REMOTE SENSING APPLIED TO THE DELIMITATION OF HISTORICAL CENTERS

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ABSTRACT

Purpose: This paper aims to propose the delimitation of the historic center of Feira de Santana from the identification of the initial urban fabric, since some of the old hovels were demolished and others had their facades altered.

Theoretical framework: with a theoretical framework I tried to approximate geoprocessing practices with studies of historic centers. Since no work was found that studied historic centers from these remote sensing techniques.

Method/design/approach: To identify the historic center, georeferencing of historic map was used as a function of the SPOT 05 image, then object-oriented (OBIA) classification was applied, since the spectral responses of old roofs differ from the roofs of newer buildings.

Results and conclusion: The statistical performance of the classifier was excellent, in addition to the high spatial correlation with the historical map, based on this, it was possible to propose the delimitation of the polygonal of the historical center of the Feirense municipality, not only based on the visual interpretation, but also on the statistical parameters.

Research implications: This work does not seek to exhaust the discussions regarding this historic center, but to suggest the first delimitation polygon for the municipality of Feira de Santana.

Originality/value: It is intended to propose a new technique for delimiting historic centers, emphasizing that this method is not valid for all municipalities, but for those that have sociocultural characteristics similar to Feira de Santana.

Keywords: Feira de Santana, Remote Sensing, Image classification, OBIA.

SENSORIAMENTO REMOTO APLICADO A DELIMITAÇÃO DE CENTROS HISTÓRICOS

RESUMO

Objetivos: Este artigo tem como objetivo propor a delimitação do centro histórico de Feira de Santana a partir da identificação do tecido urbano inicial, uma vez que alguns dos casebres antigos foram demolidos e outros tiveram suas fachadas alteradas.

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Referencial Teórico: com referencial teórico tentei aproximar as práticas de geoprocessamento com os estudos de centros históricos. Visto que não foi encontrado trabalhos que estudavam os centros históricos a partir dessas técnicas do sensoriamento remoto.

Método: Para identificar o centro histórico, foi utilizado georreferenciamento de um mapa histórico em função da imagem SPOT 05, em seguida aplicou-se a classificação orientada a objeto, já que as respostas espectrais dos telhados antigos diferem dos telhados das construções mais novas.

Resultados e Conclusões: O desempenho estatístico do classificador foi excelente, além da alta correlação espacial com o mapa histórico, com base nisso, foi possível propor a delimitação da poligonal do centro histórico do município feirense, não apenas baseado na interpretação visual, mas também nos parâmetros estatísticos.

Implicações da Pesquisa: Não se busca com esse trabalho esgotar as discussões no que se refere a este centro histórico, mas sugerir a primeira poligonal de delimitação para o município de Feira de Santana.

Originalidade/valor: Pretende-se propor uma nova técnica de delimitação de centros históricos, ressaltando-se que este método não é válido para todos os municípios, mas para aqueles que tenham características socioculturais semelhantes a Feira de Santana.

Palavras-chave: Feira de Santana, Sensoriamento Remoto, Classificação de imagens, OBIA.

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1 INTRODUCTION

Various works have been emerging within historical cartography, a relatively new area in the field of cartography. With the help of Geoprocessing, historical cartography became indispensable for reconstructing historical facts in a given territory with the due help of georeferencing. However, the historical cartography's look at the past is difficult to manipulate, as there is a variety of distortion from cartographic projections or inadequate accuracy. Thus, only with corrections and adaptations such as the use of computational algorithms is it possible to rewrite history with better cartographic accuracy. Within this context, the municipality of Feira de Santana whose historical cartography is scarce, the geo-referencing of the ancient cartographic base together with the use of object-oriented classification becomes indispensable to build the ancient cartographic bases of the municipality, helping to look at the history of the city, in particular the historical municipal architecture.

