Comparative Study of Nearest Neighbor and Bilinear Interpolation Raster Transformation Techniques for Predicting Urbanization

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ABSTRACT
The haphazard urbanization of metropolis is an alarming situation in front of all developing countries and this situation may leads to the so many problems. For sustainable development, decision makers and planners always seek for better solution for the exiting land related problems. To get better solution, decision makers and planners are always considering current state of city as well as futuristic view of the city. To get futuristic view there is need to model a system to predict the Land use / Land Cover changes. To model such predictive situation, there is need to use proper simulation technique. Cellular Automata (CA) is the raster based tool to predict Land Use/ Land Cover changes. CA algorithm mostly deals with the transformation of geographical raster data. Geographical Information System (GIS) deals with geographical data and has two many techniques to transform geographical data from one format to another.

In this paper we have studied existing geographical data transformation techniques and studied the comparison of nearest neighbor (NN) and Bilinear Interpolation (BI) raster-raster transformation technique. From the comparison it has been observed that BI technique is most suitable technique for the CA algorithm in predicting Land Use / Land Cover of the city.

KEYWORDS
Geographical Information System (GIS), Cellular Automata (CA), Raster Data, Resampling methods, Bilinear Interpolation (BI), Nearest Neighbor (NN).

1. INTRODUCTION
Geographical Information System (GIS) is a science that deals with geographical data. This geographical data is generally utilized by planner and decision makers to give better solution for the existing land specific problems. For town planning of any city decision makers and planners always takes into consideration the Land Use / land cover changes of that city as Land Use / land cover changes shows the current development of the city. While considering the sustainable development, decision makers and planners are always attempting to have the knowledge of the future development of the city. Considering the need of planners, there is need to have predictive system or model which will simulate the futuristic land use and land cover of any city. And the prediction of any city can be developed with the help of cellular automata geospatial technique and Decision Support System as input from the decision makers and planner will play vital role in futuristic town planning of any city.

Cellular Automata (CA) is a raster-based tool that can effectively be used for modeling cities and land use changes. [1]. The basic principle of CA is to predict the land development which is a historically dependent process in which development in the past consequently influences the future through local interactions among land parcels as studied by Wu and Webster, 1998. [2] Predictive simulation with help of CA is the outcome at the previous iteration has important effects on the outcome at the consecutive iteration.

Along with CA, decision support system deals with the selecting one feasible spatial alternative among the multiple alternatives. These multiple spatial and nod spatial alternatives act as an input to the CA simulation model [3]. Along with input parameters, CA simulation models require the process to show better outcome to the decision makers and planners.

Here to predict the land use and land cover changes of any city, the CA simulation model need to deal with geographical data. In GIS, geographical data are in two types of format – Raster and Vector. Raster and Vector acts as data models in GIS. In simulation, geographical data can be converted from raster to raster format. This data conversion can be done with the help of some known methods

- Vector-raster transformation
- Raster-raster transformation (e.g. Resampling)
- Overlay or buffer operations
- Other complex operations (e.g. classification)[4]

CA predictive simulation model are usually implementing using Raster format-cells. Hence the inputs of GIS to CA models should be prepared in raster format. For predictive simulation, we have used the Raster –raster transformation that is Resampling method.

2. RESAMPLING
It is a process that involves the extraction and interpolation of grey levels from pixel locations in the original uncorrected image. The resampling methods; Nearest Neighbor, Bilinear Interpolation and Cubic Convolution, 8 point $\sin(x)/x$, and 16 point $\sin(x)/x$. [4] determine how the cell values of an output raster are determined after a geometric operation is done. The
method used depends upon the input data and its use after the operation is performed. [5]

3. RESAMPLING METHODS

3.1 NEAREST NEIGHBOR
It is best used for categorical data like land-use classification or slope classification. The values that go into the grid stay exactly the same, a 2 comes out as a 2 and 99 comes out as 99. The value of the output cell is determined by the nearest cell center on the input grid. Nearest Neighbor can be used on continuous data but the results can be blocky.

