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IMPLICATION OF IMAGE PROCESSING ALGORITHM IN REMOTE SENSING AND GIS APPLICATIONS

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ABSTRACT

An algorithm solves the complex problems more efficiently and consistently. The traditional ways of solving the problems, have been replaced, by several new algorithms. The selection of an appropriate algorithm for any given chore is an imperative issue because different algorithms are based on the different concepts. One problem can be solved in more than one way; in this regards many alternative algorithms are developed with computational proficiency. This review presents evaluation and utilization of different algorithms such as Simple Recursive Algorithm, Backtracking Algorithm, Divide and Conquer Algorithm, Dynamic Algorithm, Branch and Bound Algorithm, Brute Force Algorithm and Randomized Algorithm. This paper generally analyzed and branch out algorithms to perceive their limitations and delimitation. This review emphasizes the effects and consumption of different algorithms in different image processing applications. Minimum Spanning Tree (MST), the most functional algorithm, described exclusively by the undirected graph in which all nodes are connected. Greedy algorithms expresses as a simple solution algorithm that choose a local optimum solution at each step to achieve a global optimum. We considered the drawbacks and advantage various algorithms and concluded that Greedy algorithm is comparatively better than other algorithms regarding the optimal solution.

Keywords: *Minimum Spanning Tree, Prim's Algorithm, Kruskal Algorithm, Greedy Algorithm.*

1. INTRODUCTION

Digital image processing is an expanding area with applications regarding to our daily lives. Many image processing and analysis techniques have been developed to aid the interpretation of remote sensing images and to extract as much information as possible from the image. Remote sensing and Geographic information system (GIS) are very significant tools, that can provide crucial information to various fields such as Army, agriculture, environmental, transportation, medicine, industries, forestry and etc. The recent developments in technology have heightened the need of remote sensing and GIS in all fields, such as monitoring and mapping of natural resources, including land, ocean and natural hazards. Remote sensing and GIS involve in acquisition, digital processing and manipulation of airborne and spaceborne and other spatial data. GIS software is exceedingly functional to manipulate geospatial data, therefore image processing software offer the significant solution to access the data in easy way and distribute new data to the extensive GIS user society. An algorithm is basically an instance of logic written in software by software developers to be effective for the intended target, in order for the target machine to produce output from the given input. Every field of science has its own problems and needs efficient algorithms to resolve these problems.

Several algorithms developed for the diversifying functions of image processing. These algorithms are designed to implant complete logic solution by manipulate the data and represented as a variable of data type in the computer program. The vast spectrum of complex computer applications, such as sorting, searching, text processing, graph and image processing problems, have been solved by the algorithms. In this study,

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different algorithms and their capacity in broaden horizons fields, particularly in image processing, has been reviewed.The focal issue is to review the implication of different image processing algorithms in remote sensing and GIS applications.

2. RELATED WORK

Any specific problem in data processing can be resolved by an algorithm which is the set of comprehensive instructions. Algorithm analysis is an important part of broader computational complexity theory, which provides theoretical estimates for the resources needed by an algorithm which solves a given computational problem. Currently various algorithms as shown in (Figure 1), have been developed to solve the problems in diversifying aspects, such as Simple Recursive Algorithm, Dynamic Programming Algorithms, Brute Force Algorithms, Randomized Algorithms, Branch and Bound Algorithms, Backtracking Algorithms, Divide and Rule Algorithm and Greedy Algorithms. Each of the algorithms has its advantages and drawbacks. The focal point of the study is to review the different data processing algorithms particularly Greedy algorithms in GIS applications.

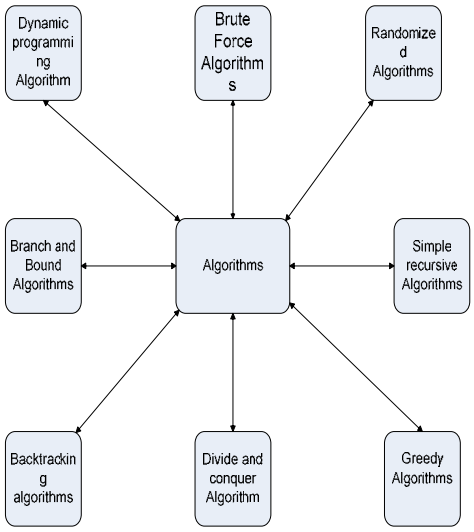

Figure 1 Different types of Algorithms

2.1 Simple Recursive Algorithms

Simple recursive algorithm is a versatile programming tool for intricate and extremely complex problems. It can solve most base cases problems directly by re-emerging the problem into simpler parts, at the each iteration and switch a solution to simpler sub problem solution. Recursion is one of the repeatedly used computing techniques such as for computing factorial function:

```
int factorial (int n)
if n >1 then
        return (n* factorial(n-1));
else
        return (1);
end
```