To know the history of the municipality is fundamental for the construction of its identity, although the municipal history is well founded, to the spatialization of it is scarce. In this context, geo-referencing ancient maps to visualize the development of the urban fabric becomes fundamental to identify the historical municipal center. However, only the old cartographic base is ineffective for mapping the original urban fabric, in this sense the record of this map overlapping the satellite image SPOT 05 panchromatic bands with spatial resolution of 1.5m becomes fundamental.

So, in the face of various adversities arises the question, is it possible to map historical centers using satellite images? Mapping historical centers from orbital images is not an easy task, since there is a dialectical relationship between culture and real estate speculations, which often economic power stands out over cultural agents, implying mischaracterization, mainly of the facades. It is soon necessary to know the region (fieldwork besides rescuing old maps) so this article stands out in the promotion of the methodological proposal for this type of mapping.
Since it uses the complex relationship between historical maps, modern geo-referencing techniques and robust algorithms for identifying spatial patterns.

Shortly afterwards, the objective was to map out the historical center of Feira de Santana, from the identification of the urban fabric that originated the city. In order to carry out this mapping it was necessary to register the plan of the municipality dated 1878 as a function of the satellite image, then the process of photo interpretation, segmentation and classification of the image was carried out. The result was satisfactory and it was possible to identify the original nucleus of the urban fabric.

The municipality of Feira de Santana is located in the interior of Bahia, approximately 105 km from the capital, with an estimated population of 650,000 inhabitants, according to data (IBGE, 2020), has a transition climate between wet coast and dry interior.

![Location Map of Feira de Santana Center](image)

**Figure 1** Location Map of Feira de Santana Center, according to the splitting of neighborhoods of the Municipal Planning Bureau

### 2 THEORETICAL FRAME

#### 2.1 Historic Center

Cities are a social product that are physically built and culturally built, in a continuous process of intertemporal transformation. Considering the city from small urban agglomerations (small settlements) of antiquities to the current global metropolises, they have always concentrated the social functions (economic, civic, commercial), constituting legacy of past societies and space substrate for future generations, therefore space of constant transformations. For Barata e Salgueiro (2005), the historical centers are more than "the oldest parts of the city" are marks of the urban landscape that materialize various eras, monuments that bring us alive the past, in the temporal dimension with sequences of facts that structure identities.

The historic center can be considered the oldest area of the city that has progressively become the center of the modern city, usually coinciding with the core of origin of agglomerations where other urban centers irradiated, thus conferring this zone an intrinsic characteristic delimiting in the set of conservation and valorization rules (Dgotdu, 2005).
Historical centers are not linear, that in smaller cities it is easy to identify when it expands little, modern development is peripheral, this identification becomes more complex in large cities that have suffered multiple historical periods, and where the urban ordinances of the nineteenth century can be legitimately considered as historical (Cavém, 2007). The historical center, corresponds to an area in which the functions overlap with the place where the activities seen as particularly important are carried out, those that are located at a higher hierarchical level extrapolating the symbolic being par excellence, that of the history of collective memory (Rémy & Voyé, 2004). This symbolism of the historical areas is justified by the fact that the pre-industrial cities have a much greater value, higher than what was built later, materializing in a smaller part of the global heritage, being preponderant not only as support of everything else, as a sign of identification of the places and references of the collective imagination, but also as a cluster of cultural goods (Benévolo, 1995).

In the historical centers are found times relative to the importance of the city center, such as larger cafes, shops, theaters, cinemas that confirmed the term "center" in the full sense of the word, in its various dimensions, since it is endowed with geographical and economic centrality (Barata e Salgueiro, 2005). Historic centers are still today as identifiable urban spaces of high representative quality, with several emblematic elements (Bohigas, 1999) being the city as such, with all its attributes recognizes in the center the name, identity, representation, monuments, collective integration and urban quality (Bohigas, 1998) guiding the fundamental axis of its safeguarding and valorization. Therefore, the need to preserve the old historical centers of the cities is unquestionable, since defending and valuing the rugosities of the urban historical landscape represents an imperative for contemporary societies and a challenge for the territories (Henriques, 2003), besides, these areas appear as privileged places, making it possible to raise the land values and reintroduce it in a speculative process of urban production (Barata e Salgueiro, 1999).

