*Conference Proceedings Paper*

# Detection of Urban Buildings with Use of Multispectral Gokturk-2 And Sentinel 1A SAR Images

**Mustafa Kaynarca [1], Nusret Demir [2,*]**

[1] Akdeniz University, Institute of Science and Technology, Dept. of Remote Sensing and GIS, Antalya, Turkey mustafakaynarca@gmail.com
[2] Akdeniz University, Faculty of Science, Dept. of Space Science and Technologies, Antalya, Turkey, nusretdemir@akdeniz.edu.tr
* Correspondence: nusretdemir@akdeniz.edu.tr; Tel.: +90-242-3102235

Published: date
Academic Editor: name

**Abstract:** Urban areas are important for city planning, security, traffic purposes, an decision makers etc. Remotely sensed data are useful to detect the urban areas either with active or passive systems. Each system has advantages and disadvantages. Passive images are mainly multispectral images, and they have rich information with their rich spectral resolution. On the other hand, they are affected with atmospheric conditions, so there should not be clouds over the sensed region during the data acquisition. On the other hand, SAR systems are not affected by the atmospheric conditions, but their spectral resolution is low, mainly with one channel. On the other hand, the structure of the passive images is completely different than the multispectral images. Secondly, the geometrical and electrical properties of objects play an important role in the pixel values. In this study, multispectral GOKTURK-2 MS image and SENTINEL 1A SAR image have been used to detect the urban buildings to use the advantages of the both datasets. Firstly, SVM method is applied to detect the buildings in GOKTURK image. The buildings are detected from SAR image with fuzzy logic approach. Finally, the buildings have been detected with intersection of the both results. The results from SAR image could eliminate false negative results from GOKTURK-2 image. Study area is selected from Antalya, Kepez distinct. The detected urban area is 288.353 m² at the selected study area.

**Keywords:** building detection; multispectral image; Gokturk, Sentinel, SAR, fuzzy, SVM

## 1. Introduction

The buildings are important objects for many purposes such as city planning, flood simulation, real state, municipality progress etc. The satellite data are efficient sources for detection and updating the building objects. There are two types of remote sensing methodology, which are passive and active remote sensing, they have both some advantages and disadvantages compare to each other. Optical satellite image data are used in building detection purposes in the past [1–5].SAR satellites can operate in all weather conditions and 24 hours per day since they use their own energy to detect the radiation reflected from the Earth surface. This makes SAR remote sensing is time and weather independent. Detection of urban features was also focus of many previous research works [6–10].

In this work, the buildings are detected from multispectral Gokturk images and also Sentinel 1A SAR images. Support vector machine classification method has been applied on MS images, and fuzzy clustering has been used for detecting the buildings from SAR data. In the last step, the intersection of the results from two datasets gives the most accurate detection results.

## 2. Experiments

### *2. 1.Test Site*

The study area has been selected from one of the developing neighborhoods in Antalya province Kepez district where the building objects are intensive. The test area is approximately 771.861 m². The following figure shows the test site.

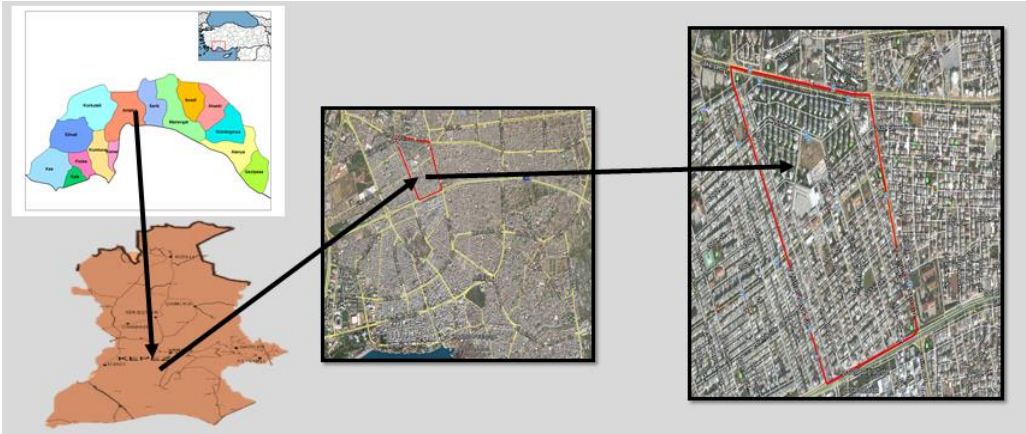

**Figure 1.** Test site (Left: Antalya(up),Kepez(below), middle (test site on Google Earth), right: Zoomed view

### *2.2.Used Data*

In this study, Gokturk MS and Sentinel 1A SAR images have been used. GÖKTÜRK-2, the first high resolution ground observation originally developed in Turkey designed by Turkish engineers and placed in the mission orbit by launching operation in 2012. 4 band visible bands blue, green red and near infrared / with resolution 2.5 m and pancromaric band with 5 m resolution.1