[1]Proposed Otsu's approach used as a general recursive algorithm for image segmentation, in this regards at each recursion the object with the lowest intensity have been segmented from the image. This process continues until only one object left in the image. An austere flaw with this technique is that, it is very difficult to grip the algorithm as procedural or object oriented programming. Consequently the system becomes more complicated by excessively practice of simple recursive algorithm.

2.2 Backtracking Algorithms

This algorithm based on depth first recursive search; in this type of algorithm there are series of choice for the best decision. Once the solution is found, return successfully, otherwise make the choice to recur and return the solution. If there is no choice then return unsuccessful.

```
Color a map of different countries with 4 colors
Color (n)
if n >number of countries then
        return successfully;
else
        if C = 4 then
if n is not adjacent with C then
        Choice - 1
        Choice - 2
        if successful then
return successful ;
else
failure
end
end
end
end
```

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Face recognition algorithm are very much supportive for automatically identification of a person from a digital image. One of the efficient backtracking algorithms used by [2] is Viterbi backtracking algorithm. In this study face recognition feature points extracted from the input image then compared with the given database. Digital Video Recorders (DVR) used as an alternative of closed Circuit Television (CCTV) for recognition and verifying faces. Real time DVR system based on hidden Morkov Model (HMM) Hidden Markov model designed for face detection in the research. But the limitations regarding to back tracking algorithm is that it does not categorize the foremost cause of the problem; therefore a search result becomes unsuccessful.

2.3 Divide and Conquer Algorithms

The most efficient and powerful algorithms that can be analyzed by using recurrences is divide and conquer algorithm. The model of divide and conquer algorithm is incorporation of three fractions, i.e. Divide, Conquer and Combine. At the initial state divide the problem into sub problems subsequently solve these sub problems recursively finally merge the solutions of all sub problems.

Divide and conquer algorithm proposed [3] for disparity estimation and matching salient features from the image recursively. Initially strong feature points matching has been taken afterwards the original problem is divided into many several sub problems and solved recursively. The major flaw is low sensitivity to control parameters and approaches of this kind carry with a shortcoming because the recursion process is very sluggish due to the repeating subroutines calls.

```
var l, p, g
if l(q)<=1 then
    return q
    select a pivot value from q
    for each value x in q except the pivot
    value
    if x<pivot value then
    add x to l
      if x      pivot value then
    add x to g
    add pivot to p
    return concatenate(quicksort(l),p,
    quicksort(g))
      end if
    end if
```

2.4 Dynamic Programming Algorithms

The idea behind using this algorithm is dependent on the previous results; on the bases of this results find the new results. It is usually apply for optimization problem in longer subsequences. From multiple solutions find the best one, solution sub problem can be reused.

```
Find nth Fibonacci number
if n= 0 OR n=1 then
return 1;
else
computeFabonacci(n−1)
Fabonacci(n−2)
  Find the sum of both numbers
  Store the result
return
```

Many identicalrecursive calls in any calculation causes incompetence and overlapping sub problems such as discrete optimization problems. Dynamic programming algorithms expressed as a powerful algorithmic scheme by [4] particularly for solving discrete optimization problems. Since one major drawback of the algorithm, is the requirement of immense memory space for the result at each state.

2.5 Branch and Bound Algorithms

The algorithm use for combinatorial optimization problems; the algorithm searches the complete solution for given problem in the best solution. The original problem consider as a root and the sub problem as the tree. The upper and lower bounds for a given problem can apply bounding method on each node. If the bound matches then it is the feasible solution. If the bound cannot match then separate the problem of the node into two sub problem as children nodes. Persist on the process until all nodes are solved.

```
Visit each (n) city and minimize the distance
   Let R is the longest path to visit all cities
        To find shortest path select N
              Split N into n1 and n2
n1 is the shortest path to visit city1
n2 is not a shortest path to visit city1
        Continue sub divide the nodes until all
        cities are visited
```

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Branch and bound algorithm generally concerned with the networking scheduling problems such as assembly scheduling to minimize the total flow time. The branch and bound algorithm used to minimize the total weighted flow time for the two-stage assembly scheduling problems and find the optimal solution[5].It provides interesting approaches for finding heuristic solution, for the two stage assembly scheduling flow time problem. However this approach carried with enormously time-consuming restriction because of large number of nodes in branching tree.