### 2.2 Historic Center of Feira de Santana

The human occupation in the region where the city of Feira de Santana is located goes back to the first governor general of Brazil, Tomé de Souza, who, upon arriving in the state of Bahia, donated the land to the Portuguese known as Dias D'Ávila, the latter being a great rancher. With this, the need arises for the movement of cattle from the interior towards the coast of Bahia, arising the expansion of cattle raising in the interior of the State of Bahia (Guimarães, 19??). The cattle journeys towards the coast took several days causing tiredness, obliging the cowboys to make several stops. These were carried out in areas with high availability of water, a region with several lagoons providing the necessary water availability for livestock and for human consumption.

However, effective colonization of the region only occurred in the eighteenth century since the area was already full of ranches and cattle raising (Figure 02 A). However, the city developed about 14 km south of the church of São José, by the Portuguese couple Domingos Barbosa de Araújo and Ana Brandoa (Figure 2 B), who installed in their farm a small chapel intended for Lady Santana. Surrounding this chapel is a free fair offered by the parade that travelers held in the region, with this, were built senzalas, houses establishing a small settlement, which continued to grow leading in the year 1833 the elevation of the category of village to the city of Feira de Santana (Guimarães, 19??).

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5 The year of its publication is not in the consulted book. According to the reference adopted by the Library Julieta Carteado - Universidade Estadual de Feira de Santana, the sign ?? must be used twice in a row.
Figure 2 A and B. In A the big house that originated Feira de Santana, old photos and after restoration. In the image B the Cathedral of Santana, before the construction of the tower and post construction of the towers, as well as the reform of the same.

Source: A SECOM; B André Pomponé (2016) adapted.

One can understand the emergence of the municipality of Feira de Santana based on the duet (Environmental and Economic): environmental, due to the availability of water, highlighting the lagoons, which provided water to travelers who made their stops in this region. Economic in that it was the internalization of the cattle that obliged the traders to carry out large journeys in order to be able to negotiate the cattle. The emergence of the free market as a
determining factor for the establishment of the town that later gave rise to the city of Feira de Santana. In this sense, the streets that arise around the main church (Figure 3), are based on the emergence and strengthening of local commerce acquiring the character of urban centrality.

![Figure 3](image)

**Figure 3.** First streets of Feira de Santana highlight the square of the matrix, right street, and some buildings of the original urban fabric. Images captured between the late 19th and early 20th centuries. **Source:** authors' personal collection

At present, this center is not being respected for its historical and architectural character, several houses are being demolished to become "modern" parking lots or buildings, besides, many buildings without maintenance have their facades modified by disproportionate advertising signs (Figure 4).
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Figure 4. First streets of the city of Feira de Santana, currently located around the square of the Matrix (Church of Our Lady Santana), the presence of the renovated building, the Center of Culture and Art - CUCA is an exception to the rule, because the other buildings are quite modified.
Source: Authors’ personal archive.

2.3 Visual Interpretation of Satellite Images (Photointerpretation)

Remote Sensing is the technology that allows the sensing of the Earth's surface in a remote way, which allows the imaging of the Earth's surface (Aragão, Pereira, Silva, 2022). Among the various types of possible sensors for the identification of patterns on the surface, we can highlight the satellites.

Photointerpretation is the identification of spatial objects or patterns in photographs or images from other sensors, i.e. remote sensors, with the aim of understanding their meaning. Marchetti & (Garcia, 1986) define photointerpretation as the art of examining the images of objects in photographs and of deducing meaning. However, (Walf apud Loch, 1993) defines photointerpretation as the act of examining and identifying objects (or situations) in aerial photographs (or other sensors) and thus determining their meaning. (Loch, 1993) also states that photointerpretation can be understood as predictability of what can be seen in an image. (Summerson apud Loch, 1993) this can be explained when one cannot characterize an object directly in the image, needing to rely on known data, to extract or deduce what represents the object in question, so knowledge of the surface represented in the photographs or images is fundamental for the photointerpreter.

