Université de Bretagne Occidentale

Master 2 Recherche en Informaticque

Lab-STICC

Bibliographic Report

Propagations and Geographical Contexts

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1. Introduction

With widespread applications, Wireless Sensor Networks have rapidly developing in information technologies over the last few years. They are infrastructures containing sensing, computing and communication elements that aim measure, collect and react to occurrences in the monitored environment [9]. The calculation of radio ranges is an example of a propagation problem which can become very difficult in some contexts. These calculations are necessary for the planning of sensor networks for environmental measurements. Radio propagation is the behavior of radio waves as they travel, or are propagated, from one point to another, or into various parts of the atmosphere. Radio propagation has many practical applications, from choosing frequencies for international shortwave broadcasters, to designing reliable mobile telephone systems, to radio navigation, to operation of radar systems [5]. It is obvious that take into account the terrain topology is essential for the assessment of the scope during the planning of a network and during its maintenance. However, and there are other "obstacles" that will influence the propagation, for example the presence of electromagnetic disturbances, pollution, or meteorological data. The propagations themselves can be in line-of-sight, or undergo changes during the journeys. Line-of-sight propagation is a characteristic of electromagnetic radiation or acoustic wave propagation which means waves which travel in a direct path from the source to the receiver [6]. In addition, they are not necessarily in the domain of signals, and may relate to biological (plant propagation, propagation of species…), physical or chemical phenomena (Chain propagation).

The radio propagation is (for example) carried out by cellular automate which quantify the line-of-sight of the transmitter on all the cells of an area. The management of topologies, radio sources, propagation simulation results are carried out on an open information system, allowing the integration of varied data and the treatments publication. The objective of this internship is necessary of modeling a database which can handle data input and integrate public database to simulate propagation.

From these issues, we propose explore and use public data sources, focusing first on topologies (SRTM, Lidar, ..), second on contextual physical data, critical for the course. Data access and data conditioning are essential. Third, we study cellular automata, cell network, Netgen.

2. Cellular Automata

Cellular automata provide deterministic mathematical model to simulation biological, physical, computational systems. Cellular automata has ability of complicated behavior and to produce complex pattern and structure although their construction is simple [1]. Physical systems containing many discrete elements with local interactions are often conveniently modelled as CA. Beside, CA was used to model many biological systems. The development of structure and patterns in the growth of organisms often appears to be governed by very simple local rules (Thompson, 1961; Stevens, 1974) and is therefore potentially well described by a CA model. In addition, the problems in number theory and their applications have used CA to tapestry design. And cellular automata may be considered as parallel processing computers [2] [10].

According to Wolfram, cellular automata have 5 main characteristics of: they consist of a discrete lattice of sites, evolving in discrete time steps, each site takes on a finite set of possible values, the value of each site evolves according to the same deterministic rules and the rules for the evolution of a site depend only on a local neighborhood of sites around it [3].

Basically, there are two main components which CA consists:

- The first: is a cellular space that cells grid, each cell has an identical pattern of local connection to other cells for input and output. Usually, the cell contain several states that is chosen from a finite number states. The cell only has binary value (0,1) is the simplest case. Cells neighborhood is defined relatively to the specified cell (center). The number of neighbor depend on the pattern chosen in modeling process.

The state of center cell will be calculated by using the defined rule and it cells neighbor state.

- The second component is a transition rule (CA rule) which used in the update of the state (at time t+1) of each cell according to its current state and the states of its neighborhood (at time t). Typically, the rules for updating states of all cells are the same and no change over time. Generally, the CA exits under various forms. The simplest CA is one being the one dimensional lattice, meaning that all the cells are arranged in a line. Then, the neighborhood of the cell are just in its left and its right. Meanwhile, for the two-dimensional lattice, the most common types of neighborhood are Moore neighborhood and Von Neumann neighborhood [2] [10].