2.6 Brute Force Algorithms

Brute force algorithm, also known as naive algorithm, considers all possible paths to find the optimal solution; therefore it can work more efficiently than any other smart algorithm. It is easier to implement for the reason of its simplicity.

In database design brute force algorithm searches and compares all stored images in the database [6]. It is a general problem solving technique and constantly tries to find the solution if it exists. The drawback in brute force algorithm is that it can works efficiently in limited sized problems only. However the algorithm is unpredictably worked leisurely in large sized problems because of its recursive characteristic and not too much beneficial than other methods.

```
Search pattern in the text
initially align the pattern of text
move from left to right
compare each character until all
characters are found
if character found then
successful
else
mismatch
realign again
repeat move.
 end if.
```

2.7 Randomized Algorithms

Randomized Algorithm is used as a tool in computational number theory to find the extensive applications in many types of algorithms. Provide well-organized proper solution for stubborn problems. Speed and straightforwardness are two foremost advantages of this algorithm.Graph theory problem can be solved by randomized algorithm known as minimum-cut algorithm as described in the example below:

```
find minimum-cut (undirected graph G)
whilenodes > 2 in Gdo
choose an edge(u,v) at random in g
        contract the edge, while preserving
multi-edges
        remove all loops
        output the remaining edges
end while
```

One of the simplest data structure known as cactus, represents minimum cut of weighted undirected graph described by [7].Cactus is a tree like graph which contains cycles with more than one vertex. This approach is useful for inter programs, network augmentation and reliability problems. Though the problem is that, the algorithm requires extra storage of memory size according to the input array size.

2.8 Greedy Algorithms

The algorithm finds not only a solution but the best solution instantaneously, for the optimization problem. The functionality of greedy algorithm courses in multiple phases. In each phase initially take the best one result, without observing the final result. Subsequently choose the optimum result at each phase locally and finally leads to the optimal solution globally.

```
Count up USD 5.39 amount using least
number of bills or coins
Select the largest bill or coin first
Choose USD 4 bill
Choose USD 1 bill, to make $5 bill
Choose 25 coins, to make USD 5.25
Choose 10 coins, to make USD 5.35
Choose four 1 coins, to make the USD
5.39
```

Greedy algorithms executes very rapidly and easily, and don't require too much computing resources. A novel kernel-based fuzzy greedy multiple hyperspheres covering algorithm (KFGMHC) for pattern classification proposed by [8]. In the training process, the proposed method

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constructsmultiple hyperspheres covering all training data of each class, each of which encompasses as many data as possible via the greedy method. In the classification process, this approach gives the fuzzy membership function to label the testing data. With appropriate parameters, experimental results showed that KFGMHC's classification is effective on artificial and real data sets. Compared with SVM, this method can have the comparable performance, and compared with the hypersphere-based algorithms, also shows the distinctive advantages in the time complexity and classification accuracies.

However one of the problems is that it always tends to explore the optimal solution globally, but not always reach at the optimal solution. At the time reached at the sub optimal solution, so consider it as a very good solution.

3. EFFECT OF GREEDY ALGORITHM IN GIS AND REMOTE SENSING

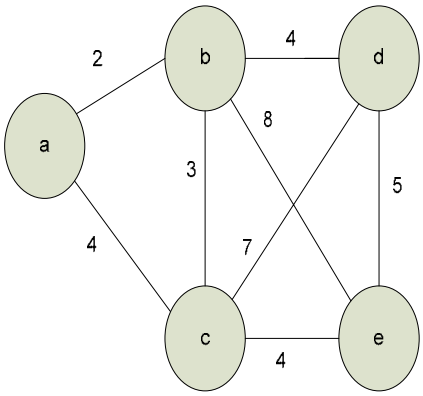
In recent years, there has been an increasing amount of research done on bases of algorithm. By the comprehensive survey of algorithm it is observed that various algorithms designed to map labeling, but the reliable methods are based on techniques such as greedy and exhaustive algorithm [9]--[12]. One of the greedy search algorithms namely Rank and Overlap Elimination (ROPE) proposed by [13]), it provides near optimal solution to the problem by iteratively selecting, the most visibly dominant observer with minimum overlapping landscapes.

