the partial determinant technique was used. Studies using the partial determinant technique require a lot of time and include complex mathematical operations. The method is a method of defining the dimensions of the areas with the defining feature on the face by comparing their distances and geometry or the vectors they form. It is the first face definition method used to date. While defining the facial characteristics, various methods such as determining the eye sockets, scanning the areas surrounding the cheekbone, determining the corners of the mouth, and analyzing the earlobe are used. It has been found that there are 120 distinguishing features that attract attention on the face, and 68 main features have emerged among them. These main features become a mathematical expression by measuring the distances between their elements (definition algorithm) and placing these distances in the necessary places in the recognition algorithm. This expression is called a completely different formula from another expression that belongs to the face used and that will be obtained from someone else's face. As a result, it is quite easy for previously introduced faces, in short, people, to be easily remembered with the help of computers and to be defined when needed.

If we give an example of the points selected to perform geometric recognition on the face; the eyes, eyebrows, mouth, nose and chin, which have defining features on the face, can be given as examples. The most important stage of face recognition methods is finding the faces in the image. The number and quality of the faces found directly affect the success of the face recognition method. As face recognition steps; any face is detected by the computer by applying the following steps and recorded in the necessary places. Matching is done with the data that is desired to be compared. This stage; includes the digital/analog display of the face. If the image obtained is analog, it is digitized, the distances of the elements in the digital image, using the identification algorithm, and the coordinates within the general area of the face are determined, the values obtained are converted into a mathematical expression using the recognition algorithm, the expression is stored to be compared with other expressions to be obtained later and to be used for other applications.

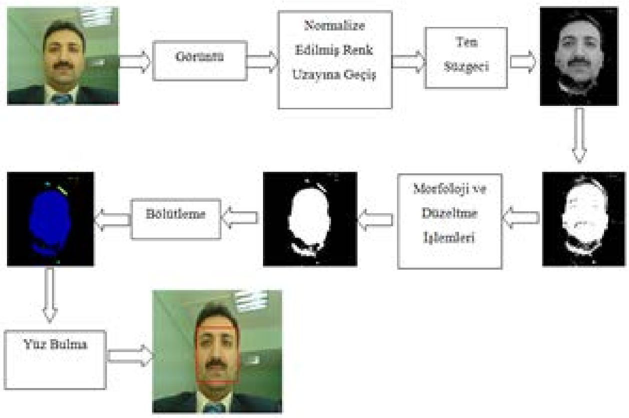
Figure 12. Process diagram for face matching



To date, many studies have been conducted to identify and track human faces. These studies continue today. Many intuitive and feature-based approaches are proposed to produce a precise and complete result. Among these feature-based studies, methods that use skin color as a means of recognition are gaining more importance than others. Considering that skin color can be easily distinguished by humans, it seems more accurate to use this feature for face detection (Yavuz 2007).

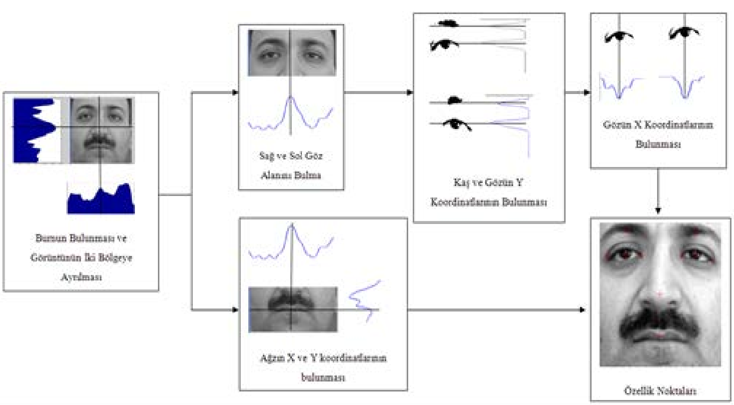
Within the scope of the study, face detection was performed as follows many studies have been conducted in different color spaces on skin color recognition, and the normalized RGB color space was used to find skin color in the image. Pixels that could be skin color remain the same, while pixels that are not perceived as skin color are converted to black. Thus, areas that could only be skin color are separated from other areas. Another way to determine the face area in colored images is to use some restrictions in the normalized RGB color space to find the face (Vezhnevets et al., 2003).