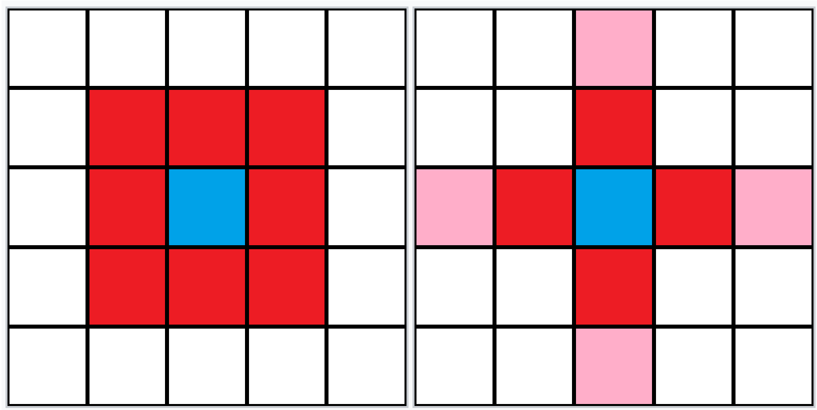

Figure 1. Von Neumann and Moore neighborhood

3. PickCell tool and cell networks

3.1 PickCell tool

PickCell is a model tool which was developed by Lab-STICC s allowing to produce inputs and organizations for physical simulations. These simulation involve lot of computations. In using this tool, the input data will be from diversity public resource such as GooglеMap, OpenStreetMap, etc. These data are geographic data. They will be analyze and process to produce cell network structure which represent for physical system. Usually, this process consist three main steps: preprocessing data, segmenting data into cells, recognizing similar cells and grouping into layers [8].

Preprocessing for image preparation: In the case of maps, geographic information is yet presented in a comprehensive way. However analyzing maps is still useful to obtain information without the direct contact of an initial information system (GIS). More difficult is the case of satellite or air images, because the synthesis of objects necessitate preprocessing [8].

Segmenting the image into cells: To obtain regions, it is necessary to group zones of the image based on similarities of different kind. The first operation is a fragmentation into blocks of different size and geometry [8].