The visual interpretation, as the name suggests, the interpreter extracts from the image what interests him most. At the moment that one analyzes a photo or satellite image, the interpretation may be precise or not, complete or partial. These variables are modified according to the interpreter, the purpose of the work or the quality of the available photos (Loch, 1993).

In the process of photointerpretation some elements can facilitate this process, however should always consider acuity of the photointerpreter that second (Loch, 1993) "Visual acuity is the ability of the individual to separate the identifiable details in the visible objects, a fact that depends on the resolution power of the eye." To facilitate interpretation, the use of some keys is necessary (Lillesand, 2004). The key to photointerpretation is the use of a guide that will help photointerpreters quickly identify characteristics of the image. (Marchetti, 1986).
These keys are based on the description, typical illustrations of objects of a certain category. For the interpretation of the natural characteristics, training and fieldwork is essential, so that the researcher can produce consistent work (Marchetti, 1986).

When the photointerpreter is familiar with the observed space will facilitate the interpretation of the form, second (Loch, 1993) consists of the individual configuration (shape) of the object in the image (Lillesand, 2004). In photointerpretation, some precautions should be taken by the researcher as: shadow, a consequence of the form that the object in question is being represented, at the moment that the photo was taken (or the moment of the imagining of the satellite) thus revealing the spectral position (Loch, 1993). The size of the element represented in a photograph or satellite image depends on the scale of the photo and not only on the size of the object (Loch, 1993; Lillesand, 2004). Aerial image density refers to the number of objects (pictorial elements), dimensional or not, represented per unit area (and in a UTM system will be metric) (Loch, 1993).

2.4 Object Oriented Classification

Object-oriented classification is a recent, historical technology in which spatial information (texture and correlation context) is used in addition to spectral information to classify data (spatial objects) (Bhaskaran, Paramananda, Ramnarayan, 2010). This method is useful for extracting and mapping resources from high spatial resolution images. Object-oriented classification is guided by an understanding of the object image, i.e. spatial objects rather than pixels (Bhaskaran, Paramananda, Ramnarayan, 2010).

An image object is pictorially represented as a homogeneous group of pixels/regions that have similar spectral and/or spatial characteristics and not just a specific pixel. They form pictorial blocks consisting of abstract information that can be used in different images and object levels (Bhaskaran, Paramananda, Ramnarayan, 2010). Imaging objects can be extracted using different segmentation parameters related to homogeneity (weights, similarities and areas) criteria adopted by the multi-resolution segmentation algorithm, and correlating as a homogeneous or heterogeneous image, object and within itself (Hofmann, 2001). Both spectral and heterogeneous heterogeneity based on pictorial parameters arising from color photointerpretation, were defined by users and thus could control the scale parameter to define acceptable level of heterogeneity, with a larger scale parameter resulting in larger objects (Benz, Hofmann, Willhauck, Lingenfelder, & Heynen, 2004).

Traditionally, the classification of digital images is focused on spectral signatures, i.e. pixel values. From this perspective, the object-oriented classification is not focused on isolated pixels, but on entire objects, in which the content of the satellite images is divided, that is, the identification of a completely homogeneous area, which is representing each class of use and occupation for determining its area (Coelho, Junior, Fonseca, 2022). Thus, it extrapolates the spectral signature by also analyzing the shape created by the pixels and the relationships between these objects (landscape elements), simulating the visual interpretation of the texture diversities of the image can also be taken into account in this analysis (Leminski E Zaremski, 2004).

(Durkin, 1996) states that object-oriented classification performs analysis on the objects or segments in the image and not just on the pixel, so an object represents an element that can be individualized, with its own attributes and the same properties as the original classes.

