

Using High Resolution Satellite Images and GIS Tools to Count Palm Trees in Iraq- Mahmodia as a Case Study

Muthanna M. Abdulhameed Al Bayati¹

¹ Civil Engineering Department, University of Technology – Iraq, Baghdad, Iraq

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ABSTRACT

Introduction: Lorem In the 20th century, Iraq was one of the most sources of dates in the world, so the dates can be considered as one of the important products which affect the national economy.

The Ministry of Agriculture and the Ministry of Planning made annual statistical for strategic products, they find that the date production in decreasing in the period between 2004 until 2020, for that these ministries decide to make a national project to count palm trees to study the issue and find solutions.

Objectives: This paper as a pilot project to suggest different methodologies of palm trees counting using geomatics tools like very high-resolution satellite images and Geographic Information Systems, where these techniques suggested to reduce time, efforts and the budget of the project if we compare with the prices of field counting.

Methods: Two types of Satellite images used, Pleiades 50 cm and SPOT6 1.5 m resolution, two samples of palm groves were taken dense and sparse and two methods of office counting used manual by drawing points in GIS software and automatic techniques using ERDAS Object Extraction Counting, as well as field survey counting made as a reference for assessment.

Results: The results also showed that the accuracy of counting using 50 cm images reaches more than 90% for automated method and more than 95% in the case of manual counting, while the 1.5 m resolution images give us less accurate results ranging between 61% and 86% depends upon to the dense and sparse grove.

Conclusions: The study proved that we can used high resolution satellite images to count palm trees in both groves (dense and sparse), also if 0.50 m images were used, both counting methods (manual and automated) can be applied, while when using 1.5 m images only automated method applied.

Keywords: high Resolution, Palm Trees, Automatic counting, Dense and Sparse.

INTRODUCTION

The first known palm trees were found in Mesopotamia, particularly in Babylon and Aridu, which date back over 4,000 years BC. Date palms were prominent in this location. Many Sumerian inscriptions were found in these cities indicating the presence of palms in that area. [1].

Iraq was the largest suppliers of dates, making dates an important product for the country. The growth in output from 488 thousand tons in 1988 to 932 thousand tons in 2000 is noteworthy. Up until 2003, this value rose to become 790 thousand tons. In 2004, just 402 thousand tons of output were produced. The basic progressive growth in production continued in 2012, reaching 589 thousand tons. This output accounted for almost 63 percent of the total in 2000. [2] In Iraq, palm cultivation and date production have been hampered by a number of barriers and challenges that have persisted for over two decades. The number of palm trees has dropped, which encouraged the Ministry of Agriculture and the Ministry of Planning to conduct a statistics censuses to count palm trees, study the reasons of decreasing and find solutions. [3]

Due to the challenges of field surveying in general and the security situation in Iraq, new remote-sensing technologies detect high-quality and large-quantity forest data. [4]

Many research organizations and academics are now using remote sensing technologies in tree and forest statistics and other related applications due to technological advancements.

The significant progress made in the field of Earth-observing satellites over the last quarter-century, as well as the development in computers and software for interpreting satellite images, has aided the use of forest and tree monitoring practice and exploited by decision-makers. [5]

The methodology is evaluated in two scenarios: detect trees in urban areas automated counting in groves, with an accuracy more than 82 % for detection and more than 90 % for tree counting. [6]

Fabien Hubert Wagner and others [10] , Demonstrate a novel approach for the automated delineated crown tree based on extremely clear photos from the WorldView-2 satellite and apply it to a section of the Atlantic forest in Brazil by very varied canopy tropical cover of the forest of the Santa Genebra reserve. The method principally utilizes two techniques: mathematical morphological processes and rolling ball algorithm to strengthen crown boundaries and make tree crown extraction easier. By comparing the identified individual tree crowns ITCs with a sample of ITCs defined manually by eye judgment, crown detection is validated. With known species, they enhance the stability of species prediction using automatic and hand demarcated crowns. Our approach can detect up to 80% of ITCs, according to our findings.

Changlin Xiao , Rongjun Qin and Xu Huang [7], suggested a unique approach for detecting individual trees and delineating their crowns using multi-view satellite data. The "DSM" produced using high-resolution images and merging them spectrally to recognize the trees, as opposed to prior approaches that just used image information. They thoroughly analyze the detected trees in a one-to-one connection to properly measure the performance. A quantitative examination at three separate locations reveals that the suggested technique is capable of accurately detecting individual trees in diverse regions.