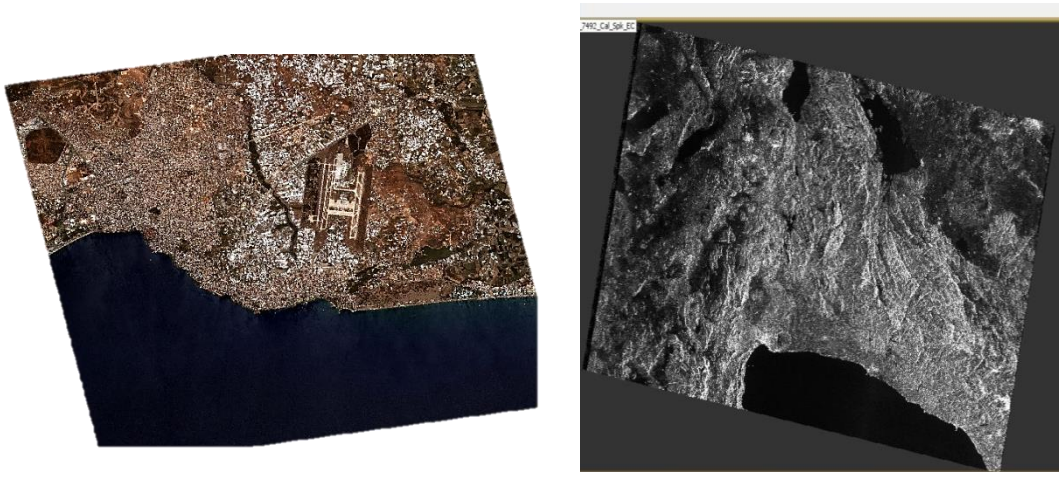

**Figure 2.** Göktürk 2 Multispectral Image(left) and Sentinel 1A SAR image(right)

Used SAR image is acquired in Interferometric Wide Swath Mode (IW) and GRD file type is selected. The properties of used SAR image are given in Table 1.

Table 1. Features of the S1A level-1 product GRD

| **Date:** | **04.08.2016** |
|---|---|

| | |
|---|---|
| Instrument: | SAR-C |
| Operational mode: | IW swath mode |
| Polarization: | VH, VV |
| Range and Azimuth Spacing: | 10 m |
| Azimuth and Range Looks: | Single |

*2.3.Method*

The method consists three parts. Firstly, the building areas have been detected from Gokturk image with use of SVM method. Then, fuzzy clustering has been applied on SAR image to detect the buildings. Then, intersection of the results are selected as final buildings.

2.3.1. Building detection from Gokturk image

The workflow of building methodology is shown in Figure 4.

