Estimation of Soil Electrical Conductivity using Dual – Polarized SAR Sentinel -1 Imagery

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ABSTRACT

Soil to mankind is a basic natural resource. Soil is a blend of solid, liquid and gaseous substances, shapes the top most layer of the Earth's crust. The saline soil are the 'salt affected soils' generally found in arid and semi – arid regions. These soils are generally found in 'low precipitation area' where precipitation and evaporation ratio is less than 10.75[5]. This paper manages soil electrical conductivity estimation utilizing Sentinel -1 SAR imagery.. The support vector regression (SVR) technique, with RBF kernel function, was utilized to relate illustrative factors to ground estimated saltiness. We additionally applied K-Fold method for upgrading the model..

General Terms

Regression, Algorithm

Keywords

SAR imagery, Support Vector Regression, microwave, soil, electrical conductivity

1. INTRODUCTION

Salinization of soil is one of the most significant ecological issues in dry and semi-dry zones.[4]. Microwave remote detecting on regular earth material, for example, soil and water has a nearby reliance on their electrical parameters[2]. Nonetheless, few examinations have explored the capability of SAR imagery for saltiness checking[6]. Radar backscattering is for the most part impacted by two primary variables : (1) sensor parameters to be specific wavelength, polarization, incidence angle, and (2) target parameters, for example, surface roughness, slope orientation, and dielectric properties of an objective[7]. Soil complex dielectric permittivity range relies mostly upon soil volumetric water substance and saltiness, however other soil properties, for example, temperature, density and clay content can likewise altogether affect its dielectric properties[3]. This paper aims to evaluate the chance of utilizing radar imagery to recognize salinization

2. SUPPORT VECTOR REGRESSION

This algorithm is utilized to forecast continual parameter[1]. It tries to fit the best line within a pre-defined or threshold error value. As it can be seen from figure 1 that this algorithm takes 28 samples (x1, x2,.., x28 etc.) as input and $K(x_i, x_j)$ represents the kernel function, where x_i, x_j are sample data and Y represents the output i.e. EC.
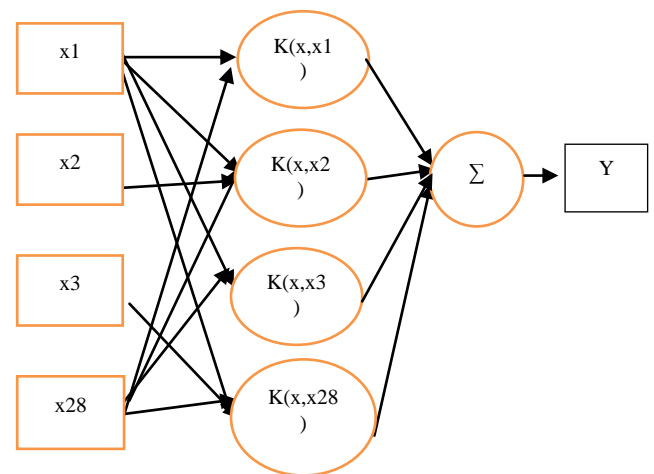

Figure 1. Structure of SVR algorithm

3. K – FOLD CROSS VALIDATION

Cross validation is a resampling strategy to assess artificial intelligence models on a finite data sets[10]. The technique has a single parameter K that alludes to the number of groups that a given data sets is to be divided into.

4. MATERIALS AND METHODS

4.1 Study Area and Datasets

Kuh Sefid is a town situated in the central district of Qom country as shown in figure 2. This zone has hot and dry atmosphere with yearly rainfall of 115.5 mm, this region is influenced by serious saltiness risk predominantly because of region to the salt lake Qom.

Figure 2. Location of Qom country in Iran

Figure 3 is the image of Kuh Sefid district acquired from Google Earth.

Figure 3. Google Earth image

4.2 Field Investigation

The field observations were done on 4th March 2017, and 58 soil tests were randomly gathered.

