Computer Software for Generating Digital Cadastral Databases

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Abstract

The most recent and major spatial information technology development in Malaysia is the establishment of the National Land Information System (NaLIS). It is a system which enable the exchange and sharing of land related information between government bodies, private agencies and general public. Computerization and digital data are the keywords in the new venture. With this in mind, Center for Geographic Information & Analysis (CGIA) has taken a step forward in the direction of establishing a Digital Cadastral Databases (DCDB). This paper describes the development of a software package for generating DCDB being developed by CGIA.

1. Introduction

In the 1990s, Malaysia has been experiencing rapid development. One of the crucial element in planning and monitoring the development is the availability of land-ralated information. However, the retrieval of land-related information is very problematic and time consuming. This has led to the establishment of various information systems by land-related agencies in Malaysia based on individual perceptions, specifications and standards. The lack of a standardized system has resulted in :

- The duplication of data capture and preparation by the agencies
- Inconsistencies and inaccuracies in the information made available through different land related agencies
- The need to liaise with several land related agencies in order to extract all the required information
- Inefficient storage of land related data and information with no facility for correlating and updating of the information in a timely and accurate manner
- Delays in the implementation of projects due to the unavailability of information within the required time-frame as well as incorrect or outdated information being erroneously obtained

In order to deal with this problem, there is a need to integrate existing land related information systems so that the physically isolated islands of information systems (Figure 1) can function as a single system (Figure 2). Thus comes the concept of NaLIS.

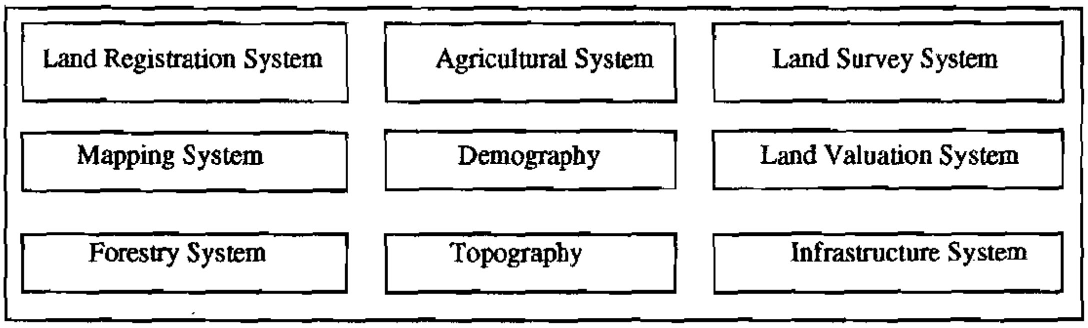

Figure 1 : Islands of Information Systems

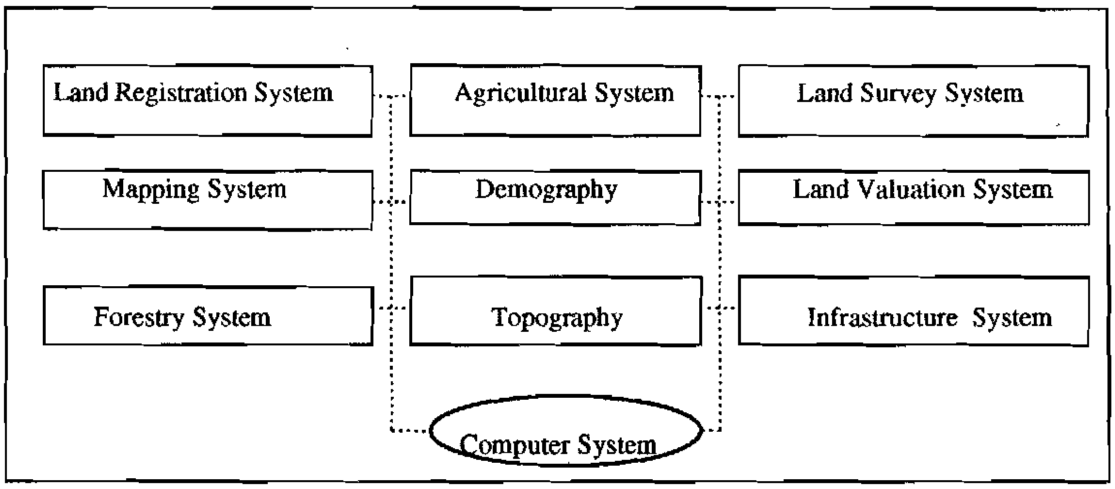

Figure 2 : The Concept of NaLIS

NaLIS consists of a physical infrastructure made up of computer hardware, software and communication designed to:

- Enable effective sharing and exchange of land related information between government and private organizations
- Facilitate the evolution and sustenance of a national land inventory
- Assist the process of land uses planning and management

It is inevitable that the Land Survey System (LSS) consists of data (graphic) pertaining to land lots. As land is an expensive comodity especially in the urban areas, this data is very important because it determines the legal boundary of land ownership. Besides, LSS go hand in hand with the national Land Registration System. With the establishment of the NaLIS, LSS will also provide the coordinate system as a base for most information systems. Thus there is a prerequisite that LSS is to be created first.