Thus, as in photointerpretation, the semantic information needed to interpret an image is not represented in a single pixel, but in significant image objects. For example, the number of trees can form a cluster, and a large cluster of trees can then be classified as a forest (Benz, Hofmann, Willhauck, Lingenfelder, & Heynen, 2004). Besides the spectral attributes, the spatial objects of the image carry shape, texture and a whole set of relational or contextual aspects of information, that is, pictorial elements (Gitas, Mitri, & Ventura, 2004).
In urban mapping, two sets of roofs may be spectrally similar, but their respective uses may not be identified by a spectral approach alone (Benz, Hofmann, Willhauck, Lingenfelder, and Heynen, 2004). However, using spatial attributes such as: area, shape, pattern and other elements of spatial visualization, the roof type can be categorized into residential, industrial or commercial building (Benz, Hofmann, Willhauck, Lingenfelder, & Heynen, 2004). In addition, another advantage of sorting objects in the image relative to pixels is their higher signal-to-noise ratio, which leads to a robust sorting. Therefore, the object-oriented approach takes into account form, texture, and spectral information, one of the fundamental steps in object-oriented classification is image segmentation (Benz, Hofmann, Willhauck, Lingenfelder, & Heynen, 2004).

The semantic information present in the objects of the image is therefore absent in an approach in which pixels are assigned to a class taking into account only their spectral capacity of affiliation to one class or others (Casals-Carrasco et al., 2000). Pixel classification is therefore limited in its ability to model spatial relationships as proven by studies by (Zhou and Robson, 2001), (Dean and Smith, 2003), (Pizzolato and Haertel, 2003), found that non-spectral indices, such as texture information, were necessary to obtain accuracy in classifying remote sensing data.

3 METHOD

Urban fabric plant of Feira de Santana year 1878 tif format, Image SPOT 07 of 2014 (Fusion of panchromatic bands with NIR band tif format) computer Icore 07. QuantumGIS, SPRING 5.6. For the construction of the map of the historic center of Feira de Santana, a series of technical and statistical procedures was needed that can be summarized in figure 5.

Figure 5 Procedural steps to identify the historic center of Feira de Santana, delimitation of the historical center, is closely linked to object-oriented classification and field work to validate the segmentation.

Source: Authors.

3.1 Registration of the Plant

Georeferencing or recording of an image is a set of metric operations that modifies or alters its geometry in order to adjust it to a coordinate system considered as a reference (Phillips and Swain, 1998). This procedure can be performed by a polynomial equation,
whose coefficients are calculated from the control points. These points must be identifiable, both in the base image and in the image to be adjusted, a uniform spatial distribution of these points must be sought (RICHARDS, 1986; MATHER, 1999). The accuracy of the control points must be verified, this is possible by increasing the number of degrees of freedom in determining these parameters. The projection system adopted was the WGS 84 zone 24 south, the same as the image SPOT 05, the polynomial function of degree 1 was adopted, applied to 6 control points and the values of RMS were 1.2, 0.9, 3.5, 0.89, 0.53, 2.25, generating a residual error of 1% (Figure 6). By geo-referencing the 1876 map as a function of the SPOT 05 image, it was possible to perceive that the map rationed around 90°, that is, although the spatial representations presented in the map were well designed, its suitability for a reference system was far removed from current technologies. However, when registering the image, the errors found were very small, for a map that was produced a long time ago.

Figure 6 Plan of the city of Feira de Santana in 1887, given in raster format without registration yet. Source: Authors' personal archive.

3.2 Vectorizing and Overlapping Layers

The vector data model consists of a structure of spatial representation by points, lines and polygons, with a primitive structure being the point, defined by a pair of geographic coordinates X and Y located in the reference system. Geometrically the line can be considered the set of interconnected points, and the polygon the structure bounded by connected lines such that the endpoint is coincident with the starting point (BORGES, 2002). Therefore, the vectorization allowed creating the polygons of some existing buildings in 1876, the existing courts, and the lines represented the first streets of Feira de Santana. The vectorization used in this work was carried out manually, this after the geo-referencing of the map of 1876 (figure 7A).