Greedy algorithm is developed for robust image matching, fusion and registration in remote sensing imagery [14].This study used the point location information and supply one-to-one correspondence to ensure the consistency of matching results. This new approach matches two images and applies greedy algorithm on real remote sensing IKONOS image. Therefore the algorithm can select 0 unique points from several candidate points with both global and local constraints.

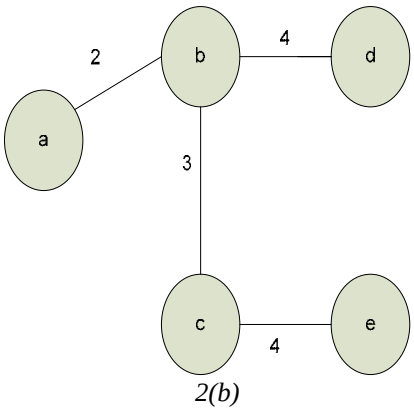
The comparative analysis of three automatic classification algorithms such as Quilan's C4.5, Support Vector Machine(SVM) and Ada Boost(Adaptive Boosting) were carried out [15].In this research before going to Quilan's C4.5 the basic algorithm is build decision tree by using greedy algorithm.

3.1 Minimum Spanning Tree (MST)

MST is one of the most functional algorithms in GIS and remote sensing; it works as single graph with many spanning trees and connected vertices (figure 2). The semiautomatic road extraction system for uploading and storage network data bases was developed [16]. In this research Fuzzy C-Means (FCM) clustering technique and graph theory and greedy algorithm Minimum Spanning Tree (MST) were used. The greedy algorithms such as Kruskal algorithm and Prim's algorithm, utilized to find out MST based on edges and MST based on vertices respectively. The exact exponential time algorithm described [17]used for Generalized Minimum Spanning Tree (GMST). It is based on dynamic programming with the facilitation of Kruskal and prim's algorithm. The robust model was developed, appropriate for a range of problems like, highways, communication links, public facility, branches and distribution centers.



2(a)



2(b)

Figure 2(a) undirected graph with5 vertices and 8 edges (b) reduces the edges by using MST

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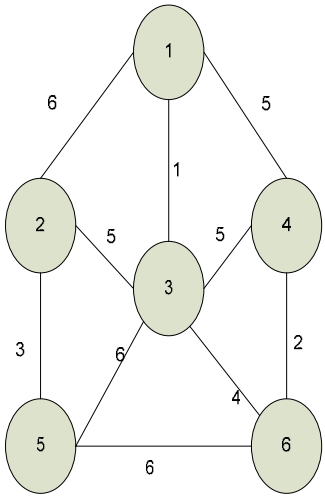
GMST problem defined as an undirected graph with vertex V, edges E and n nodes.

G= (V, E)
| V | = n
K= {1, 2……m} (set of nodes with m portioned clusters)
V= V1, V2…….. Vm
V2 Vk = for all l.
kK (l k)
Let the edges are between the nodes belongs to different clusters and each edge e= {i, j} E. (Has non-negative value Cij or C (i, j))

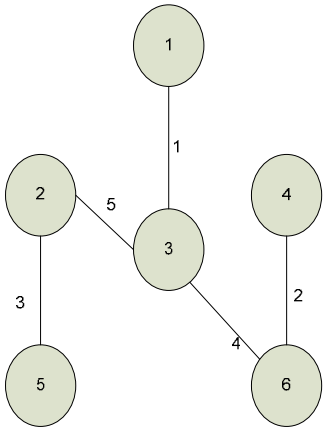
3.1.1 Kuruskal Algorithm

Mosaicking of images have been in practice since long time before the age of digital computers. The construction of mosaic images use of such images on several computer vision/graphics applications have been active areas of research in recent years. There have been a variety of new additions to the classic applications to enhance the image resolution of field of view. Image mosaicking not only create a large field of view using normal camera , but it also used for texture mapping of 3D environment such that user can view the surrounding surface with real image, Therefore image mosaicking is one of the significant features of image processing. Various algorithms are developed to fasten the image registration. The undirected weight mosaicking graph wasintroduced [18], for 2D microscopic images. In this research several approaches based on spanning tree were evaluated. The Kruskal algorithm (figure 3) was applied for mosaicking graph of a series of microscopic images. This method proved that minimum spanning tree of mosaicking graph is better than other methods based on local registration.