3.2 BILINEAR INTERPOLATION
This method uses a weighted average of the four nearest cell centers. The closer an input cell center is to the output cell center, the higher the influence of its value is on the output cell value. This means that the output value could be different than the nearest input, but is always within the same range of values as the input. Since the values can change, Bilinear is not recommended for categorical data. Instead, it should be used for continuous data like elevation and raw slope values.

3.3 CUBIC CONVOLUTION
This method looks at the 16 nearest cell centers to the output and fits a smooth curve through the points to find the value [6]. Not only does this change the values of the input but it could also cause the output value to be outside of the range of input values (imagine a sink or a peak occurring on a surface). This method is also not recommended for categorical data, but does an excellent job of smoothing continuous data.

3.4 SIN(X)/X 8PT AND 16PT
8pt determines the grey level from the weighted average of the 64 closest pixels to the specified input coordinates and assigns the value to the output coordinates. 16pt does the same, using the 256 closest pixels. The image is sharper than that produced by bilinear interpolation, and it does not have the disjointed appearance produced by nearest neighbor interpolation. Because the grey level values are altered by this method, any image classification processes should be performed before the interpolation. Sin(x)/x with an 8 x 8 window require about 20 to 40 times the computation time required by the nearest neighbor method. Sin(x)/x with a 16 x 16 window require 40 to 80 times the computation time required by the nearest neighbor method.

4. CA ALGORITHM DESIGN:

5. METHODOLOGY
1. Satellite Imaginary data is classified into different number of Land Use / Land Cover classes named as Barren Land, Forest Land, Water bodies and urban land.
2. Cellular Automata technique has implemented to predict Land Use / Land Cover.
3. These classified images in the step 1 are given as input to the CA predictive simulation model.
4. Bilinear interpolation and Nearest Neighbor raster – raster transformation techniques has been used in CA algorithm.
5. Nearest Neighbor is developed by considering the state of nearest neighbor one cell of raster data which is present in the form of classified satellite imageries.
6. Bilinear Interpolation (BI) is developed by considering the state of nearest neighbor four cells.
7. Output of BI and NN has compared and the depicted the corresponding results.
6. PRACTICAL DEMONSTRATION

![Fig2](image1.png)

**Fig2.** GUI for Nearest Neighbor (NN) and Bilinear Interpolation (BI) CA model.

7. RESULT

7.1. NEAREST NEIGHBOR

![Fig3](image2.png)

**Fig3** Input Raster data to NN and BI CA Predictive Simulation model

![Fig4](image3.png)

**Fig4** Output of Nearest Neighbor (NN) CA Predictive Simulation model

7.2. BILINEAR INTERPOLATION

![Fig5](image4.png)

**Fig5** Output of Bilinear Interpolation (BI) CA Predictive Simulation model
8. CONCLUSION
1. Nearest Neighbor (NN) deals with one dimensional data, Bilinear Interpolation (BI) deals with two dimensional data, Cubic convolution deals with 3-dimensional data and \( \sin(x)/x \) deals with 4-dimensional data.
2. CA is raster based tool and raster data is generally available in one or two dimensional. So we have considered Nearest Neighbor (NN) and Bilinear Interpolation (BI) techniques for the study.
3. But the purpose of study is to find out the most suitable raster – raster transformation technique for CA algorithm.
4. Nearest Neighbor (NN) is mostly deal with the choice of single alternative whereas Bilinear Interpolation (BI) deals with the choice of multiple alternatives. To predict the Land Use / Land Cover, there is need to consider multiple alternative (Barren Land, Forest Land, Water body and Urban Land) approach.
5. After implementing CA with Nearest Neighbor (NN) and Bilinear Interpolation (BI), it was depicted that the output image from Bilinear Interpolation (BI) CA had better resolution than NN CA output image.
6. The study also reviewed that Bilinear Interpolation (BI) has entertained multiple alternatives as input but Nearest Neighbor (NN) had accepted only one alternative at a time.

9. FUTURE SCOPE
Implementation of remaining resampling raster to raster transformation techniques.

10. REFERENCES