Figure 13. Flowchart for face detection in image.



After finding the face area in the image, the extraction of the feature points on the face is started. In this study, eyebrows, eye lens and eye sockets, nose and lips are selected as the feature points on the face. First, the horizontal and vertical projection of the face is extracted. The minimum and maximum points in this projection graph are found. These points show the locations of the feature points on the face. These values showing the location of feature points are accepted as approximate values and the locations of these points are determined more precisely.

Figure 14. Finding feature points on the face.



After the facial elements are precisely found, Euclidean distances and ratios between these points are calculated and recorded. The newly obtained facial data is compared with the recorded facial data and a connection is established with at least one facial representation. When the comparison is complete, the system assigns a comparison value. If this value is above the predetermined threshold, the similarity is declared.

In general, the centered or normalized Mutual correlation coefficient **(ρ)** is calculated in the calculation. The maximum of the calculated **(ρ)** correlation coefficient gives the location of the best match between the model and the part (Varlık 1999). The calculation of the centered or normalized correlation coefficient **(ρ)** at each pixel location, which finds the correlation between the two parts with a high approximation, is as follows.

$$\rho(x,y) = \frac{\sum_{x=1}^{m}\sum_{y=1}^{n}\left(f(x,y)-\bar{f}\right)*\left(g(x,y)-\bar{g}\right)}{\sqrt{\sum_{x=1}^{m}\sum_{y=1}^{n}\left(f(x,y)-\bar{f}\right)^{2}*\sum_{x=1}^{m}\sum_{y=1}^{n}\left(g(x,y)-\bar{g}\right)^{2}}} \qquad (6)$$

Here;

f(x,y), g(x,y): input and draft matrix

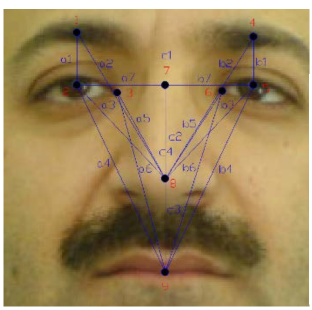
$\bar{f}$, $\bar{g}$: average values of input and draft matrix

m,n : number of rows and columns of input and draft matrix

The correlation coefficient is in the range ρ [-1 , 1]. If the calculated coefficient ρ = -1, it is understood that there is no correlation between the two correlation matrices. If ρ=1, there is a complete correlation between the matrices. For the mutual correlation method, the edges between the feature points in the input and research image, Euclidean distances are calculated and the feature vector is created using the ratios of these edges to each other. The mutual correlation value is calculated between these feature vectors, if this value is greater than the specified limit value, it is accepted, if it is smaller, it is rejected (Varlık.,2008). (For the affine transformation, the squared mean error $m_0 <= \pm 5$, the mutual correlation value $\rho >= 0.95$ is taken) The face feature points, used edges and feature vector are shown in the figure below.

The feature vector is created from the ratios of the distances of the feature points of the face to each other. For example; the ratios of the distance between the eyebrow and the eye to the distance between the eye line and the nose, the distance between the nose and the mouth, the distance between the eye line and the mouth, the ratios of the eye base (the distance between the right and left eyes) to the distances between the eye line and the nose and the mouth. Within the scope of the study, the feature vector is created as a 4x4 matrix. If desired, it is possible to create feature vectors of different sizes by using different Euclidean ratios.

Figure 15. Numbering of feature points of the face, Euclidean distances between them and feature vector formed by the ratios



$$\mathbf{A} = \begin{bmatrix} \frac{a1}{c1} & \frac{a1}{c2} & \frac{a1}{c3} & \frac{a1}{c4} \\ \frac{b1}{c1} & \frac{b1}{c2} & \frac{b1}{c3} & \frac{b1}{c4} \\ \frac{c1}{a3} & \frac{c1}{b3} & \frac{c1}{a4} & \frac{c1}{b4} \\ \frac{c1}{c2} & \frac{c1}{c3} & \frac{c1}{c4} & \frac{c2}{c3} \end{bmatrix}$$

Although face images are not as secure as biometric signals such as iris and fingerprint, there are important features that distinguish face recognition systems from others. The most important of these features is that the face image can be taken remotely via a camera. Therefore, the scenarios in which face recognition algorithms can be applied are very diverse. The biggest problem faced by two-dimensional face recognition systems is that the differences created by the changes in the obtained signal are very high. The changes created by the changes in lighting, pose and expression on the same face are generally greater than the difference between the pictures of different people.

