Quad Tree: New Approach of Representing and Traversing

Deepak Kumar Sharma
School of computer science and engineering,
Bahra University Shimla Hills,
India

Sonia Vatta
School of computer science and engineering,
Bahra University Shimla Hills,
India

***Abstract*:** As we know the computers are widely used in every field either it is of geography, medical, pharmacy, astrology. Astronomy and so on. The ongoing advancements in all these fields require a big database and the place from where this data is retrieved easily to use. The data is some time is in hierarchal format. But the array of memory that we use to save information is in only in 2-D, we have trees for such information in data structure. Q- Tree or Quad tree one of the ways of representing data in the memory. The problem is of representing data in this tree so that one can do searching, insertion and deletion in a fastest manner. With the increase in traversing and searching the performance of the computer too increases.

Keywords: *QLN, BLN, BRN, QRN, Level 1, Level 1+, ROOT*

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1. INTRODUCTION

The tree is term used to describe a class of hierarchal data structure whose common property is that they are based on the principle of regular decomposition such data structure are becoming increasingly important as representation in the fields of image processing , computer graphics, climatic study , geographical area study , study of mutation rate with a change of environment. It means that the tree is very help full for data which is extracted from a parameters and then there sub parameters and so on.

A non linear data structure that is required to represent the data structure is called tree. This data structure is manly contains a hierarchal relationship between elements e.g. records, files, family tree and tables.[1][2]

Tree is of various kinds of tree depending on their applications in computer sciences. Some of the tree kinds are mentioned as

Binary tree: - In a binary tree, each node is having 2 child nodes

Ternary tree: - in ternary tree, each node is having 3 child nodes[3][4]

Quad tree:-quad trees each node is having 4 child nodes[5]

The quad tree is widely in practice in detecting collision in 2D and 3D games and pixel processing to detect image in different image resolution. Many games require the use of collision detection algorithms to determine when two objects have collided, but these algorithms are often expensive operations and can greatly slow down a game As such the collision detection is very costly process in gaming . So in many games we use Quad Tree to detect collision. The Quad Tree is too used to process the polygon or images in graphics. The techniques used to process the polygons in graphics are point to point processing, edge to edge processing and region by region processing. Commonly used techniques for collision detection is spatial portioning and bit- interleaving.[11]

The research is a Qualitative based as the tendency of an accurate search of an element from a multiple hierarchal data of a memory increases. This will increase the search performance when there requires a huge data base to bring out a desire output. Example of such kind of data base and data search is astronomical survey, weather forecasting, study of evolution process on earth and so on. [12]

The research increases the speed of consecutive searches by reducing the back tracking steps. As the increase in speed helps to reduce the time of outcomes of search. This will save time.

2. EARLIER SEARCHING PROCESS

NEIGHBOUR FINDING TECHNIQUES

In this algorithm, each element is individually searched until the desired element is searched. As shown in diagram below, the element search starts from root, after comparing root leftmost leaf element of root node is traversed and compared. If in case the node does not have any node the back tracking is done to previous node and then again next node is searched. This continues until the element is found.

In the diagram below, the node with black color shows the node does not containing data element. Whereas node with blue color shows the node containing element.

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If we count the comparisons and backtracking steps in the diagram below to find out an element in a node. The comparisons are 6 out of which 5 are failed comparisons and 2 are backtrackings steps.

Suppose it is taking 1millisecond time to compare one node and 1 millisecond time for backtrack. The total time used by this approach to find out an element is as

Total time of search an element = 5 failed comparison * I millisecond + 1 successful comparison * 1 millisecond + 2 backtracking * I millisecond (= 8 millisecond)[13][14]

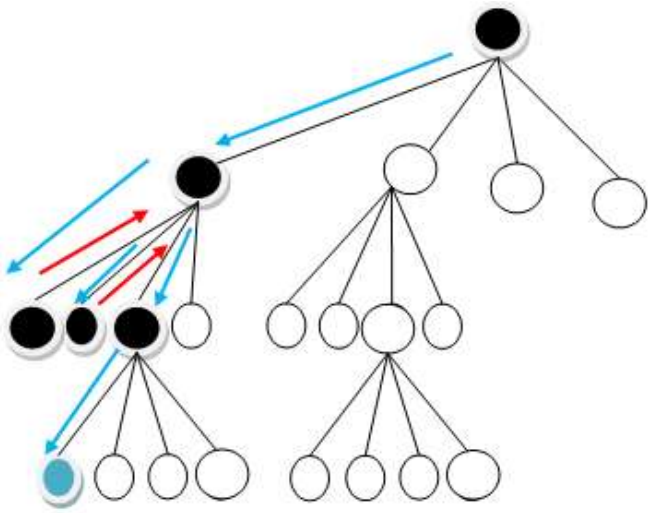

Fig. showing neighbor finding technique

3. PROPOSED TECHNIQUE

To traverse a quad tree it is important to design a quad tree first in such a manner that a particular kind of data resides in a group.

QUAD TREE

Suppose Q is a Quad tree. Then Q is called Quad tree if each node of T is having maximum (2) ^2n leaf where n is a levels of tree.

PROERTIES OF QUAD TREE

In a quad tree each node have maximum four sub-node which is as Quad tree left node [QLN], bottom left node [BLN], bottom right node [BRN] and Quad tree right node [QRN].