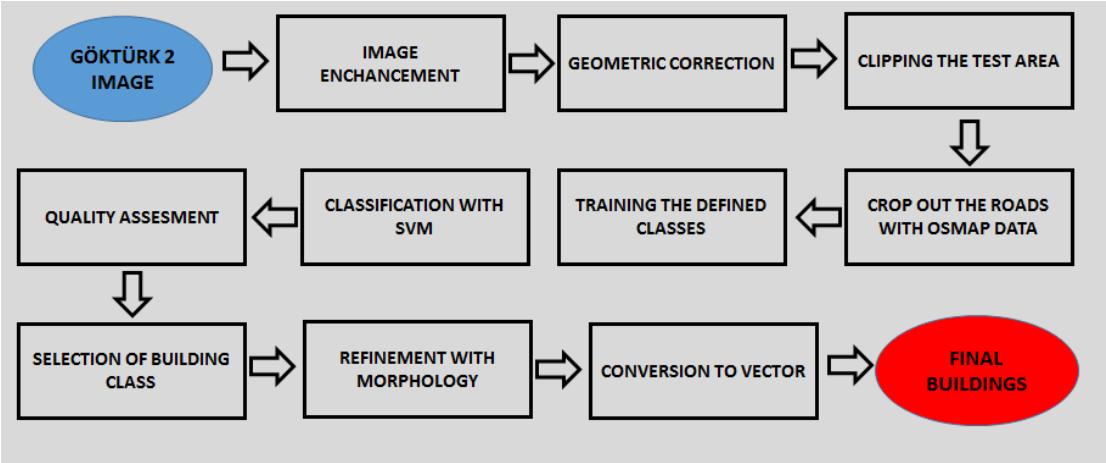


**Figure 4.** Workflow of building detection from Gokturk image

Six training classes were defined, which are road, vegetation, bare ground, shadow, orange colored roofs, concrete roofs (Fig.5).

Support vector machines classification is applied with collecting 150-200 pixels for each class. The used radial basis function is as following

$$K(xi,xj) = \exp(-g||xi - xj||2),\ g > 0, \quad \text{where g:gamma function}$$

The seperability values are analyzed. According to the analysis, concrete roofs and roads are not well separated. Therefore, OSM data were used to determine the road classes. The accuracy of the classification was calculated as 82%. The classes of vegetation, bare ground, shadows were excluded. The concrete and orange roofs were merged. Then, morphological erosion operator(3x3) was applied to eliminate the errors. The final roofs class was converted to the vector format as building detection result.

2.3.2.Building detection from Sentinel image

The workflow of the methodology for building detection from SAR image, is shown in Figure 5.

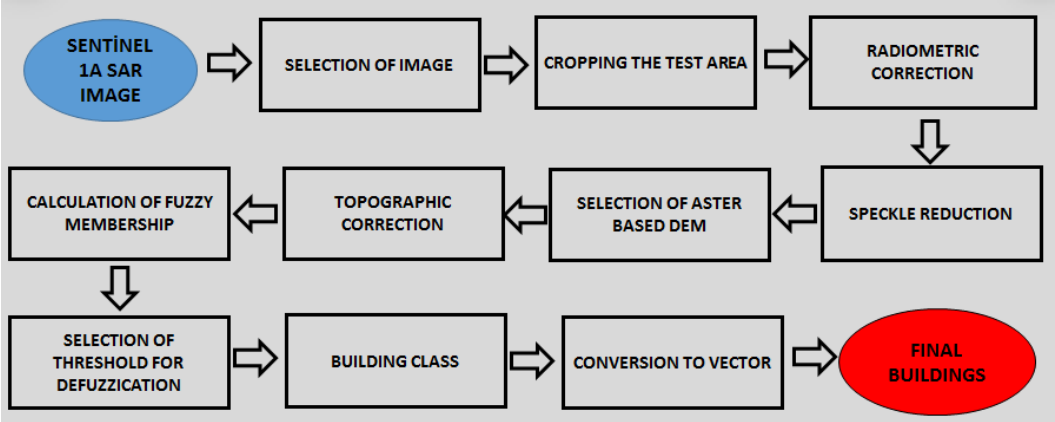


**Figure 5.** Workflow of building detection from Sentinel 1 SAR image

After acquiring the Sentinel 1A SAR image, it was preprocessed for speckle reduction and topographic correction. Then, MSLarge fuzzy membership function was used to calculate the building membership values. Defuzzification was applied with thresholding on the membership values. It was assumed that the pixels had larger membership value than 0.5 , they were considered as buildings. The following equation was used to calculate the membership:

$$\text{If } x > a * m: \quad u(x) = 1 - (b * s) / (x - (a * m) + (b * s))$$

Where m is the mean value of all the pixels, s is the standard deviation, a and b are the multiplier parameters.

## 3.Results and discussion

The building detection results from Göktürk and Sentinel 1A images were intersected , and the final detection result was produced.

**Figure 6.** Final detection results (Left: Buildings from SAR (pink), Göktürk(green), Right: Intersection result

As shown in Figure 6, the open market roof has been eliminated with the intersection (red circle). Because this roof does not reflect the signals of C band with its thin structure which is smaller than the used RADAR wavelength. The roof of open market is shown in Figure 7.