4. RESULT

When the results are examined, it is seen that the fingerprint matching algorithm developed within the scope of the study works properly and achieves the desired success. It is clear that the success of the algorithm is due to the properties of the Affine transformation used. It has been seen that the Affine transformation can be used in point-based matching and that this provides some advantages to the system. It has been seen that in a system where fingerprint and face matching are evaluated together, the probability of the system making an error is almost zero.

With the study, the situations and processes that cause errors in point-based matching techniques used in fingerprint matching have been eliminated by using the developed algorithm. The fact that scaling, translation and rotation operations are performed with a single transformation instead of separately, that there is no need for a central point in the fingerprint, that there is no need for the angles of the feature points, and that the effect of deformations in the fingerprint image is reduced with the Affine transformation used provides great advantages to the system.

In the face recognition section, it was seen that the face matching algorithm worked well and was sufficient. However, the success rate in finding face elements is quite low. This has a negative effect on the success of the system. Because the face images used in the system are images taken from the front profile of the face, with a rotation of less than 15^0. Error operations increase in images where the inclination and rotation are greater than this value. The matching process gives more accurate results in face images where the inclination and rotation are close to 0.

REFERENCES

Ahuja,N.,Yang,M.,Kriegman,D., 2002,Detecting Faces in Images: A Survey, in IEEE Transaction On Pattern Analysis and Machine Intelligence, Vol. 24 (1), Pp. 34–58.

Jiang, X., Yau, W.-Y., Ser, W., 2001. Detecting The Fingerprint Minutiae By Adaptive Tracing The Gray-Level Ridge. Pattern Recognition 34 (5), 999–1013.

Jiang, X., Yau, W.-Y., 2002. Fingerprint Minutiae Matching Based On The Local And Global Structures. 2000, Icpr 2000, Pp. 1042–1045.

Jain A. K., Ross, A.,2004,Multi Biometric System, Communicatıons Of The Acm Vol. 47, No. 1, West Virginia University

Karahan.H, Akbay,E.,2003, Parmak İzi Doğrulama, Ijcı Proceedings Of International Conference On Signal Processing, Issn 1304-2386, Volume:1, Number:2.

Maltoni,D., Maıo,D., Jain,A.K., Prabhakar,S., 2003, Handbook of Fingerprint Recognition, New York.

Nanavati, S., Thieme, M., Nanavati, R.,2002, Biometrics, P.300, Wiley Computer Publishing Press, Usa.

Özkaya, N.,2003, Otomatik Parmak izi Tanıma Sistemi, Yüksek Lisans Tezi, Erciyes Üniversitesi, Fen Bilimleri Enstitüsü.

Sağıroğlu, Ş., Özkaya, N.,2006, Otomatik Parmak izi Tanıma Sistemlerinde Kullanılan Önişlemler İçin Yeni Yaklaşımlar,Gazi Üniv. Müh.Mim.Fak. De. Vol 21 No 1 11-19 .

Varlık,A.,1999, Digital Fotogrametride Alana Dayalı Görüntü Eşleme Metodları, Yüksek Lisans Tezi, Akü Fen Bilimleri Enstitüsü. Afyon

Varlık,A.,2008, Fotogrametri Teknikleriyle Kişi Tanıma. Doktora Tezi, Selçuk Üniversitesi Fen Bilimleri Enst, Konya

Vezhnevets, V., Sazonov, V. Andreeva, A., 2003, A Survey On Pixel-Based Skin Color Detection Techniques”. Proc. Graphicon, Moscow, Russia.