A → //initially A is a null set
Edges e;
Vertex u, v;
V v (G) // V trees containing each vertex in graph
(u, v) E // Sort the edges E by nondecreasing order
if u v //(start loop)
Then
A← A (u, v)
Return A



3(a)



3(b)

Figure 3(a) undirected graph with 5 vertices and 9 edges (b) reduce edges Using Kruskal algorithm

3.1.2. Prim's Algorithm

One of the most significance greedy algorithm used by [19] to find out MST for a connected weighted undirected graphs with minimum total length is Prim's algorithm (figure 4). This algorithm is directly based on MST property and maintains a set of vertices in the spanning tree. An integrated structure priori model, based on MST and Prim's algorithm, for predicting pairing approach of Interferometer Synthetic Aperture Radar (InSAR) data recommended [20]. In result small baselines pairs obtained with a predictable optimal InSAR quality.

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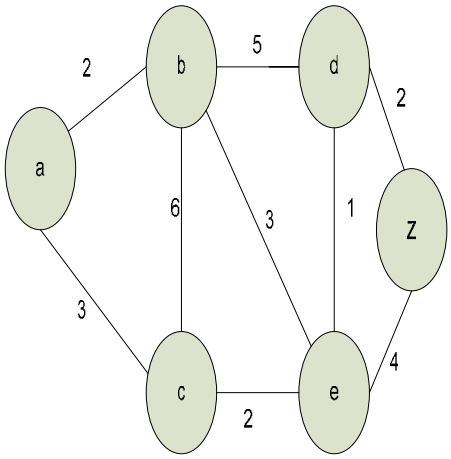
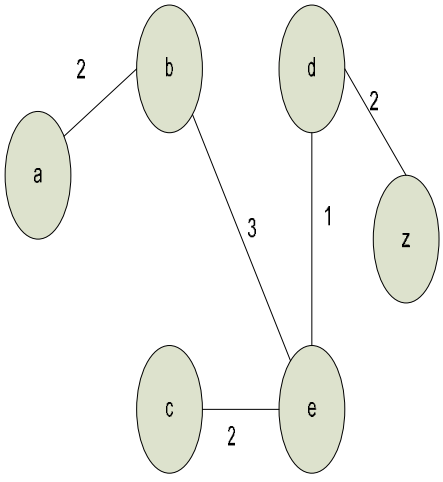
Let *G* is a connected graph with n vertices

T= minimum weighted edge
for*i=1 to n-2* **do**
E=edge of minimum weight at vertex
T=*T* with *E* added
end
return (*T*)



4(a)



4(b)

Figure 4(a) undirected graph with 6 vertices and 9 edge (b) reduce edges using Prims Algorithm

4. IMAGE PROCESSING AND GREEDY ALGORITHM

One of the standard techniques to amend the values of image pixels, for improved visual observation, is the image enhancement. Scalar objective function designed by [21] used to estimate and evaluate contrast image and solve optimization problem. In their research Greedy iterative algorithm was proposed to controls the image enhancement and to prevent color saturation. It will be better if Greedy Kruskal and Prim algorithms can be used to obtain optimal solution by minimum spanning trees. Another research by [22] used Watershed segmentation algorithm with different exponent denoted as power watershed, to maintain the speed of MST algorithm while producing improved segmentation performance. Therefore it is concluded that watershed algorithm can be utilized in different application with computer vision field.

5. DISCUSSION AND CONCLUSION

In this review we examined different algorithms and their convention in image processing. Sorting algorithms used to arrange the data in specific ascending and descending order becomes too slow, when there is large amount of data to be sorted. Recursive algorithm becomes more complicated when continuously recursion occurred. Backtracking algorithm cannot categorize the problem therefore the result become failure. Divide and conquer algorithm is very slow because of its repeating calls. Dynamic programming algorithms required massive memory space and, branch and bound algorithm are time consuming due to large amount of nodes. Brute force algorithms are also very slow because of the recursive nature. We concluded that greedy algorithm can be employed to select optimal result. Other than the important limitation need to be considered is that, the entire time greedy algorithm explores for the best and optimal solution. Every so often if cannot reach the optimal solution, at this time the sub optimal solution selected as the optimal. Greedy algorithms can be proven to yield the global optimum for a given problem class, it is typically becomes the method of choice because it is faster than other optimization methods like dynamic programming.It can be used to solve optimization problems in finite number of steps. Greedy algorithms make choices that look best at that very moment. Therefore greedy algorithm has features that play very well for remote sensing and GIS applications.

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