As a result, The Center for Geographic Information & Analysis (CGIA) Universiti Teknologi Malaysia being the first and sole center in the country specialized in the development of GIS has taken the initiative to develop a computer software for building the graphical lot data. The digital form of this data is known as Digital Cadastral Databases (DCDB).

Section 2 of this paper discusses the need for a digital cadastral database. This followed by an overview of the developed prototype software in Section 3. The principles and parts of the program are also discussed here. Following this section is an explaination of the commands and menus. Section 4 discusses a sample session. The results and analysis of the product from the package is probed in Section 5. Finally the paper concludes with the positive outcomes of having a DCDB.

2. The Need for Digital Cadastral Databases

Before addressing a database system, the concept of database must be stated. A database is defined as a collection of interrelated data stored together without harmful or unnecessary redundancy to serve multiple application; a common and controlled approach is used in adding new data and in modifying and retrieving existing data within the database [Martin 1975].

The question then arises, why is there a need for a Digital Cadastral Database. There are four main reasons. They are :

- A common database so that all users or government departments can economically access to the information at ease
- Digital information allow easy access through the computer network without the loss of precious time
- An inventory of cadastral information that could be updated and maintained in a very easy and feasible manner
- Information extracted shall always be up to date and accurate at run time thus minimising losses

With the development of a Digital Cadastre Database, users from within or outside their respective information community will be able to exchange data and information with no fear of misunderstanding since they are all expressed in terms of a common set of attributes.

The Digital Cadastre Database plays a vital role, not only in the management of fiscal, legal or multipurpose cadastre information but also in providing an infrastructure to assist with the management of development plans, permits and government policy.

3. ZAPSS System

3.1 Overview

The purpose of the software is to convert cadastral data into digital forms of attributes and graphics. The information to be converted is obtained from existing Certified Plans (CP). The method of data entry is through keyboard. This method was chosen instead of digitizing which is definitely cheaper and faster was due to several reasons. They are as follows:

- Digitizing proves less accurate especially working on worn certified plans and exhausted digitizer
- Digitizing causes the data to lose her quantitative values which are significant in the legal aspect

Data from certified plans such as bearing and distance, positions of boundary marks, coordinates, area, lot numbers and other related attributes are first entered. After data entry, all values of boundary marks will be computed and adjusted.

3.2 Developing ZAPSS

The prototype software has three modules. They are:

- Data pre-entry computation
- Data entry and processing
- Combination of data files to form continous DCDB

3.2.1 Module 1 : Data Pre-entry Computation

This module is only executed in cases where the bearings and/or distances of boundary lines between internal lots or better known as sub-divisional lines of a closed polygon are scaled values. The system will calculate the mean values to determine the attributes. It must be noted that roads and vacant lands connected to the traverse lines must be assumed to be a polygon in order for the computations to be done. Nevertheless, these cases are very rare in nature.

3.2.2 Module 2 : Data Entry and Processing

In the first part of the module, data entry via keyboard is done. Unless the coordinates are found to be erroneous, they will be used as the basis for the deriviation of all coordinates in the CP.

This followed by the second part of the module which is data processing. Coordinates of boundary marks will be computed and adjusted using transit rule for data from each sheet of certified plan. Transit rule is used to preserve the shape of the lots. This computation is done on lot per lot basis and the coordinates computed from one lot shall be carried to the adjacent lot. To deal with cummulative errors along the computation path, conformal transformation is executed to eliminate the discrepancies between the computed coordinates and the given corner coordinates of a CP.

The end product will be each point will having her own absolute coordinate. As an output, digital files having the new values will be generated by the system. Figure 3 depicts the data entry and processing stage of the software.

```
main( )
{
fstream f;
f.open ( "open input file " ) ;
ifile>>bearing,distance;
if (scaled_values = = present )
  {
     run module 1 for mean computations;
  }
else
  {
    compute coordinates;
    compute linear misclosure;
    run transit adjustments;
    perform conformal transformation;
  }
ofile<<new_coordinates;
return 0;
}
```

Figure 3 : Pseudocode depicting the data entry & processing stage.

3.2.3 Module 3 : Combination of Data Files To Form Continous DCDB

After entering all the data from a series of certified plans covering a mukim or even a state, it is time to combine all the data files generated by the second stage to form a continous database. This operation is executed by the third module.