Yaşayan, A .,1978, Hava Fotogrametrisinde İki Boyutlu Doğrusal Dönüşümler Ve Uygulamaları, Ktü Yayın No: 102, Ybf Yayın No:19, Trabzon

Yavuz,Z.,2007, Bilgisayarlı Dudak Okuma , Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü,Trabzon

İHA TEKNOLOJİSİNİN HEYELAN İZLEME VE ANALİZİNDE KULLANIMI: YÜKSEK ÇÖZÜNÜRLÜKLÜ HARİTALAMA VE DEFORMASYON ANALİZİ

Nehir UYAR[1]

1. GİRİŞ

Heyelan, yer çekimi etkisiyle zemin veya kayaçların yamaç boyunca aşağı doğru hareket ettiği doğal bir olay olup, jeolojik, meteorolojik ve insan kaynaklı faktörler tarafından tetiklenebilir. Jeolojik faktörler arasında kaya yapısı, zemin özellikleri ve topografik eğimler önemli rol oynarken, meteorolojik etkenler arasında yoğun yağışlar ve kar erimeleri öne çıkmaktadır (Hussain ve diğ., 2002). Ayrıca, ormansızlaşma ve yapılaşma gibi insan faaliyetleri de heyelan riskini önemli ölçüde artırmaktadır. Heyelan izleme ve haritalama süreçleri, geleneksel olarak saha çalışmaları, topografik haritalar ve uydu görüntülemeleri gibi yöntemlerle gerçekleştirilmiş olsa da bu yöntemler geniş alanların sürekli izlenmesi ve yüksek çözünürlüklü veri elde edilmesi konusunda bazı kısıtlamalara sahiptir (Belardinelli ve diğ., 2003).

Son yıllarda, uzaktan algılama teknolojileri, heyelanların izlenmesinde kritik bir role sahip olmuştur. Özellikle İnterferometrik Sentetik Açıklıklı Radar (InSAR) gibi teknikler sayesinde yer hareketlerinin ayrıntılı bir şekilde izlenmesi mümkün hale gelmiştir, ancak bitki örtüsünde meydana gelen

[1] Öğretim Görevlisi Dr, Zonguldak Bülent Ecevit Üniversitesi, Zonguldak Meslek Yüksekokulu, Mimarlık ve Şehir Planlama Bölümü, nehiruyar@beun.edu.tr, ORCID: 0000-0003- 3358-3145

değişimler ve sedimantolojik süreçler, aktif heyelan yüzeylerinde sinyal bozulmasına yol açabilmektedir (Belardinelli ve diğ., 2003). Ayrıca, pankromatik QuickBird uyduları gibi pasif uzay tabanlı görüntüleme sistemleri, 0,61 metreye kadar yer çözünürlüğü sunarak heyelan izleme çalışmalarında önemli veriler sağlamaktadır (Niebergall ve diğ., 2007).

Heyelan izleme çalışmalarında yer altı koşulları hakkında veri toplayan jeoteknik ve jeofizik yöntemler, yüzey verilerini toplayan topografik ve jeodezik yöntemlerle birleştirilmektedir. Bu yöntemler, ya karasal bazlı (yer tabanlı) ya da hava veya uzay tabanlı (uzaktan algılama) tekniklerle gerçekleştirilebilir (Schlögel ve diğ., 2015). Teknolojinin ilerlemesiyle birlikte, Diferansiyel GPS (DGPS), robotik total stationlar, hava kaynaklı Light Detection and Ranging (LiDAR) ve Karasal Lazer Tarayıcılar (TLS) gibi araçlar, Dijital Yüzey Modellerinin (DSM) periyodik olarak toplanmasını devrim niteliğinde değiştirmiştir (Westoby ve diğ., 2012). Bununla birlikte, DGPS ile yapılan saha çalışmalarının zaman alıcı olması ve sınırlı alansal kapsama sağlaması nedeniyle, DSM'nin ince ölçekli arazi yapısını göz ardı etme riski vardır (Martha ve diğ., 2010). TLS, görüş hattı sorunlarıyla karşı karşıya kalabilir ve hava kaynaklı LiDAR ise bireysel heyelan çalışmaları için genellikle maliyet açısından sınırlayıcı olabilir (Westoby ve diğ., 2012).