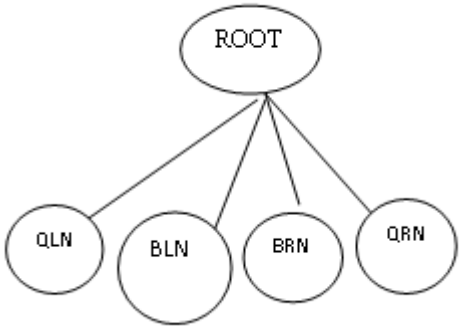

Fig. New proposed design

LEVEL i

Element arrangements of Quad tree in this technique in LEVEL i nodes are as follows:

i= level of tree

1. QLN contains all elements ranging in between 0 to ROOT/2^2*i.

2. BLN contains all elements which come under range ROOT/2^2*i to 2*ROOT/2^2*i i.e. BLNLB (bottom left node lower limit) to BLNUB (bottom left node upper limit).

3. BRN contains all elements having range from 2*ROOT/2^2*i +1to 3*ROOT/2^2*i i.e. BRNLB (bottom right node lower limit) to BRNUB (bottom right node upper limit).

4. QRN contains all elements which contains all elements lies in range 3*ROOT/2^2*i+1 to ROOT

NEW APPROACH OF SEARCHING

To search an element in a quad tree, the new design technique is as follows:

STEPS FOR SEARCHING ITEM

SEARCHING (ROOT)

1. Put ITEM in LOC. Take RANGE = ROOT
2. Calculate range of each sub node of level i
   a. QLN has range 0 to RANGE/2^2*i
   b. BLN has range RANGE/2^2*i+1 to 2*RANGE/2^2*i.
   c. BRN has range 2*RANGE/2^2*i + 1 to 3*RANGE/2^2*i
   d. QRN has all values lies between 3*RANGE/2^2*i+1 to RANGE
3. Selection of initial node to traverse for searching

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3. Selection of initial node to traverse for searching

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4. i=1
    If (0<ITEM< RANGE)

    {
      If (ITEM < RANGE/2^2*i)
    //    search QLN

              {
                 If (LOC = = INFO NODE)
                       Return to ROOT,
                       i++,
Else                                  Traverse QLN
SUB NODE;
SEARCHING (ROOT);
                          }
Else     if(ITEM     <2*(RANGE/(2^2*i))     to
(ITEM>(RANGE/(2^2*i))))
            {
          If(LOC== INFO NODE)
               Return to ROOT.
                    i++;
        else
         Traverse BLN SUB NODE;
          SEARCHING (ROOT);
           }
Else     if(ITEM     <3*(RANGE/(2^2*i))     to
(ITEM>2*(RANGE/(2^2*i))))
        {
              If (LOC== INFO NODE)
                Return to ROOT.
                 I++;
    Else Traverse BRN SUB NODE Searching
(ROOT);
          }
Else     if(ITEM     <4*(RANGE/(2^2*i))     to
(ITEM>3*(RANGE/(2^2*i))))
          {
              If(LOC==INFO NODE)
               Return to ROOT;
               i++;
              Else
                 Traverse QRN SUB NODE
                  Searching (ROOT)
           }
  Else
    {
            ITEM NOT FOUND;
     }
```

MEMORY REPRESENTATION OF A NODE

To reduce the time between two comparisons the new field is introduce to represent the node in a memory along with other 6 field as shown in diagram below.

INFO	ADD	CN1	CN2	CN3	CN4	ROOT

Fig. Representing node in memory

In this diagram, INFO field contains the information or the element that is present in a node. INFO node is followed by NODE ADDRESS which contains the address of the memory location where the INFO element is present. Then there is a child node address of four sub nodes as 1 CHILD NODE (CN1), 2 CHILD NODE (CN2), 3 CHILD NODE (CN3) and 4 CHILD NODE (CN4). After child node addresses there exist an additional field which contains the address of ROOT node.[9]

When the item is search in a node traversing all node one by one. To search a next element in a memory hierarchy the pointer instead of traversing back from same path it will jump to the root node and then new search begins accordingly.

4. CONCLUSIONS

This new approach is useful as it
1. Increases the speed of traversing of quad tree
2. Increases the performance of memory management in distributed data.
3. Gives the efficient way of representing hierarchal data.
4. Increases the speed of searching in the distributed information.
5. Time between two search is reduced.
6. Unnecessary comparisons are reduced.
7, Backtracking steps reduces.

REFERENCES

[1] Data Structures, The McGraw Hill companies, G A V PAI
[2] http://searchoracle.techtarget.com/definition/quad-tree
[3] https://github.com/mbostock/d3/wiki/Quadtree-Geom
[4] http://cboard.cprogramming.com/c-programming/157784-help-me-understand-quadtree-traversal.html
[5] http://ibis.geog.ubc.ca/courses/klink/gis.notes/ncgia/u37.html
[6] www.ncbi.nlm.nih.gov/m/pubmed/21869244/
[7] Artificial Intelligence, Third Edition, Elaine Rich Kevin Knight, Shivashankar B Nair, The McGraw Hill companies
[8] The Introduction to Algorithm, Thomas H. Cormen, Charles E Leiserson, Ronald L. Reivst and Clifford Stein

[9] Data Structures and Algorithms: Annotated Reference with Examples First Edition Copyright Granville Barnett, and Luca Del Tongo 2008.
[10] Hanan Samet computer science Department University of Maryland college park, USA
[11] Sarah F. Frisken and Ronald N. Perry, Mitsubishi Electric Research Laboratories
[12] Kasturi Varadarajan May 2, 2013, journal of applied mathematics.
[13] H.Samet, C A Shaffer, R C Neison, Y. G huang, K . Fujimura and A hosenfeld, recent development in quad tree based geographical information system.
[14] Ivan ·Sime·cek, Sparse Matrix Computations using the Quad tree storage format Department of Computer Science and Engineering, Czech Technical University, Prague
[15] P. Barrett ,Universities Space Research Association & Laboratory for High Energy Astrophysics, NASA/Goddard SFC, Greenbelt, MD 20771