Priyakant Sinha and others [8] have been conducted several research to determine the primary issues that poor holder banana producers confront at various levels of the banana value chain, with a shortage of agricultural data policies being one of primary bottlenecks. The "World Bank's Living Standards Measurement Study – Integrated Surveys on Agriculture LSMS-ISA" began a systematic research approach intended at assessing the range of banana types at the individual household level throughout several significant Ugandan agricultural areas. Various methods were tested to attain this goal, involving ground-based assessments.

Eu Koon Cheang, Teik Koon Cheang and others [9], provided a deep learning method for enumerating and locating palms in high resolution satellite data in panchromatic mode ranged between (0.4 to 1.5) m/pixel. The classifier application trained on a set of satellite images to classify palms and no-palms photos via the moved windows approach. A uniform filter is used to smooth the resulting confidence map. The system achieves a tree count accuracy of over 99 percent.

Ramesh Kestur, Akanksha Angural, Bazila Bashir and others [10], highlighted the use and promise of low-altitude remote sensing in vegetation, particularly in low-scale farming. For remote sensing, two "UAVs" are employed. high resolution RGB aerial photos of several farms were acquired using LARS. The authors offer a method for detecting, delineating, and counting treetops in high spatial resolution "RGB" pictures using spectral-spatial categorization. Neural network classifier was used for supervised classification. ELM was created with RGB DN values from input features as vectors and binary system output classifying features to tree or non-tree feature.

A. Moradi, M.Satari, M. Momeni [11], suggested an approaches for extracting individual trees first detect tree top or bottom points before utilizing them as starting points in a segmentation process. As a result, the quantity and locations of observed peak points have a significant impact on the detection process in these approaches. As a result, the quantity and positions of identified peak points have a significant impact on the impact of the results of trees and plants in these systems. In this paper, a new technique for extracting single tree segments from "LiDAR data" with a 10cm point density is provided.

Eu Koon Cheang and others, [12], developed a supervised learning system and used the system for palm trees counting. Images from 0.4m to 1.5m resolution used by neural network classifier system to distinguish palm and no-palm trees. They able to achieve more than 99% accuracy.

OBJECTIVES

As stated in the introduction, Iraq has experienced a decrease in palm trees and palm dates since 2003, which is a strategic production. The production of palm dates was about million tons in 2000 while breakdown to the half amount after 15 years. Ministry of Agriculture wants to count palms, study locations, and purposes a solution to this issue.

The main aims of this study are using different geomatics techniques to count palms and check the accuracy of each one, and then suggest the methodology of palm counting, which makes the balance between accuracy, cost and, activity.

METHODS

Previous studies observed the use of satellite images in counting trees in general and palms in particular. Satellite image spatial resolution, software recognition capabilities, and palm tree crown characteristics are the three parameters that can be defined as the main benefits that help distinguishing palms from satellite images [13].

Applications designed to allow users to guide the automatic detection of trees from satellite imagery [14]. Automated trees counting is also used in Spain for olive trees counting based on image processing of satellite imagery [15].

To assess the effectiveness of using satellite imagery to count palm trees, this paper presents the results of a pilot study of palm trees counting in Iraq, by using the steps bellow:

- A. The study area was carefully selected as Al-Mahmoudiyah is one of the areas known for palm cultivation and producing good dates. It is also close to the capital, Baghdad, which facilitates field visits to the study area.

Al-Mahmoudiyah is located to the southeast of Baghdad. The area of interest selected carefully in a site rich in palm trees. 3 x 4 km AOI used located between the coordinates of:

UL ($44^{\circ}29'06''$, $33^{\circ}11'10''$), and LR (456000 , 3669000) = ($44^{\circ}31'41''$, $33^{\circ}09'3''$)

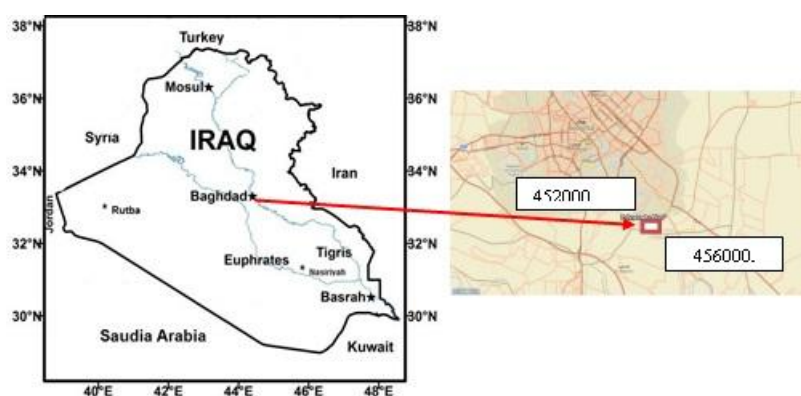


Fig 1. Study Area Location

- B. Preparing the data and tools required for this research, the following data and tools were used in this case study:

- 0,5 m resolution @ 20 /3/2017, from Pleiades Satellite.
- 1.5 m resolution @ 17 /5/ 2017, from SPOT Satellite.
- Satellite image Processing Software (ERDAS Imagine) and its extension Imagine Objective (ERDAS_Object_Extraction) used.

- GIS software, Geomedia Pro used.
- C. Palms counted manually and by applying machine-learning techniques on both satellite images.
- D. While the counting by satellite images and software manually or auto got different accuracy between the dense orchards from those sparse orchards, samples of both categories were randomly selected to check the results by field survey counting.
- E. To check and assess the counting of palms in the office by software, the real field survey required..
- F. Compare numbers of trees counted based on image data counting method using software in the office and field survey.
- G. For comparison purposes, the field survey palms counting are assumed the reference.

In this study, two computerized approaches were used to count palm trees as well as the field survey counting which assumed as the reference for checking the accuracy of those two.

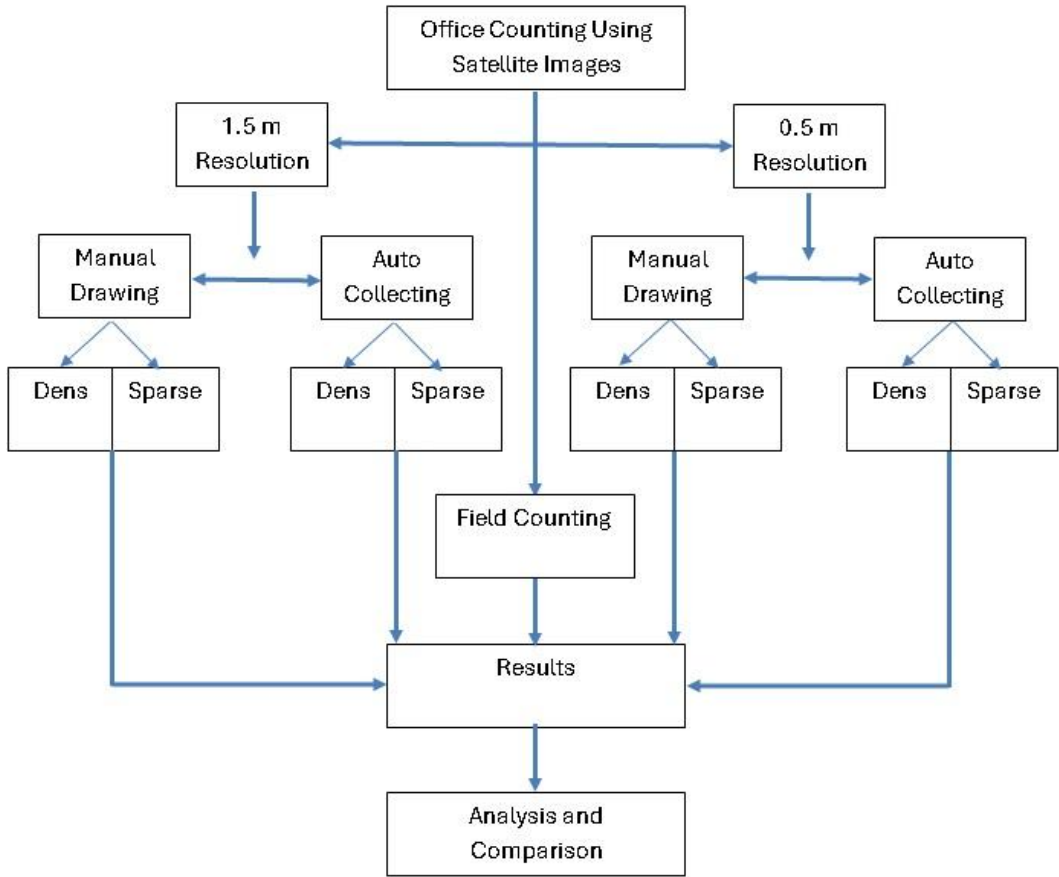


Fig 2. Experimental Workflow chart

1- Manual Counting

There is no doubt that the appearance of palm trees in a satellite image is distinctive, as they have a clear crown of palm fronds. It is also known that the larger the trees, the easier and more accurate the counting process. The palm trees were manually counted using GIS software, and each palm tree was represented by a dot above it. A problem has appeared, as this process was successful when 0.5 m resolution used, but it was nearly impossible with second type of images. Therefore, the manual counting was limited to the 0.5 m images.

