

# Global Position Indexing: Applications

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*Abstract: In this research paper, the problem of indexing physical locations across a planet (like time indexing based on dates/ months/years) is addressed and a solution is provided. Different countries around the world devised various geographical location specification codes (along with state/ province names, district names, city/ town/ village names etc.). But, to this day, there is no addressing scheme to specify various types of geographical locations such as hospitals, hotels etc. around the world. Apart from coarse grain localization of spatial locations using longitude, latitude (on the globe), and fine grain specification of spatial positions is an open research problem. In this research paper, we provide an interesting solution to this problem and its applications. This research paper is an effort in that direction to provide global position addressing. Various interesting applications of such local/global position indexing are provided. It is hoped that such indexing when linked with other addresses such as IPv6 addresses will be very useful.*

*Index Terms: IPv6 addressing, Tuple idea, Global position indexing..*

## I. INTRODUCTION

Human civilization across the planet understood essential concepts associated with nature (physical reality): Space, Time, and Matter. Various types of calendars were proposed to specify time and various generations of gadgets were innovated to measure time. Also, the discovery that planets were spheres led to some ways of specification of location of various geographical regions, such as local/global maps. Kepler discovered and utilized triangulation method to discover laws of planetary motion. Triangulation method formed the basis of Global Positioning System (GPS) using satellites. Google deployed the technology enabling local navigation using Google maps. Google also provided various navigational services on mobile phones such as real time voice based navigational guidance. Sophisticated cars also provide interesting navigational aids. This research paper is organized as follows. In Section 2, local position indexing problem is addressed and a solution is provided. Also, some applications are discussed. In Section 3, global position indexing solution is proposed and some applications are proposed. This research paper concludes in Section 4.

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## II. LOCAL POSITION INDEXING: NODE REPRESENTATION AND APPLICATION

The spatial locations on the planet are classified into various categories. For example, continents, oceans, forests, farms and so on. The invention of agriculture led to widespread occupation of land region called farms. With the progress of civilization, land regions are designated for various purposes such as houses, schools, temples etc. Also Homosapien were trained for various professions resulting in designations/ classification of inhabitable region into various categories such as hotels, administration places, forts etc. The onset of industrial revolution led to the birth of cities, towns etc. and their occupation by various industries, hospitals, residential, places, universities etc. Thus, spatial locations around the globe were locally classified/labelled and assigned different names in the local language. Also time was organized using different calendars.

For navigation purposes local and global maps were proposed. Advances in information & communication technologies as well as technologies like global positioning system (GPS), internet, World Wide Web enabled navigation using smart phones a reality.

The planar (Euclidian plane) approximation of regions on the planet locally seems to be a good for navigation using cars, trucks, trains and other such vehicles. Thus the locations on plane can be well represented using graph data structure. The vertices of a weighted graph (of different types of weights such as distance, road conditions etc) belong to different types/classes such as hospitals, hotels, schools, universities, prisons etc.

### A. Goal

To find a representation for nodes/ vertices of a graph locally as well as globally such that every spatial location on the planet is uniquely specified with respect to type/class and other attributes (e.g. country, state, district etc.).

This objective has relationship to utilization of IPv6 addresses in realization of IOT. In fact, we propose utilization of some of the bytes in 16 byte IPv6 addresses for specification of various types of nodes on the planet.

### B. Tuple idea

There are 195 countries in the world. These countries have number of states, cities, towns, villages etc. Further each of these cities/towns have number of various institutions like hospitals, universities, restaurants etc.

Let's say a tourist wants to take a tour of a city. Now, this person not only needs to know about various tourists spots but also hotel (where he wants to stay), railway station (from where he can catch a train) and other such places. Many of these institutions will then have further constraints like

rating, comfortability, good services, near to railway station or airport and cost efficient. Since he is new to city, he will have lots of difficulty in making his decisions.

Therefore, we need to think of a way through which we can index each and every building an institution keeping in mind all the mentioned and other unmentioned constraints. Not only indexing, we need to think of an algorithm through which we can represent these institutions and buildings as nodes of graph which then can be optimize using suitable graph optimization algorithm. This will in turn help that particular person in making best possible decisions. There can be various kinds of institutions in a particular city. Some of these are as follows:

1. Hospitals
2. Police station
3. Railway station
4. Restaurants
5. Hotels
6. Airport
7. Malls
8. Movie theatre
9. Various kinds of shops
10. Educational institution (schools, colleges etc)
11. Administrative buildings
12. Gardens and parks (stadiums)
13. Bus stop
14. Temples
15. Club and bars

All these institutions can have various constraints as discussed earlier.

### C. Tuple idea (for indexing)

Just like an IP address, we can assign each and every above mentioned institution a unique tuple. For now, let's say that this tuple consists of 5 elements. Element 1 is assigned for a particular country. For e.g. If the code for India is 91, then we can assign element 1 as 91 to represent India. Element 2 and 3 are assigned for representing a state and city in that country (which is represented by element 1) respectively. Element 4 is assigned to a particular kind of institution like hospital, temple, hotel etc. Element 5 will be assigned value according to the various constraints on institution represented by element 4.

In this way, we can assign a unique tuple to a institute with particular set of constraints/requirements. In other words, based on different attributes / types associated with a geographical location, unique tuple is used for indexing it. We expect large number of applications for global position indexing using unique tuples. We explicitly specify some applications in the following discussion.