The main operation here is the joining of adjacent lots in all CP's. This is done by joining lots which are adjacent in different CP's. The system does this by searching for common boundary marks and verifying its absolute location. Should it satisfy the system's criteria, thus the lots are joined. This process of conglomerating all the adjacent lots will then lead to a formation of a network of cadastral lots which we call the digital cadastral database (DCDB). Figure 4 illustrates the stages involves in the combination of lots.

```
main( )
{
fstream f;
f.open ( "open output files from module 2 " ) ;
search_files:
ifile>>common_boundary_marks,adjacent_lots;
 while ( common_boundary_marks II adjacent_lots = = present )
  {
   join all adjacent cadastral lots;
  ofile<<new cadastral database;
  }
goto search_files;
return 0;
}
```

Figure 4 : Pseudocode depicting the process of combining lots to form a digital cadastral database.

3.3 Prototype Software : ZAPSS Version 1.0

ZAPSS Version 1.0 is a prototype implementation of the cadastral database software described in Section 3.2. It was programmed in FORTRAN 77 and Turbo Pascal Version 5.0 using a PC 486 DX2/66.

In is undeniable that every good software has its own organization. ZAPSS's organization chart is shown in Figure 5.

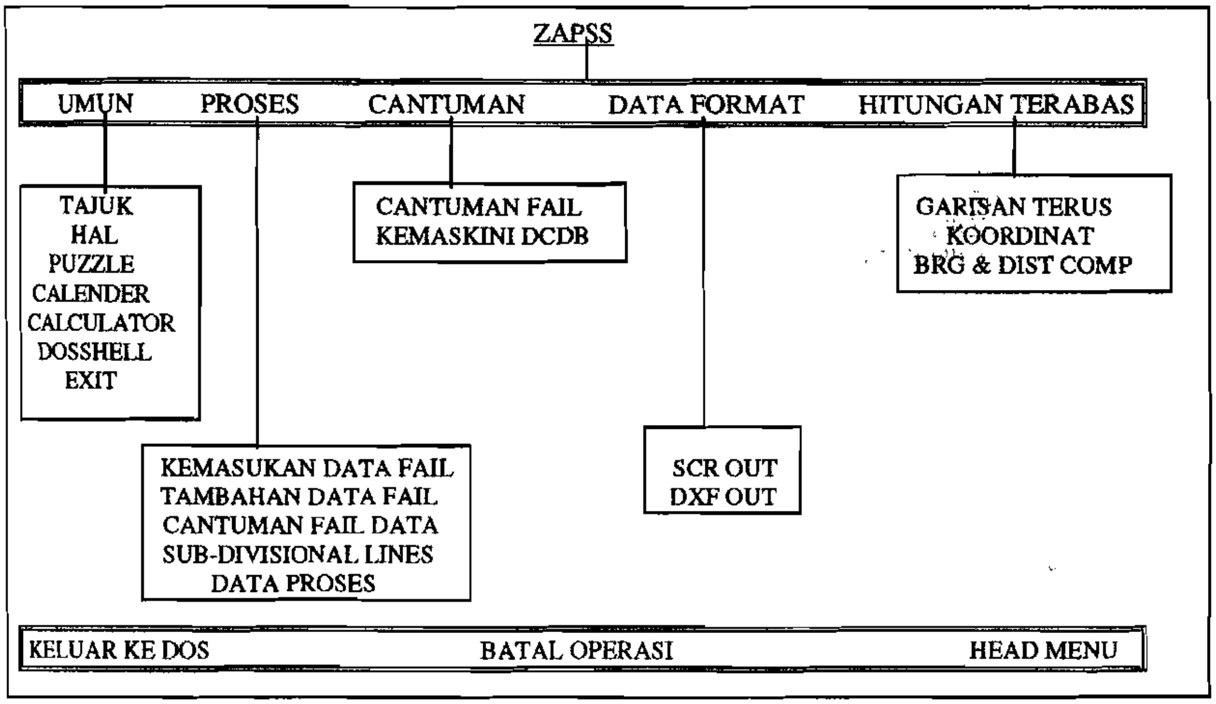

Figure 5 : ZAPSS's organizational chart

4. Sample Session

A typical session using ZAPSS is presented in this section.

Six Certified Plans (C.P) were used as data sets. They are PA20257, PA57342, PA57343, PA57344 and PA57346. All the data are keyed as it is in the existing CPs. For example, all bearings and distances for every lot will be entered as it is. All roads and vacant lands will be taken as polygons.

The following steps shows how the process of building the DCDB.