The images with 1.5 m resolution were tested to determine the possibility of obtaining useful data when use machine learning application.

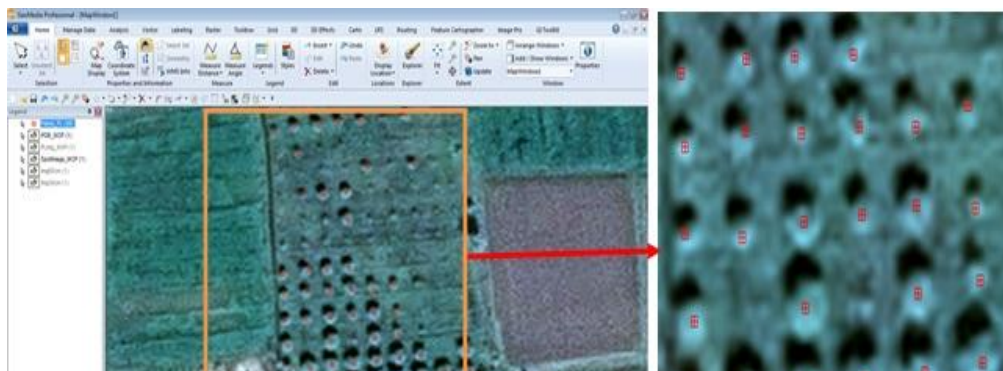


Fig 3. Manual Counting of palm trees using Geomedia Software

2- Machine Learning App.

ERDAS-Imagine and its extension Imagine Objective- (ERDAS Object Extraction) software for image processing, used as a Machine learning technique as in steps bellow:

- Identifying sample of palm trees.
- Generating templates then tested.
- Thresholds were adjusted.
- The results were performed.



Fig 4. Template Matching palm trees using ERDAS imagine & Imagine Objective

3- Field Survey

After the counting of palm trees in the office by two methods mentioned above, field survey counting undertaken by typing a number on each palm using dyes of bright colors.



Fig 5. Field Manual Counting

RESULTS

When the study completed, the following results found out:

1. For the whole area of interest, the results of palm trees counting as in table 2 bellow:

Table 2 Palms Counting Results		
No	Counting Method	Palm Counted
1	Pleiades Manual	8,003
2	Pleiades Auto	9,741
3	Spot Auto	8,276
4	Field Survey	100 %

The table illustrated the results with the following notes:

1. The automated approach identified about 20% more palms than the manual, using Pleiades images with 0.5 m.
2. The results of automated counting of SPOT Images (1.5 m Resolution) has about 17% more than the automated approach of Pleiades and around 3 % more than the manual approach of Pleiades.
3. Despite the advanced capabilities and high accuracy of the satellite images used, errors are observed when visually examining the distribution of trees automatically identified by the application using SPOT images, the number increased in some areas and in decreased in others.
4. Therefore, to conduct more accurate results, 2 small training areas were chosen randomly as test samples, with contrast density of palm trees:
 - a) Dense test area.
 - b) Sparse test area.

a) Counting Palm Trees - Dense Test Areas

The Palms counting in the dense area, with comparison with the manual field survey counting as a reference:

- Manual counting using (Pleiades data 0.5 m) identified 97 % of the palms.
- Automated Approach counting using (Pleiades Data 0.5 m) identified 90 % of the palms.
- Automated approach counting using (SPOT Data 1.5 m) identified about 62 % of the palm