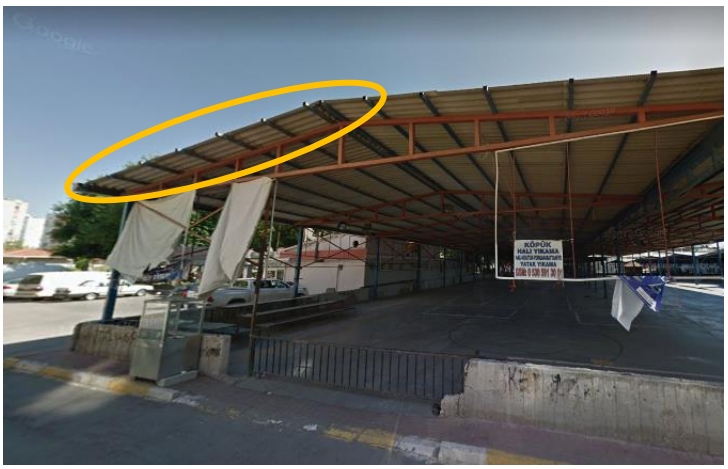

**Figure 7.** Thin roof (<5 cm.)structure of open market(image: Google Street view))

## 5. Conclusions

The göktürk image can be used to detect the buildings except with including the structures which are not buildings, like open markets, because of the similar reflectance of the roofs with the other buildings in multispectral channels. But the use of SAR image can eliminate this problem since this type of sturtcures does not reflact in C band RADAR. So, urban buildings could be detected much accurately. Total urban building area has been calculated as 288.353 m² with this study. As a future work, integraton of 3D data might improve the detection result.

**Author Contributions:** Authors both developed the idea, Mustafa Kaynarca implemented the methodology, and they both wrote the paper.

## References

1. Turlapaty, A.; Gokaraju, B.; Du, Q.; Younan, N. H.; Aanstoos, J. V A Hybrid Approach for Building Extraction From Spaceborne Multi-Angular Optical Imagery. *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.* **2012**, *5*, 89–100, doi:10.1109/JSTARS.2011.2179792.
2. Vakalopoulou, M.; Karantzalos, K.; Komodakis, N.; Paragios, N. Building detection in very high resolution multispectral data with deep learning features. In *2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*; 2015; pp. 1873–1876.
3. Zhang, Y. Optimisation of building detection in satellite images by combining multispectral classification and texture filtering. *ISPRS J. Photogramm. Remote Sens.* **1999**, *54*, 50–60, doi:https://doi.org/10.1016/S0924-2716(98)00027-6.
4. Jin, X.; Davis, C. H. Automated Building Extraction from High-Resolution Satellite Imagery in Urban Areas Using Structural, Contextual, and Spectral Information. *EURASIP J. Adv. Signal Process.* **2005**, *2005*, 745309, doi:10.1155/ASP.2005.2196.
5. Liu, W.; Yamazaki, F. Object-Based Shadow Extraction and Correction of High-Resolution Optical Satellite Images. *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.* **2012**, *5*, 1296–1302, doi:10.1109/JSTARS.2012.2189558.

6. Jendryke, M.; McClure, S. C.; Balz, T.; Liao, M. Monitoring the built-up environment of Shanghai on the street-block level using SAR and volunteered geographic information. *Int. J. Digit. Earth* **2017**, *10*, 675–686, doi:10.1080/17538947.2016.1216616.
7. Chen, J.; Wang, C.; Zhang, H.; Wu, F.; Zhang, B.; Lei, W. Automatic Detection of Low-Rise Gable-Roof Building from Single Submeter SAR Images Based on Local Multilevel Segmentation. *Remote Sens.* 2017, *9*.
8. Solari, L.; Ciampalini, A.; Raspini, F.; Bianchini, S.; Zinno, I.; Bonano, M.; Manunta, M.; Moretti, S.; Casagli, N. Combined Use of C- and X-Band SAR Data for Subsidence Monitoring in an Urban Area. *Geosci.* 2017, *7*.
9. G.Vijayalakshmi , B. Sathyasri, V. M. M. A. B. DETECTION AND RECONSTRUCTION OF RADAR FOOT PRINTS FOR MAP UPDATING. **2017**, *8*, 111–123.
10. Che, M.; Du, P.; Gamba, P. 2- and 3-D Urban Change Detection With Quad-PolSAR Data. *IEEE Geosci. Remote Sens. Lett.* **2018**, *15*, 68–72, doi:10.1109/LGRS.2017.2773471.