After geo-referencing and vectorization of the streets, blocks and buildings in 1876, it was possible to overlay these vector layers in the layer of the SPOT 05 satellite image (Figure 7B). The overlapping of layers is a tool made available in the Geographic Information Systems - GIS, which allows efficient manipulation of data of the raster format (satellite image) and vector data (vector generated from the map of 1876), making possible physical operations such as overlapping and storage, of the spatial representations as they point (HARRIS and BATTU,
The coincidence of the darker roofs in line with the vectors of old streets and buildings is observed, it was from this premise that spectral samples were collected for statistical analysis.

Figure 7 Presents the map of 1876, recorded. It is observed that it rotated around 90°. In B one observes the excellent quality of the design of the old map, the courts and streets were very much in line with the satellite image.

4 RESULTS AND DISCUSSIONS

4.1 Photointerpretation

According to Loch, (1993) photointerpretation is the act of examining and identifying objects (or situations) in aerial photographs (or other sensors) and thus determining their meaning. Photointerpretation can be understood as the predictability of what can be seen in a given image (LOCH, 1993). Knowledge of the surface represented in the photographs or images is of fundamental importance for the photointerpreter, therefore the fieldwork is indispensable. Some keys are used to facilitate interpretation (LILLESAND, 2004). The key to photo interpretation is the use of a guide that will help you quickly identify characteristics of the image. Marchetti (1986). In figure 8 it is possible to verify the texture and coloring of the roofs, where the older properties have darker coloration (figure 8B), in the central regions (figure 8A), west and east (figure 8C) the roofs are newer, this comes from the climatic processes that change the coloration of the same, so the longer the exposure to the darker climatic action.
4.2 Object-Oriented Classification of the Historic Center (Segmentation)

Segmentation is a statistical procedure that aims to reduce spatial information in the same homogeneous regions (objects). Conceptually, one can include the segmentation process as an object-oriented analysis procedure (OBIA), because it does not only consider the digital value of the pixel to be classified, but also of the pixels in its surroundings, looking for similarity and statistical evaluation of the grouping of these sets that allows the characterization of the features studied (PASSO, 2013). The first step of this process is to expose each pixel as a different region, then it is calculated similarity criterion for each region, to make grouping is calculated by testing statistical regions that averages between the regions.

After this step, the image is fragmented into a set of "various images" within the whole image, the union between these parts is realized according to the aggregation threshold defined by the user, before starting the segmentation process (OLIVEIRA et. al., 2007) this process is defined as similarity (of the pixels) area (aggregation of the same), so the more heterogeneous the image is the smaller the segments, obliging the researcher to choose with caution the criteria of similarity and area. Another point to be observed is that very different spectral responses of the same object investigated may indicate a variation, both in use and in time, of a given spatial element. In this context, two segmentations were tested: similarity 12 area 32 (figure 8A) and similarity 16 area 32 (figure 8B). The two segmentations were satisfactory, however, as the objective was to identify the roofs of the properties the segmentation 12-32 had better visual response so it was adopted for classification.

Figure 8 Example of the segmentation adopted in the border region between the old roofs and new roofs. You can see that the pixels are grouped together in a dark color, bordering on the reddish colored pixels.
Source: Authors.
In the analyzed image, to emphasize the difference in the spectral responses of the object roofs of the historical center and roofs of the newer residences, an analysis of descriptive statistics was carried out with the samples of the collected pixels (Table 1).