Günümüzde, İnsansız Hava Araçları (İHA) teknolojisi, heyelan izleme ve analizi çalışmalarında yeni bir dönemi başlatmıştır. İHA'lar, fotogrametri ve 3D modelleme teknikleriyle entegre edildiğinde, yüksek çözünürlüklü görüntülerin ve nokta bulutlarının üretimi sayesinde heyelan alanlarının hızlı ve hassas bir şekilde haritalanmasını mümkün kılar. Bu teknoloji, aynı zamanda heyelan hareketlerini ve deformasyonlarını izlemek için önemli bir veri kaynağı sağlar (Giordan ve diğ., 2017). İHA'lar, geleneksel yöntemlerle erişilmesi zor olan alanlarda yüksek çözünürlüklü veri toplayarak, heyelanların dinamik süreçlerinin detaylı analiz edilmesine olanak tanır. Özellikle fotogrametri ile elde edilen veriler, coğrafi bilgi sistemleri (CBS) ile entegre edilerek, zamana dayalı deformasyonların tespitinde kullanılabilir (Belardinelli ve diğ., 2003).

Sonuç olarak, heyelan izleme çalışmalarında uzaktan algılama yöntemleri ve İHA teknolojisi, geleneksel tekniklere kıyasla daha esnek, daha düşük maliyetli ve daha yüksek çözünürlüklü veri sağlama kapasitesine sahiptir. Bu teknolojiler, heyelan alanlarının detaylı analizine ve tekrarlayan izlemelere olanak tanıyarak, doğal afetlerin etkilerinin daha etkili bir şekilde yönetilmesine katkıda bulunmaktadır (Schlögel ve diğ., 2015; Chae ve diğ., 2017). Heyelan yer çekimi etkisiyle zeminin veya kayaçların yamaç boyunca aşağı doğru hareket ettiği doğal bir olaydır ve jeolojik, meteorolojik ve insan faaliyetlerine bağlı olarak meydana gelebilir. Jeolojik faktörler arasında kaya yapısı ve zemin özellikleri, meteorolojik faktörler arasında ise yoğun yağışlar ve kar erimeleri öne çıkmaktadır; ayrıca ormansızlaşma ve yapılaşma gibi insan faaliyetleri de heyelan riskini artırabilir. Geleneksel heyelan izleme ve haritalama yöntemleri, saha çalışmaları, topografik haritalar ve uydu görüntülemeleri gibi teknikleri içerir. Bu yöntemler, güvenilir veri sağlamalarına rağmen, geniş alanların sürekli izlenmesinde ve yüksek çözünürlüklü veri elde edilmesinde kısıtlı kalabilmektedir. Son yıllarda insansız hava araçları (İHA) heyelan izleme ve analizinde önemli bir araç haline gelmiştir. İHA'lar, özellikle ulaşılması zor alanlarda yüksek çözünürlüklü ve detaylı veri toplama imkânı sunmakta, aynı zamanda maliyet etkinliği ve hız açısından da avantaj sağlamaktadır. Bu teknoloji, heyelan alanlarının hızlı bir şekilde haritalanmasını ve dinamik süreçlerin izlenmesini mümkün kılmakta, geleneksel yöntemlere kıyasla daha esnek ve verimli bir alternatif sunmaktadır.

2. İHA TEKNOLOJİSİ VE EKİPMANLARI

İnsansız Hava Araçları (İHA) teknolojisi, özellikle son yıllarda heyelan izleme çalışmalarında önemli bir ilerleme kaydetmiştir. Geleneksel yöntemlerle geniş alanların sürekli ve detaylı bir şekilde izlenmesi zorlu ve maliyetli olabilirken, İHA'lar sayesinde bu zorlukların üstesinden gelmek mümkün olmuştur. Özellikle jeolojik tehlikelerin zamanında ve etkili bir şekilde tespit edilmesi, toplulukların güvenliği açısından kritik öneme sahiptir. İHA'lar, yüksek çözünürlüklü verilerin hızlı ve etkin bir şekilde toplanmasını sağlayarak, heyelan izleme ve analizinde geleneksel yöntemlerin sınırlamalarını aşan bir teknoloji olarak öne çıkmaktadır.

İHA teknolojisi, heyelan izleme çalışmalarında devrim niteliğinde yenilikler getirmiştir. Farklı tipte İHA'lar, operasyonel gereksinimlere göre seçilerek çeşitli görevlerde kullanılmaktadır. Sabit kanatlı İHA'lar geniş alanları hızlıca tarayabilirken, döner kanatlı (multi-rotor) İHA'lar dar ve ulaşılması zor bölgelerde yüksek manevra kabiliyeti sunar (Giordan ve diğ., 2017). Hibrit İHA'lar ise her iki teknolojinin avantajlarını birleştirerek esnek çözümler sunar.