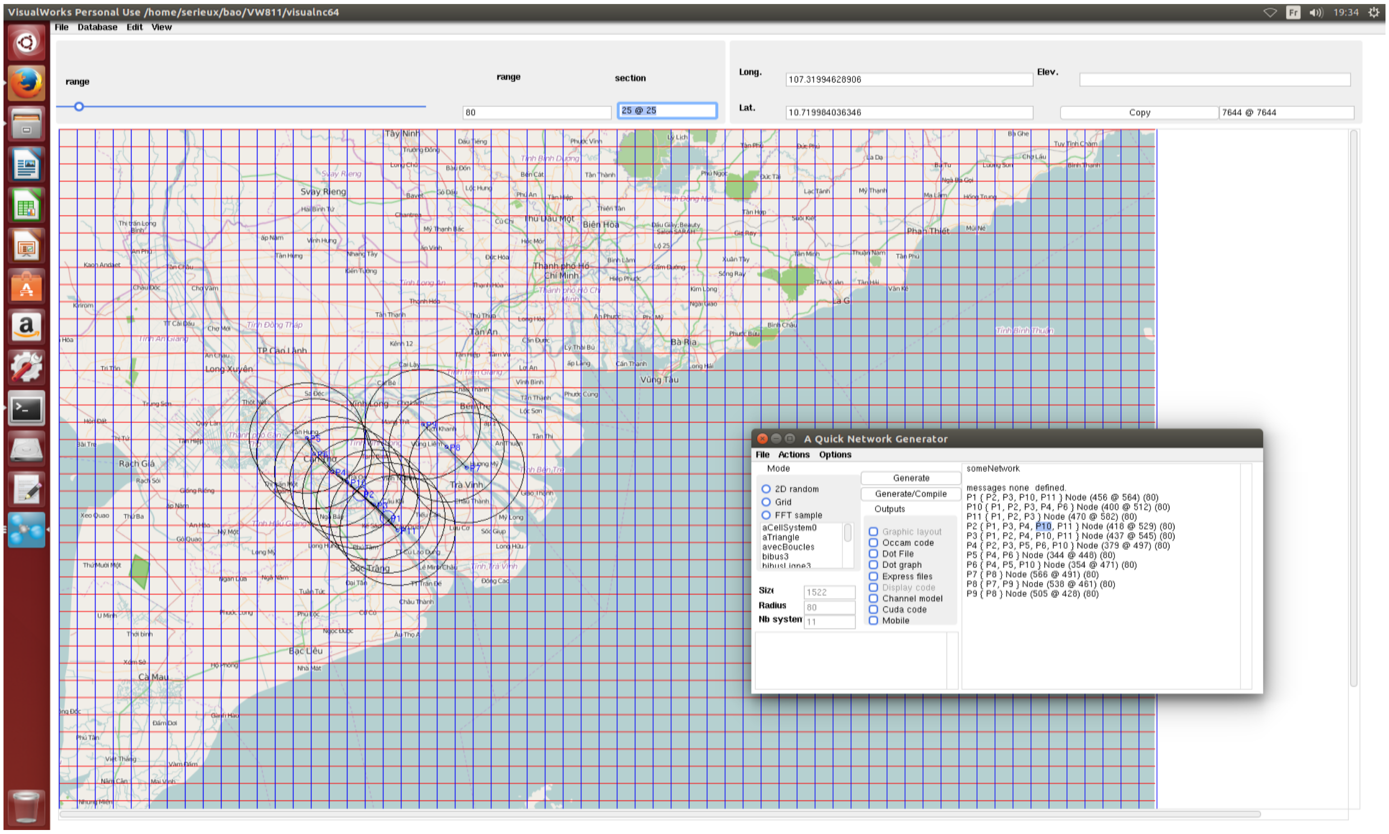

Figure 2. an example for using PickCell tool

In this example shows a simulation of establishing sensor network to monitor the pollution level on rivers. Several sensors are arranged on two rivers with range = 80. The map is a topology form for a sensor network. The small box in the figure is sensor network structure expressed.

3.1 Cell network

A cell network is a group of cells which have relations together.

There are four elements which are stored as data in each cell:

- Identity

- Local state

- Links to other cells (or its neighbour)

- Relative positions to its the neighbour (help determined neighbour and useful for simulating the weather data, water flow or meteorological data) [10].

Direction	Value
East	(1,0)
West	(-1,0)
North	(0,-1)
South	(0,1)

Table 1. A basic cell network example [10]

It is obvious that using cell network in developing physical simulations. Firstly, each cell network is a clear and consistent structure. Secondly, the problem of the latency of input data was handled because the cell networks were generated from PickCell tool. Displaying and analyzing simulated results will be more efficient via the PickCell tool allows to extract visible data [10].

4. SRTM Topography

4.1 Introduction

The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained digital elevation models on a near-global scale to generate the most complete high-resolution digital topographic database of Earth prior. SRTM consisted of a specially modified radar system that flew on board the Space ShuttleEndeavour during the 11-day STS-99 mission in February 2000, based on the older Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar (SIR-C/X-SAR), previously used on the Shuttle in 1994 [6].

4.2 SRTM data characteristic

The SRTM data sets result from a collaborative effort by the National Aeronautics and Space Administration (NASA) and the National Geospatial-Intelligence Agency (NGA - previously known as the National Imagery and Mapping Agency, or NIMA), as well as the participation of the German and Italian space agencies, to generate a near-global digital elevation model (DEM) of the Earth using radar interferometry [7].

The SRTM data have undergone a sequence of processing steps resulting in several data versions having slightly different characteristics. In addition, the different naming conventions used by the NGA and NASA can lead to some confusion. In the first step raw SRTM radar echo data were processed in a systematic fashion using the SRTM Ground Data Processing System (GDPS) supercomputer system at the Jet Propulsion Laboratory. This processor transformed the radar echoes into strips of digital elevation data, one strip for each of the 1000 or so data swaths. These strips were then mosaicked into just less than 15,000 one degree by one degree cells and formatted according to the Digital Terrain Elevation Data (DTED) specification for delivery to NGA, who are using it to update and extend their DTED products. The DTED specification will be detailed in Section 4.4. The data were processed on a continent-by-continent basis beginning with North America and proceeding through South America, Eurasia, Africa, Australia and Islands. These data were also reformatted into the SRTM format. In the next step, NGA applied several post-processing procedures to these data including editing, spike and well removal, water body leveling and coastline definition. Following these "finishing" steps data were returned to NASA for distribution to the scientific and civil user communities as well as the public [7].