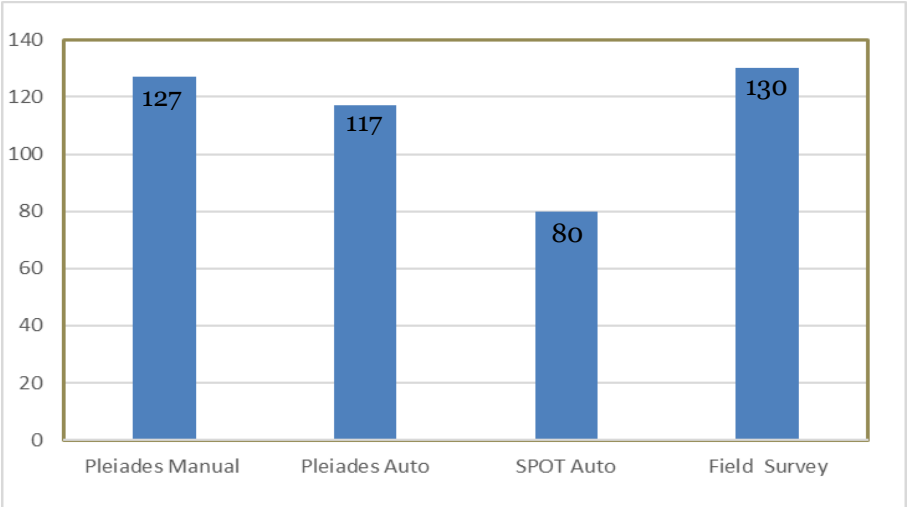


Fig 6. palm count test areas – dense

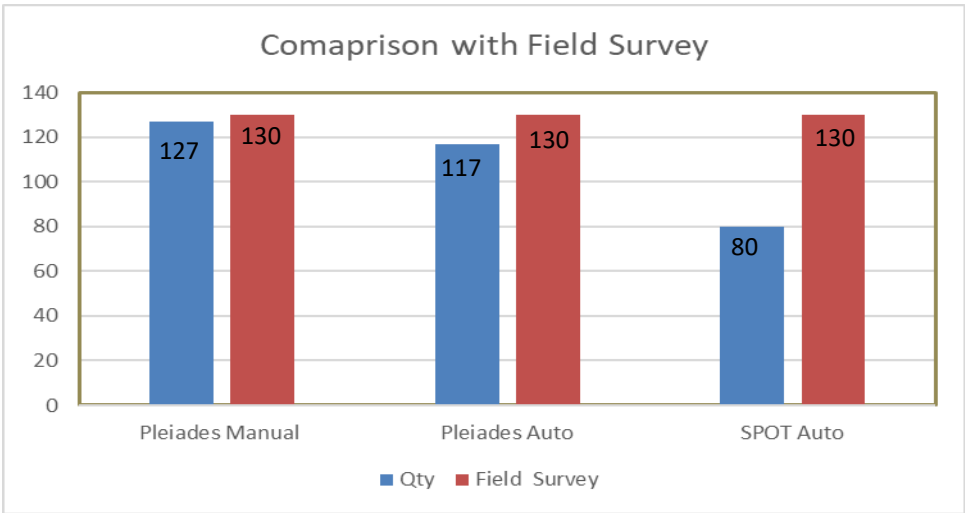


Fig 7. comparison of counting palms for dense areas

b) Counting Palm Trees – Sparse Test Areas

The Palms counting in the sparse area, with comparison with the manual field survey counting as a reference:

- Manual counting using (Pleiades data 0.5 m) identified about 98 % of the palms.
- Automated Approach counting using (Pleiades Data 0.5 m) identified 93 % of the palms.
- Automated approach counting using (SPOT Data 1.5 m) identified about 86 % of the palm

The results appear that, the Manual Counting method get more accurate results in both images.