Bu araçlar üzerine yerleştirilen sensörler de oldukça çeşitlidir. RGB kameralar temel görüntüleme sağlarken, multispektral kameralar ve LiDAR gibi ileri düzey sensörler, topoğrafik değişikliklerin ve arazi deformasyonlarının yüksek doğrulukla izlenmesine olanak tanır (Westoby ve diğ., 2012). Özellikle LiDAR, arazi yüzeyinin ayrıntılı üç boyutlu modellerinin oluşturulmasında önemli bir rol oynamaktadır, ancak maliyetli ve sınırlı erişime sahip olması nedeniyle her durumda tercih edilmemektedir (Martha ve diğ., 2010).

Bunun yanı sıra, termal sensörler yüzey sıcaklıklarını ölçerek, heyelan riskini etkileyen nemlilik ve sıcaklık değişikliklerinin izlenmesinde kritik bir veri kaynağı sağlar.

İHA'lar ile elde edilen bu sensör verileri, fotogrametri ve nokta bulutu üretimi gibi tekniklerle işlenerek yüksek çözünürlüklü haritalar oluşturulabilmekte, bu da heyelan hareketlerinin detaylı analizini mümkün kılmaktadır (Schlögel ve diğ., 2015).

İHA'lar sayesinde geleneksel yöntemlere kıyasla daha hızlı ve daha hassas veri toplama imkânı doğmuştur. Bu teknoloji, özellikle zor erişilen heyelan alanlarının sürekli izlenmesi için düşük maliyetli ve yüksek verimlilik sunan bir çözüm olarak öne çıkmaktadır (Belardinelli ve diğ., 2003).

Sonuç olarak, İHA'lar ve bunlara entegre edilen gelişmiş sensör sistemleri, heyelan izleme ve analiz süreçlerinde yeni bir dönemi başlatmıştır. Teknolojinin sağladığı hız, doğruluk ve esneklik, heyelan kaynaklı risklerin etkin bir şekilde yönetilmesine büyük katkı sunmaktadır. İHA'ların sağladığı yüksek çözünürlüklü veriler ve dinamik izleme yetenekleri, jeolojik olayların daha iyi anlaşılmasını ve bu olaylara karşı daha etkili önlemler alınmasını mümkün kılmaktadır. Gelişen İHA teknolojileri, heyelan izleme ve diğer doğal afet analizleri için gelecekte daha geniş bir uygulama alanı bulacaktır.

3. HEYELAN ANALİZİNDE İHA UYGULAMALARI

İHA'lar, heyelan izleme ve analizinde dünya genelinde birçok başarılı uygulamada kullanılmaktadır ve bu teknoloji giderek daha yaygın hale gelmektedir. İHA'ların en büyük avantajlarından biri, heyelan sonrası bölgelerde detaylı görüntüleme ve veri toplama kabiliyetidir. Yüksek çözünürlüklü görüntüler ve sensör verileri sayesinde topografik değişiklikler ve yüzey deformasyonları yüksek hassasiyetle izlenebilmekte, üç boyutlu modelleme ile heyelan süreçlerinin dinamikleri daha net anlaşılmaktadır (Giordan ve diğ., 2017). Özellikle İHA'larla elde edilen veriler, Coğrafi Bilgi Sistemleri (GIS) ile entegre edilerek oluşturulan risk haritaları sayesinde gelecekteki heyelan risklerini tahmin etmek ve afet yönetimi çalışmalarında önemli kararlar almak için kullanılmaktadır (Schlögel ve diğ., 2015).

İHA’lar, heyelan öncesi ve sonrası hacim hesaplamaları yaparak, kaybolan veya hareket eden toprak miktarını tespit etme imkânı sunmaktadır. Bu teknoloji, topografyanın hassas bir şekilde izlenmesini sağlarken, heyelan alanlarındaki yüzey hareketlerinin sürekli olarak kontrol edilmesine ve bu sayede hem önleyici hem de zarar azaltıcı önlemlerin zamanında alınmasına olanak tanır. İHA'ların veri toplama kapasitesi, geleneksel yöntemlere kıyasla çok daha zaman verimli ve yüksek doğrulukta sonuçlar üretmektedir (Westoby ve diğ., 2012). Özellikle zor ve tehlikeli arazilerde, İHA'ların sunduğu hızlı ve etkili veri toplama avantajı, jeolojik olayların izlenmesinde devrim niteliğinde bir ilerleme sağlamıştır.