**Table 1** Statistical performance of pixel samples for historical center and neighborhoods

<table>
<thead>
<tr>
<th>Samples</th>
<th>Medium</th>
<th>Standard Deviation</th>
<th>Variance</th>
<th>Coefficient of variation</th>
<th>Variation of kurtoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic Center</td>
<td>0.939776</td>
<td>13.01473333</td>
<td>169.6486667</td>
<td>13.87413333</td>
<td>213.2076667</td>
</tr>
<tr>
<td>Neighborhoods</td>
<td>171.16366</td>
<td>453.3660</td>
<td>2 235 58 00</td>
<td>0.2669503</td>
<td>91.5618203</td>
</tr>
</tbody>
</table>

Source: SPOT image 5 Feira de Santana

It can be observed that, although it is representing the same spatial objects - roofs - to the spectral response referring to the region of the historical center have values very different in relation to the other roofs, this is evidenced in the variation of kurtosis, where the displacement of the normal statistical curve is very distant from each other. It should be noted that even with the presence of zinc roofs in the area of the historical center, which generates very high spectral values and whitish coloration, due to high albedo, which would imply much higher mean values, yet there is enormous dissonance for the same spatial objects, this can be evidenced in Figure 9 where the logarithmic scale graph of base 10 demonstrates how far spectrally the roofs of the historical center of the other roofs are, thus ratifying what was observed in the photointerpretation, subsidizing the object-oriented classification.

![Figure 9](image.png)

**Figure 9** Sample graph referring to the roofs of the historic center and of neighborhoods, on a logarithmic scale of base ten.

Source: SPOT image 5 of Feira de Santana

### 4.3 Classification

Classification is the extraction of information in images for the purpose of recognizing homogeneous patterns and objects. Classification methods are used to map areas that have the same meaning in satellite images (KÖRTING, 2006). The objective of the classification is to replace or assist visual analysis by the automatic identification of the scene's features, since the values of each pixel are grouped into approximate value classes. These groupings into standards of classes with similar responses involve the analysis of multispectral data and the application of statistical decision rule (PASSO, 2013).
Two methods of supervised classification are distinguished, with direct interference from the researcher and not supervised where there is a preponderance of statistical methods. The Isoseg, Batthacharya and ClaTex algorithms stand out as unsupervised classifiers, as they are classifiers by homogeneous regions based on their spectral signatures (KÖRTING, 2006). Based on this premise, the Batthacharya classifier was adopted as a classification algorithm.

Classification with Bhattacharya requires samples of some segments to train the classifier, then averages and covariance matrix according to classes, then each segment is allocated in one of these classes, second least distance (CORREIA et. al., 2007). Thus, the need arises to insert the threshold of acceptance, which is the maximum distance of Mahalanobis which the regions may be away from the center of the class for separation or grouping of it (BIRTH, 1998). The similarity segmentation 16 area 32 with acceptance threshold was classified at 75%, 90% and 99% figure 10A, 10B and 10C, respectively.

![Figure 10](image1.png)  
**Figure 10** Classification with different thresholds of acceptance, emphasizing the old center of Feira de Santana, the center of ferrese stands out by the dark coloring of the roofs, which makes it possible to determine the historical center.  
*Source: Authors.*

Classifier performance can be measured by confounding matrix, TAU index, average confounding and overall performance. In the confounding matrix (table 2) that relates the land use classes, no confusion between classes was identified, 13439 pixels were collected and approximately 40.93% were from the old roofs. On the other hand, in 33% of the new roofs and 25% of the pixels collected were from vegetation, no samples were collected from the zinc roofs, since it remained outside the classification. The average confusion and TAU index were 100%, therefore statistically the performance of the classifier was excellent. The Kappa coefficient (K) according to Cohen (1960) defined the coefficient as the agreement between the data of the classification and the field truth for nominal scales. Thus, it determines the expected agreement a posteriori, that is, the expected agreement can only be determined by the construction of the error matrix (BERNARDE et al. 2006). The Kappa coefficient of this work was 1 (one), according to the criteria proposed by Landis & Koch (1977) the classification was excellent the values K that vary between 0.8 and 1. Based on this, it was possible to propose the delimitation of the polygonal of the historic center of the municipality of Fehrense (Figure 11).
Table 02: Confusion matrix of collected samples, in percent. The excellent performance of the samples is observed where there was no confusion and no abstention of the samples.