4.3 SRTM data Format

The names of individual data tiles refer to the longitude and latitude of the lower-left (southwest) corner of the tile (this follows the DTED convention as opposed to the GTOPO30 standard). For example, the coordinates of the lower-left corner of tile N40W118 are 40 degrees north latitude and 118 degrees west longitude. To be more exact, these coordinates refer to the geometric center of the lower left sample, which in the case of SRTM3 data will be about 90 meters in extent.

SRTM1 data are sampled at one arc-second of latitude and longitude and each file contains 3601 lines and 3601 samples. The rows at the north and south edges as well as the columns at the east and west edges of each cell overlap and are identical to the edge rows and columns in the adjacent cell. SRTM3 data are sampled at three arc-seconds and contain 1201 lines and 1201 samples with similar overlapping rows and columns. This organization also follows the DTED convention. Unlike DTED, however, 3 arc-second data are generated in each case by 3x3 averaging of the 1 arc-second data - thus 9 samples are combined in each 3 arc-second data point [7].

4.4 SRTM DTED Format

Digital Elevation Model: The elevation information is derived from the signals reflected on the Earth's surface. Depending on the wavelength the radar signals penetrates the ground coverage and in some cases even the ground. The short wavelength of the X-band however causes normally a reflection on the surface producing a height surface model similar to the optical stereo case. The individual elevation values are generated from signals reflected by an area on ground of an approximate size of 25 x 25 m. The model is transformed into geographic coordinates and is provided in tiles of 15' (arc-minute) size in latitude and longitude. The product volume is about 3 Mbytes including the DEM and the corresponding height error map (HEM). This allows a fast provision and distribution over the internet. The distribution format is DTED (Digital Terrain Elevation Data) [4].

Raster	size 1"x1" Lon& Lat
Height	levels 1m
Datum (horizontal)	WGS84
Datum (vertical)	WGS84
Data format	16-bit Signed Integer
Horizontal accuracy (absolute)	±20m 90% circular error
horizontal accuracy (relative)	±15m 90% circular error

vertical accuracy (absolute)	±16m 90% vertical error
vertical accuracy (relative)	±6m 90% vertical error

Table 2. DEM product

The product specification of the SRTM/X-SAR DEM is listed in Table 2.

Record Sequence and File Structure:

Both files - DEM (Digital Elevation Model) and HEM (Height Error Map) – are structured by the following records:

UHL: User Header Label

DSI: Data Set Identification Record

ACC: Accuracy Description Record

DATA: Data Record

A data file of DTED is a cell defined by latitudes and longitudes of a geographic reference system. The terrain elevation information is expressed in meters. The locations of elevation posts are defined by the intersections of rows and columns within a matrix. The latitude and longitude grid spacing will be in whole second intervals. The elevations with a data record have a constant longitude value. The first data value is the southernmost known elevation and the last data value is the northernmost. No two data records shall have the same longitude value. Within a data file, the data records are arranged by ascending longitude [6].