Sonuç olarak, İHA’ların heyelan analizindeki uygulamaları, veri toplama ve analiz süreçlerinde sağladığı hız, doğruluk ve esneklikle bu alanda vazgeçilmez bir teknoloji haline gelmiştir. İHA'lar, heyelanların daha iyi anlaşılmasını, risk haritalarının oluşturulmasını ve afet yönetim stratejilerinin geliştirilmesini sağlayarak hem araştırmacılar hem de karar vericiler için büyük bir potansiyel sunmaktadır. Gelecekte İHA teknolojisinin daha da gelişmesiyle, heyelan izleme ve diğer jeolojik olayların analizinde daha geniş uygulama alanları bulacağı öngörülmektedir.

4. İHA TABANLI HEYELAN ANALİZİNİN AVANTAJLARI VE KISITLAMALARI

İHA tabanlı heyelan analizi, geniş alanlarda yüksek çözünürlükte veri toplama yeteneği sayesinde önemli avantajlar sunmaktadır. İHA'lar, hızlı veri toplama kapasiteleri ve düşük maliyetli çözümleri ile zorlu arazilerde erişim sorununu ortadan kaldırarak, geleneksel yöntemlere kıyasla daha etkin bir seçenek olarak öne çıkmaktadır. Özellikle büyük çaplı heyelanların izlenmesinde, İHA'larla elde edilen yüksek çözünürlüklü görüntüler ve üç boyutlu haritalar, topografik değişikliklerin hassas bir şekilde analiz edilmesine olanak tanımaktadır (Ghorbanzadeh ve diğ., 2019). Bu, heyelan dinamiklerinin zaman içinde nasıl değiştiğini izlemek ve gelecekteki heyelanları daha iyi tahmin etmek için kritik bir veri kaynağı sağlar (Niethammer ve diğ., 2012).

Bununla birlikte, İHA'ların kullanımında bazı operasyonel sınırlamalar da bulunmaktadır. Özellikle olumsuz hava koşulları, İHA'ların uçuş güvenliğini tehlikeye atabilir ve veri toplama süreçlerini kesintiye uğratabilir. Rüzgâr ve yağmur gibi faktörler hem uçuşları zorlaştırmakta hem de veri kalitesini olumsuz etkileyebilmektedir. Ayrıca, İHA'larla toplanan büyük veri setlerinin işlenmesi, yüksek kapasiteli donanım ve yazılım gerektirebilir, bu da analiz süreçlerini yavaşlatabilir (Javernick ve diğ., 2014). İHA sensörlerinin ve ekipmanlarının yüksek maliyeti, küçük ölçekli projelerde bütçe sınırlamalarına neden olabilir. Ancak, teknoloji geliştikçe bu kısıtlamaların giderek azaldığı görülmektedir. Yapay zekâ destekli otonom uçuş sistemleri ve gelişmiş sensör teknolojileri, İHA'ların kullanımını daha da yaygınlaştırmakta ve verimliliği artırmaktadır.

Sonuç olarak, İHA tabanlı heyelan analizleri, heyelan izleme çalışmalarında sunduğu hız ve hassasiyet avantajlarıyla dikkat çekmektedir. Bununla birlikte, bazı kısıtlamaları olsa da İHA teknolojisi sürekli gelişen bir alandır ve yapay zekâ, otonom uçuş ve daha gelişmiş sensörler gibi yeniliklerle bu kısıtlamalar giderek azalacaktır. Gelecekte İHA'ların heyelan izleme ve analizinde daha geniş uygulama alanları bulacağı ve bu teknolojinin afet yönetimi stratejilerinde merkezi bir rol oynayacağı öngörülmektedir.