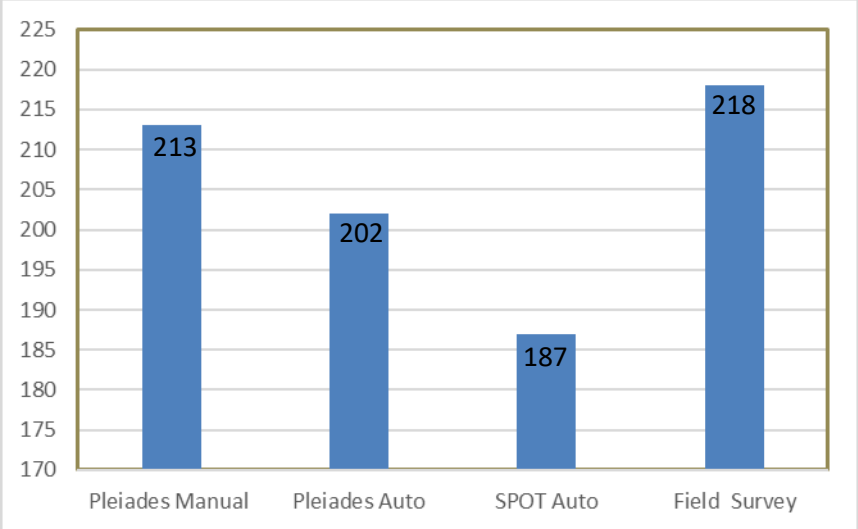


Fig 8. Palm Trees Count Test Areas - Sparse

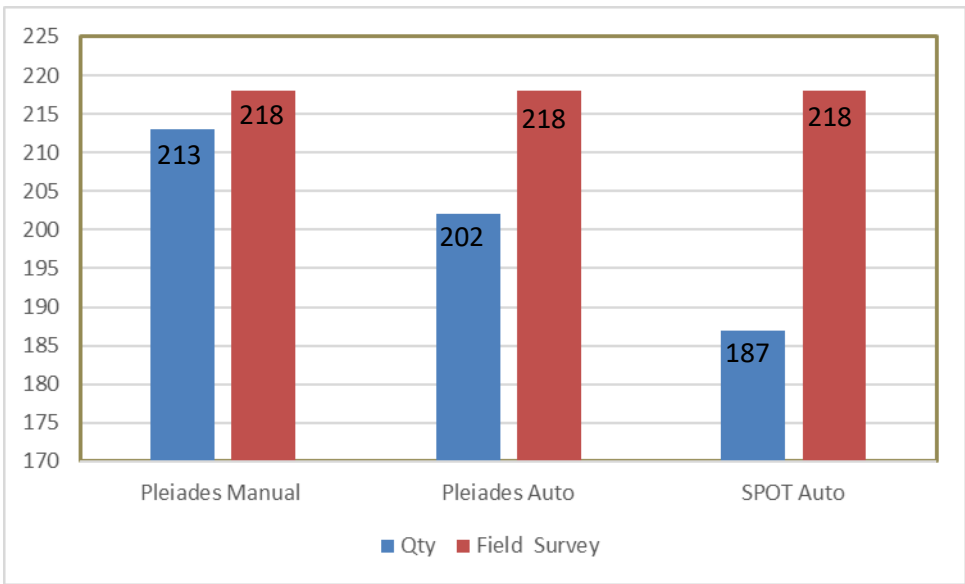


Fig 9. Comparison of Counting Palms for Sparse Areas

DISCUSSION

The results of this study proof the possibility of using high resolution satellite images like images of Pleiades Satellite with 0.5m resolution for palm trees counting. This type of image was used in two ways (manual & Automated). However, when using Spot images 1.5 m, manual counting using GIS was not possible and the counting was done automatically only using ERDAS_Object_Extraction..

Table 2 Counting of Palm Trees for Test Areas in different methods

No	Type	Dense Area %	Sparse Area %	Average
1	<i>Pleiades Manual</i>	96.70 %	97.70 %	97.2 %
2	<i>Pleiades Auto</i>	90.00 %	92.66 %	91.33 %
3	<i>Spot Auto</i>	61.54 %	85.77 %	73.66 %
4	<i>Field Survey</i>	100 %	100 %	100 %

1. The manual approach of counting using 0.5 m resolution images was able to identify about 97% of palm trees in the dense area and about 98% of palm trees in the sparse area.
2. Automated approach of counting using 0.5 m resolution images was able to identify about 90 % of palm trees in the dense area and about 93 % of palm trees in the sparse area.
3. Automated approach of counting using SPOT imagery 1.5 m resolution identified about 62 % of palm trees in the dense area and about 86 % of palm trees in the sparse area.
4. Big difference found between the measurements in dense area regarding to the sparse.
5. The results show that the counting results using 1.5m SPOT images were of low accuracy, which makes it inadvisable to use them as the results will not be reliable.
6. The results of the machine learning and automated approach used in this study could be improved in several ways like increasing training models, masking water bodies, and using newer, more accurate classification techniques.
7. Conducting a ground survey and counting palm trees manually is a true assessment. The census is considered a real census of palm trees and is very accurate, so it is considered a reference for comparison.
8. Based on the results obtained from this study, it is possible to recommend conducting a feasibility study by applying the work on a larger area and taking more samples to evaluate the possibility of carrying out a national project to census palm trees and study the reasons for the decline in their numbers and address the problems.

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