<u>User Header Label:</u>

Field	Bytes	Contents	Description
1	1-3	UHL	Recognition sentinel
2	4	1	Fixed by standard
3	5-12	DDDMMSSH	Longitude of origin (lower left corner of data set; full degree value; leading zero(s) for all subfields: degrees, minutes and seconds) H is the Hemisphere of the data
4	13-20	DDDMMSSH	Latitude of origin (lower left corner of data set; full degree value; leading zero(s) for all sub fields: (degrees, minutes and seconds) H is the Hemisphere of the data
5	21-24	SSSS	Longitude data interval in seconds (decimal point is implied after third integer)
6	25-28	SSSS	Latitude data interval in seconds (decimal point is implied after third integer)
7	29-32	0000-9999 or Not Available (NA$$)	Absolute Vertical Accuracy in Meters (With 90% assurance that the linear errors will not exceed this value relative to mean sea level (Right justi-fied))
8	33-35	U	Unclassified Security Code
9	36-47	Unique Reference	*Unique reference number (Provides Number pointer to file containing detailed file description)
10	48-51	Number of longitude lines	Count of the number of longitude (profiles) lines
11	52-55	Number of latitude points	*Count of the number of latitude points per longi-tude line
12	56	Multiple accuracy	0 - Single 1 – Multiple
13	57-80	Reserved	Unused portion for future use

Table 3. User Header Label [4]

Data Set Identification Record

Field	Bytes	Contents	Description
1	1-3	DSI	Recognition Sentinel
2	4	U	Unclassified Security Code
3	5-6	Spares	Security Control and Release Markings
4	7-33	Spares	Security Handling Description
5	34-59	Spares	Reserved for future use
6	60-64	DTED1 or DTED2	DMA Series Designator for product level
7	65-79	000000000000000	Unique reference number
8	80-87	Spares	Reserved for future use
9	88-89	01-99	Data Edition Number
10	90	A-Z	Match / Merge Version
11	91-94	0000	Maintenance Date (Zero filled until used)
12	95-98	0000	Match/Merge Date (Zero filled until used)
13	99-102	0000	Maintenance Description Code (Zero filled until used)
14	103-110	DEDLRDFD	Producer Code
15	111-126	Spares	Reserved for future use
16	127-135	Spares	Product Specification (Alphanumeric field)
17	136-137	00	Product Specification (Amendment Number 00-99)
18	138-141	0000	Date of Product Specification (YYMM)
19	142-144	W84	Vertical Datum
20	145-149	WGS84	Horizontal Datum Code
21	150-159	GeMoS2.0.0	Digitizing/Collection System
22	160-163	YYMM	Compilation Date
23	164-185	Spares	Reserved for future use

Table 4. Data Set Identification Record [4]

Accuracy Description Record

Field	Bytes	Contents	Description
1	1-3	ACC	Recognition Sentinel
2	4-7	NA$$	Absolute Horizontal Accuracy Not Available (NA)
3	8-11	NA$$	Absolute Vertical Accuracy Not Available (NA)
4	12-15	NA$$	Relative (Point-to-Point) Horizontal Accuracy Not Available (NA)
5	16-19	NA$$	Relative (Point-to-Point) Vertical Accuracy Not Available (NA)
6	20-23	Spares	Reserved for future use
7	24	Spares	Reserved for DMA use only
8	25-55	Spares	Reserved for future use
9	56-57	00	Multiple Accuracy Outline Flag 00 = No accuracy sub regions provided
10	58-2613	Spares	Accuracy of Sub regions
11	2614-2631	Spares	Reserved for DMA use only
12	2632-2700	Spares	Reserved for future use

Table 5. Accuracy Description Record [4]

Data Record

Field	Length in Bytes	Contents	Description
1	1	170	Recognition Sentinel
2	3	Data block count	Sequential count of the block within the file, starting with zero for the first block (Fixed Binary)
3	2	Longitude count	Count of the meridian. True longitude = longitude count x data interval + origin (Offset from the SW corner longitude) (Fixed Binary)
4	2	Latitude count	Count of the parallel. True latitude = latitude count x data interval + origin (Offset from the SW corner latitude) (Fixed Binary)
5	2	Elevation 1 - n	True elevation value of point 1-N of meridian in meters (Fixed Binary)
6	4	Checksum	Algebraic addition of contents of block. Sum is computed as an integer summation of 8-bit values (Fixed Binary)

Table 6. Data Record [4]

5. Conclusion

This internship will model a database to handle data input and integrate public database for simulate propagation by exploring and using public data sources, focusing on topologies (SRTM, Lidar, ..), on contextual physical data, critical for the course, studying data access and data condition, cellular automata, cell network, Netgen.

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