4.3 Used Methodology

The following section depicts the method employed to meet the goal of this work. The outline of the method adopted for this work has been shown in figure (4). In this figure, the approach is to estimate soil electrical conductivity using support vector regression with K- Fold technique. In this project, approach is to estimate soil electrical conductivity from the Sentinel -1 SAR image[9]. So the satellite dataset was available in SLC format, therefore pre – processing was carried out. Then radar intensity and texture features were derived[8] . The SVR algorithm with K-Fold technique was applied with radial basis function as a kernel.
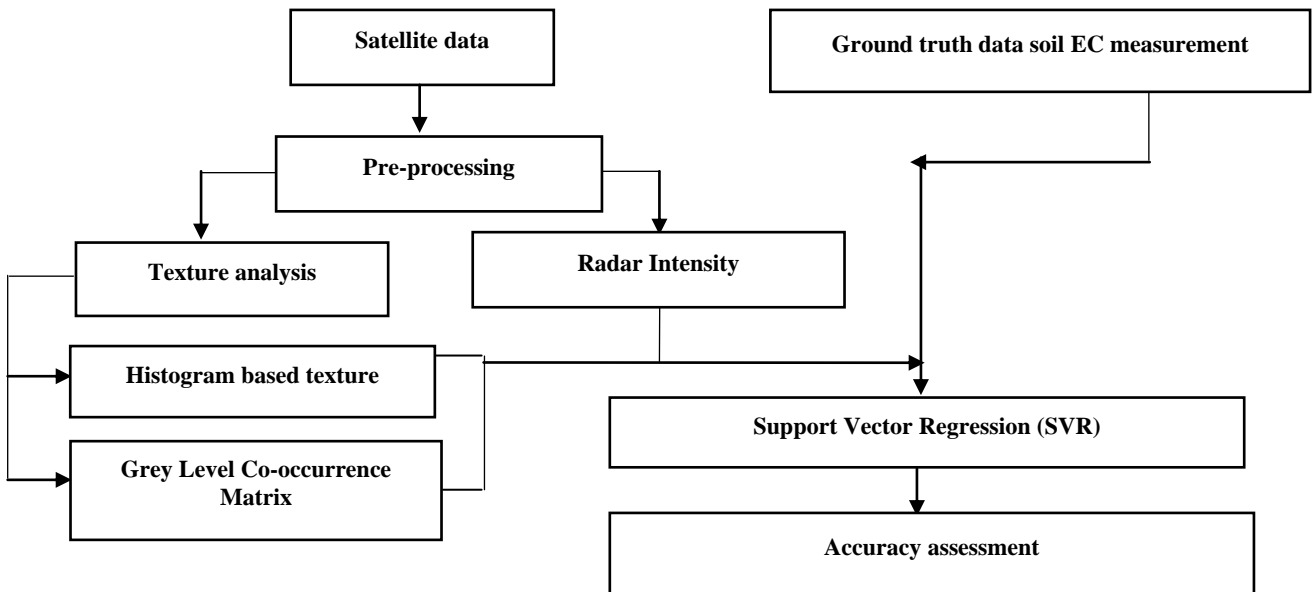

Figure 4. Flowchart of Method

5. PERFORMANCE EVALUATION METRICS

The parameters with the help of which accuracy assessment is done is given below.

5.1 Root Mean Square Error (RMSE)

Mean square error helps to find the error between predicted value and actual value over samples. If $\hat{y}_i$ is the predicted value, and y_i is the corresponding true values, then the mean squared error (MSE) estimated over $n_{samples}$ is defined as:

$$MSE(y, \hat{y}) = \frac{1}{n_{samples}} \sum_{i=0}^{n_{samples}-1} (y_i - \widehat{y_i})^2 \qquad (1)$$

Where, root mean square error is the square root of mean square error.

5.2 Normalized Root Mean Square Error (NRMSE)

The Normalized root mean square error is expressed as :

$$NRMSE = \frac{RMSE}{\bar{y}} \qquad (2)$$

5.3 Coefficient Of Determination (R²)

The r2_score function , for the most part denoted as R². It determines how well the samples are estimated by the model.

If $\hat{y}_i$ is the predicted value and y_i is the corresponding true value for total n samples, the estimated R² is:

$$R^2(y, \hat{y}) = 1 - \frac{\sum_{i=1}^{n}(y_i - \widehat{y_i})^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \qquad (3)$$

6. RESULTS AND DISCUSSIONS

This section discusses the performance of algorithm on the basis of quantitative assessment values. In this, radial basis function (RBF) is used as a kernel function.

Table 1. Accuracy Assessment

K-Fold	RMSE	NRMSE	R²
5	15.33	1.209	0.059
10	11.51	0.908	0.229
15	4.06	0.32	0.593
29	0.146	0.011	0.998
35	0.014	0.0011	0.0
40	0.014	0.0011	0.0
45	0.014	0.0011	0.0
58	0.014	0.0011	0.0

As it can be seen from table 1, the better model is achieved when values of K is 29.Accordingly, RMSE value is 0.146 and R² value is 0.998.
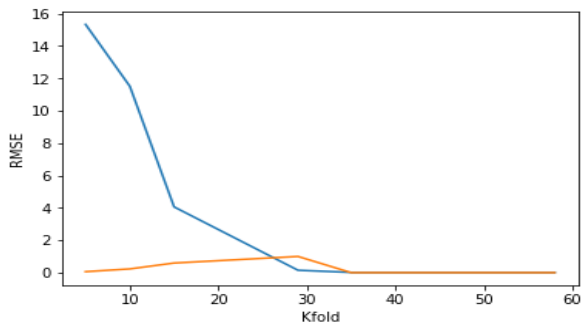

**Figure 5.Graph showing variation of RMSE and R²
w.r.t.K value**

The graph plotted showing the variation of K- Fold with RMSE and R² values is given in figure 5. The blue line indicates the variation of R² with K- Fold and orange line indicates the variation of RMSE with K-Fold. As it can be seen from graph, when value of k is 29,RMSE is minimum and R² is 0.998.

7. CONCLUSION

This paper has concentrated on assessing the capability of Sentinel -1 data in checking soil saltiness. This study helps to determine soil salinity with the help of Sentinel -1 data and then assessing the performance of algorithm on the basis of performance evaluation metrics. From the observations, it can be concluded that, for value of K as 29, we are getting root mean square error as 0.146 and R² as 0.998

8. REFERENCES

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