1. Apartment / House selection: Recommended communities in a city
2. Hospitalization satisfying various constraints (cost, nearness to a hotel/restaurant etc.)
3. Hotel reservation (for rent, for offering a party etc.)
4. Planning for future expansion of a city (gated communities, business parks etc.).

In operations research and other related disciplines, several interesting problems (related to this research paper)

are well studied and some solutions are proposed. Some of them are:

1. Transportation and Trans-shipment Problems
2. Travelling Salesman Problem
3. Community Extraction in Social Networks
4. Maximum Flow Problem
5. All-pairs Shortest Path Problem
6. Graph Coloring Problems

We expect graph/ hypergraph based optimization problems to naturally arise in navigation based on local / global position indexing. Some of these problems involve selection of nodes, paths, subgraphs, cuts, spanning trees, Hamiltonian tours, independent vertex sets etc.

In navigation problem, typically one needs information related to details associated with various types of nodes (cost of hospitalization etc.). Also, nodes of various types need to be visited based on optimal attributes related to the nodes. Also, one needs to locate a sub-graph/ sub-hypergraph in the region (e.g. city) being navigated (e.g. need a hospital close to a hotel, medical store, restaurant which are cheaper among available ones). More generally, graph/hypergraph based optimization problem with various types of adjacency/nearness constraints naturally arise.

Thus, in summary known graph/ hypergraph theoretic concepts, problems, algorithms are useful (in the global position indexing based navigation). But, more interestingly, novel graph/hypergraph concepts, problems (optimization, sorting, searching etc. problems), algorithms will naturally arise and are needed to be understood/ discovered.

In this section, we mainly discussed local position indexing and its applications. We briefly pointed out global position indexing with tuple idea. We now take a closer look at issues and applications of position indexing globally.

## III. GLOBAL POSITION INDEXING: APPLICATIONS

Invention of telephone led to the first communication network which is a wired network. It led to the concept of addressing the nodes of a communication network, namely the global telephone numbers. In due course of time, various communication networks (Ethernet, Internet) needed the addresses like IP address, MAC address etc. To be able to specify the address in computers/digital circuits, the addresses are proposed to be certain number of bytes (bits). In the case of IP addresses, they are also linked to a Domain Name System (DNS) to enable easy mnemonic based representation.

In some sense, Tuple idea for global position addressing is a natural representation for specifying a physical location globally. We are naturally led to the following questions:

1. How large should the global location address be in view of future demands?

(It seems that the answer to this question needs the known information about global dimensions (of say the inhabited area/volume, forest area, ocean area/volume etc.). For instance, with residential towers, one needs to take into account

that in a building, there can be multiple floors. In some sense divide the space into fine grain locations (to the resolution desired e.g. floors in a building) and index them into various types based on the attributes. Most generally, we are led to the need for SPACE-TIME INDEXING schemes.)

2. Can such an addressing scheme be updated based on future demands? Should IPv6 addresses (16 bytes) be linked/ Associated with tuple based location addresses? (i.e. Linking Internet of Things with Physical Location of various types of institutions that are present on the planet)

**Note:** As in the case of Internet addresses, Domain Name System type binding for tuples associated with spatial location can be facilitated ( e.g. For a location INDIA, AP, Guntur,.....). It should be noted that in the case of IP addresses, tuple value cannot fixed 256. But such restriction may not be possible with position related tuples.

#### Applications:

1. Tourism Across World: Global location indexing enables OPTIMAL PLANNING (in terms of cost, comfort, time-efficiency etc.) of locations to be visited in some time sequence, in some time frame etc.
2. For military and civilian applications, navigation of DRIVERLESS vehicles can be facilitated using global indexing.
3. Intelligent Transportation Systems can be enabled for monitoring the position of vehicles rendering issues like accident notification, congestion status etc. Also, global position indexing could enable terrorist plot forecasting and crime prediction.
4. City Administration: Most locations in a city anywhere in the world is associated with the following numbers: (a) landline and cell phone numbers, (b) Aadhar/Social Security numbers, (c) local IP addresses, (d) Fax numbers, (e) Barcodes, (f) Ethernet Card codes, (g) ZIP/PIN codes, (h) Airport/Train Station codes, (i) State/Country/District etc. codes etc. It will be very convenient for administrative officials to relate these with tuple based indexing associated with physical locations (such as apartments, hotels etc.).
5. Real Time Navigation with various types of constraints globally for civilian and military applications.

#### IV. CONCLUSION AND FUTURE WORK

In this research paper, the problem of indexing various types of physical locations on the planet is considered. It is reasoned that on a local position scale, various interesting graph/ hypergraph problems naturally arise. For some such problems, graph algorithms are known. For future work, we need to devise a way (may be a formula) to assign weight to any institution and to the path (edges) between any two institutions based on their corresponding tuple. This will give us a concise graph problem with edges and weights. We can then work various optimization algorithms on these problems which will ultimately give us the best possible solution. For e.g. this will give our tourist (from section 2.2) a best possible way to tour city (where best possible way means devising a tour keeping in mind his/her requirements and constraints). But there are several other problems for

which the solutions are not known. Also applications of local/ global position indexing are discussed.

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