<table>
<thead>
<tr>
<th>Classes Studied</th>
<th>Vegetation</th>
<th>New Roofs</th>
<th>Old roofs</th>
<th>Abstention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>25.32%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>New Roofs</td>
<td>0</td>
<td>33.75</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Old roofs</td>
<td>0</td>
<td>0</td>
<td>40.93</td>
<td>0</td>
</tr>
<tr>
<td>Abstention</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 11 - Proposal of the delimitation of the historic center of Feira de Santana, from the object-oriented classification of the image SPOT 05.

Source: Authors.

5 FINAL CONSIDERATIONS

Historical centers almost always coincide with the place of origin of the city, in Feira de Santana, is no different, following the logic of the other Brazilian municipalities the city is born next to the Catholic Church (matrix), in which the streets and cemetery are materialized around the church. In this context, arise the first streets of the municipality of Fairense where the street in the middle, street from above, the current streets Conselheiro Franco and street Marechal Deodoro arise around the church of Our Lady Santana. Thus, the initial streets guard the history materialized by architecture (the fixed ones according to Milton Santos) presented by the bands of houses, so preserving architecture means preserving an entire memory of way of life (flows of Milton Santos). It is worth pointing out that this preservation, for several cities besides redeeming the memory of the past, boosts tourism, moving commerce, generating employment and income, and in many cases this is the real reason for preservation.

The historical centers are usually transformed into shopping centers, as happened in Feira de Santana. This entails a priori three problems: property speculation leading to high values of buildings and land in this region; facade changes from old residences to commercial buildings - in Feira de Santana this fact is even more aggravating, since there are no laws that...
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protect historic landfills implying a "modernization" of the lanes with gigantic banners "hiding" the real banner of the buildings; the third problem generated is the need for internal movement from the neighborhoods to the shopping mall, where due to the serious deficiencies in public transport implies in the great use of private vehicles generating not only traffic jams, but in the demolition of historic buildings to generate parking lots (2) Thus, these sets of factors imply the complete de-characterization of the historical centers, in such a way that people no longer identify as the place of origin of the city, but as some place, without the feeling of belonging to the place. Feira de Santana is quite representative in terms of the total decharacterization of the historic center, to determine where the city was born without the support of geotechnologies is an arduous task, however, in this work was fundamental for the demarcation of the streets that started the city.

Going back to our initial question that guided the research, we found that it is possible to delimit historical centers using satellite images. This required field knowledge, medium-resolution (1.5 m) satellite images, old maps and robust algorithms for processing satellite images. However, some limitations should be considered in this methodological proposal: the algorithm recognizes spatial patterns, it is necessary that the roofs of the historic center have similar spectral responses, i.e. real estate speculation, changing only the facades and not the ceiling. Therefore, this method will not be useful if the majority of the roof has undergone renovation, with the replacement of the tiles, would imply spectral responses similar to newer areas of the city.

The evaluative indices for the classification were fundamental to support photointerpretation, the use of segmentation in conjunction with the object-oriented classification was indispensable in the aid of photointerpretation, and it was possible to propose a polygon for the perimeter of the historic center of Feira de Santana not only based on visual interpretation (photointerpretation), but also on statistical parameters. This work does not seek to exhaust the discussions with regard to this historical center, but to suggest the first polygon one for it, that is, the initial proposal to rescue the historical memory of the municipality of Feyrense.

Once we have identified the historic center of the municipality of Feira de Santana, we point out as future studies the need for use, photogrammetric restoration and increased reality for the virtual reconstruction of the facades of the buildings. With this working on two fronts of research: development of cutting-edge research, cartography and augmented reality in the other perspective consists in the preservation of the cultural memory of the historical center of the Femerse.

REFERENCES