5. SONUÇ

Sonuç olarak, İHA teknolojisinin heyelan izleme ve analizinde sağladığı avantajlar, bu alanda geleneksel yöntemlerin sınırlarını aşan bir çözüm sunmaktadır. Yüksek çözünürlüklü görüntüleme, hızlı veri toplama, maliyet etkinliği ve zor erişilen bölgelerde kullanım kolaylığı gibi özellikleri sayesinde İHA'lar, heyelan risk yönetimi ve afet öncesi/sonrası değerlendirmelerde önemli bir araç haline gelmiştir. İHA verileri ile yapılan detaylı analizler, topografik değişikliklerin hassas bir şekilde izlenmesine ve gelecekteki heyelan olaylarının öngörülmesine katkı sağlamaktadır. Bununla birlikte, hava koşulları ve veri işleme gereksinimleri gibi bazı kısıtlamalar devam etse de, teknolojideki ilerlemeler bu zorlukları giderek azaltmakta ve İHA'ların heyelan izleme alanındaki kullanım potansiyelini artırmaktadır. Sonuç olarak, İHA tabanlı heyelan izleme ve analizinin, gelecekte afet yönetimi, şehir planlama ve jeolojik risk değerlendirmelerinde daha yaygın ve etkili bir şekilde kullanılacağı öngörülmektedir.

KAYNAKÇA

Belardinelli, M. E., Sandri, L., & Baldi, P. (2003). The major event of the 1997 Umbria-Marche (Italy) sequence: What could we learn from DInSAR and GPS data? Geophysical Journal International, 153(1), 242–252.

Chae, B.-G., Park, H.-J., Catani, F., Simoni, A., & Berti, M. (2017). Landslide prediction, monitoring and early warning: A concise review of state-of-the-art. Geosciences Journal, 21, 1033–1070.

Ghorbanzadeh, O., Meena, S. R., Blaschke, T., & Aryal, J. (2019). UAV-based slope failure detection using deep-learning convolutional neural networks. Remote Sensing, 11(17), 2046.

Giordan, D., Hayakawa, Y., Nex, F., Remondino, F., & Tarolli, P. (2017). Review article: The use of remotely piloted aircraft systems (RPAS) for natural hazards monitoring and management. Natural Hazards and Earth System Sciences Discussions, 17, 1–26. https://doi.org/10.5194/nhess-2017-339

Hussain, Y., Schlogel, R., Innocenti, A., Hamza, O., Iannucci, R., Martino, S., & Havenith, H. B. (2022). Review on the geophysical and UAV-based methods applied to landslides. Remote Sensing, 14(4564).

Javernick, L., Brasington, J., & Caruso, B. (2014). Modeling the topography of shallow braided rivers using structure-from-motion photogrammetry. Geomorphology, 213, 166–182.

Martha, T. R., Kerle, N., Jetten, V., van Westen, C. J., & Kumar, K. V. (2010). Landslide volumetric analysis using Cartosat-1-derived DEMs. IEEE Geoscience and Remote Sensing Letters, 7(4), 582–586.

Niebergall, S., Loew, A., & Mauser, W. (2007). Object-orientated analysis of very high-resolution QuickBird data for mega city research in Delphi/India. In Proceedings of the Urban Remote Sensing Joint Event (pp. 1-8). Paris, IEEE. https://doi.org/10.1109/URS.2007.4435259

Niethammer, U., James, M. R., Rothmund, S., Travelletti, J., & Joswig, M. (2012). UAV-based remote sensing of the Super-Sauze landslide: Evaluation and results. Engineering Geology, 128, 2–11.

Schlögel, R., Doubre, C., Malet, J.-P., & Masson, F. (2015). Landslide deformation monitoring with ALOS/PALSAR imagery: A D-InSAR geomorphological interpretation method. Geomorphology, 231, 314–330.

Westoby, M. J., Brasington, J., Glasser, N. F., Hambrey, M. J., & Reynolds, J. M. (2012). Structure-from-motion photogrammetry: A low-cost, effective tool for geoscience applications. Geomorphology, 179, 300–314.

HARİTA MÜHENDİSLİĞİ

yaz

yayınları

YAZ Yayınları
M.İhtisas OSB Mah. 4A Cad. No:3/3
İscehisar / AFYONKARAHİSAR
Tel : (0 531) 880 92 99
yazyayinlari@gmail.com • www.yazyayinlari.com