- **C:\ZAPSS\ZAHMENU** [Type ZAHMENU in the ZAPSS directory]
- Select **PROSES**

- Select **KEMASUKAN DATA FAIL**
  [A list of questions will appear for the user to answer as in Figure 6]

```
NAMA FAIL                                                          =
NEGERI                                                             =
DAERAH                                                             =
MUKIM                                                              =
JURUKUR                                                            =
NOMBOR PELAN AKUI                                                  =
NOMBOR BUKU KERJA LUAR                                             =
KELAS PENGUKURAN                                                   =
UNIT PENGUKURAN <METER/LINK/FEET>                                  =
TARIKH FAIL <DD-MM-YYYY>                                           =
TARIKH PENGESAHAN <DD-MM-YYYY>                                     =
NOMBOR PELAN KADASTER                                              =
JUMLAH LOT TANAH                                                   =
KOORDINAT N/-S PEPENJURU PERTAMA                                   =
KOORDINAT E/-W PEPENJURU PERTAMA                                   =
KOORDINAT N/-S PEPENJURU KEDUA                                     =
KOORDINAT E/-W PEPENJURU KEDUA                                     =
ID STESEN PEPENJURU       PERTAMA <5 CHR>                          =
ID STESEN PEPENJURU KEDUA <5 CHR>                                  =
KERJA BERMULA DARI STESEN PEPENJURU PERTAMA/KEDUA                  =
```

Figure 6

Upon completion of these questions, the user will then key in the data from the certified plan in the following menu as in Figure 7.

```
---------------------------------------
LOT NO = 1
---------------------------------------
NOMBOR LOT                          =
JUMLAH GARISAN SEMPADAN             =

+---------------------------------------------------------+
|INPUT ID DARI STN < 5 CHR >         =                    |
|INPUT ID KE STN    < 5 CHR >        =                    |
|JARAK                               =    Sub-section B   |   Section A
|BEARING DDD, MM, SS                 =                    |
|STATUS BEARING DAN JARAK                                 |
|< D=DERIVED / S = SURVEYED>         =                    |
+---------------------------------------------------------+

EXIT <Y/N> =
```

Figure 7

For example, if there are only 4 boundary lines (garisan sempadan) for a lot, sub-section B will appear 4 times for inquiries before provoking section A to appear for the second lot with a change to the LOT NO = 2.

- After all the data has been entered, select **DATA PROSES**
  [The following menu will appear as in Figure 8]

PROGRAM MEMPROSES DATA KADASTER
INPUT NAMA FAIL =   *What is the data file name (from previous entry) to be processed ?*
DATA FAIL <5> / KEYBOARD <6> =   *If 5 is keyed-in then process the data from data files whereas the system will inquire the same questions as KEMASUKAN DATA FAIL command would asked if 6 is keyed in.*

Figure 8

The computation of coordinates and network adjustment will be done at this stage. The product of this stage will be files with absolute values for each respective cadastral lot.

- User will then select the option **CANTUMAN FAIL** from the sub-menu of **CANTUMAN**.
  [The following menu will appear as in Figure 9]

INPUT NAMA FAIL *Input the output file name from DATA PROSES*	=
BENAR < Y / N >	=
FAIL SETERUSNYA <Y/N> *If Y , then this procedure will be performed once again* *If N, then the following inquiry will appear.*	=
NAMA FAIL KELUARAN *Specify the output file name*	=

Figure 9

ZAPSS will then search for adjacent lots so that it can combine them together to form a Cadastral Network.

Finally, the user will then update (if there are older database the database will the newly processed digital cadastral information or include it in the system if this is the first time the user is using the system. The following step is done.

- Select **KEMASKINI DCDB**
  [This will invoke the following menu to appear as in Figure 10]

INPUT NAMA FAIL BARU	=
INPUT NAMA FAIL DATA	=
INPUT NAMA FAIL KELUARAN	=

Figure 10

The output from this stage is a network of cadastral data, specifically called the **Digital Cadastral Database**.

5. Results and Analysis

The results from ZAPSS were being plotted using AutoCad. A preliminary examination of the results have been done by comparing data in the certified plans and data in the DCDB. The outcome proves satisfying and the DCDB can be used as a foundation for many GIS and LIS applications, in particular to support NaLIS.

6. Conclusions

The availability of a quality, well-maintained, and unique digital cadastral database for use by all agencies is generally regarded as a key requirement for the development of a coordinated, nation-wide GIS. With the development of ZAPSS, a software to realize the Digital Cadastral Database, CGIA has taken a leap in supporting the National and State land information needs. Steps are currently underway to better the quality and to overcome the flaws of ZAPSS. In particular, the user interface of the system is being improved and an intensive testing is underway.

As with any initiative, there is no standing still; all systems must move. While there is no restriction on which way we are heading, the reality is that we have no choice but to move forward to achieve the objectives of the National Land Information System (NaLIS) in the year 2020.

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