DIGIRAST
The Powerful Entry Level Interactive Semi-Automated Digitizer

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ABSTRACT:

The application of a new approach for data conversion based on interactive semi-automated digitalization is described. The realization of a software package based on the same algorithm and based on Personal Computer platform is presented.

KEY WORDS: Data Conversion, Digitalization, Vector from Raster, Line Follower, PC based

1. INTRODUCTION

Most of the cost for a complete commissioned job in GIS is often due to the conversion of data represented on paper sheet. Few of such maps have been processed for conversion to digital form and both the laboriously hand digitizing and some early approaches by expensive software based on nowadays obsolete computer equipment failed to cut the conversion cost. DIGIRAST starting from experiences of both the manual and the complete automatic way solves most of the problem using a Personal Computer, a standard graphic board, an ease to use user interface and an interactive approach that allow the operator to check the automated digitalization.

2.DIGITALIZATION OF RASTER DRAWING

Galileo Siscam has been always very sensitive to new needs in photogrammetry and mapping. One of those is how to convert old map sheets in a simple floppy disk. There are several software packages that, using different approaches, are able to obtain good results but most of the time they run under expensive or not standard workstations and they approach the problem in a complete automated way.

Unfortunately by a complete automated method the map sheet, with there coded information and all kind of different symbols, are very difficult to interpret and the user often dislikes to correct the mistakes off line and spending anyway a long time. The operator would prefer to control this job in progress in an interactive way.

Furthermore due to the nowadays high performance Personal Computers and due to their cost much lower than any workstations the need is also for a package able to run on this platform with the most common operating system as MS/DOS .

So DIGIRAST was born. DIGIRAST is a software package written in C language addressed to transform any raster format drawing in vector format drawing but with a particular specialization in cartographic drawing as contour lines maps, cadastral and tax maps at low and high scale.

It has been taken particular care to the graphic by implementation of routines and data structures

particularly suited for a real time management of the raster and vector image by means of panning and zooming at high speed.

One of the biggest problem to be solved is how to adapt a digitalization method to the different cartographic information contained in every different maps. For example, the information contained in a contour line is quite simple: following the line and getting x-y coordinates, associating the relevant z of the contour to each point of the line. The situation is different for a tax or cadastral map: the line to be followed is most of the time a closed property border line : it is better to start from the inside of the property, getting to the perimeter and then following the line. Besides that, why do not use the display of the computer as a standard digitizer with advanced functions as zoom and automated coding?

The Digitalization has been provided with three different methods to answer to these and other further needs:

- Manual
- Semi-automated by DIRECTIONS
- Line Following

2.1 The digitalization in plate coordinates

The cartographic drawings have a big difference respect on the mechanical drawing: the coding. In fact a cartographic drawing is not just a set of lines but it consists of information as type of line, color, thickness, code of elements, elevation. So to avoid the mistakes and the lack of information that a traditional automated digitalization software produces, it has been preferred to maintain a level of freedom to the operator. Instead of running an automated procedure that produce a final vector file with many errors to be corrected anyway off-line by the operator, by means of DIGIRAST the user is able to follow the job and then to decide when to input other information or to correct some errors in real time. The final goal is to decrease drastically the revision time of the final vector file that anyway has to be performed by a CAD software after the digitalization.

But sometimes it is not possible to use just one of the above mentioned methods. The experience

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shows that there are many cases that need a
combination of methods: with DIGIRAST the user
can at any time combines the different
digitalization algorithms to approach the case
with a kind of "best fitting procedure".

Here below the Manual mode, the Semi-automatic by
Direction mode and the Line Following mode are
described.

2.2 Manual digitalization mode

It consists of collecting, on the drawing showed
on the screen, the extreme points of a vector
creating manually the graphic feature. This can
be considered the "computerized" way of a
traditional digitalization by digitizer table.

The procedure is to be used for all the difficult
situations on the raster drawing (disconnected
line, spot on the map, merged drawing due the
pour scanner resolution etc.) where any other
semiautomatic or automatic mode would fail.

The Manual Digitalization mode represents the
missing link between the traditional method and
the new automatic mode to convert a raster map in
a vector map; it was taken particularly care to
maintain the procedure as much as possible close
to the traditional method so that an operator,
used to work in that way, would not find a
different sequence of steps.

2.3 Semi-automatic mode by directions

Working on map with large scale or cadastral
(tax) maps it is common to find a rectilinear set
made by segments. Besides that an urbanized area,
typical of a large scale map, has typically
parallel and perpendicular segments (the walls of
a house, the borderline of a property etc.).

For this kind of map could be faster to approach
the digitalization finding first the main
directions (typically two perpendicular ones),
then the intersections and, finally, collecting
each segment delimited by intersecting lines.

The semiautomatic mode by directions performs the
above procedure. The operator picks a "raster"
segment with the mouse , then the program
individuates the straight line to which the
segment belongs.

The visualization of the straight line in a
different colors allows the operator to check if
the segment can be represented by a Rectilinear
line or needs a sequence of segments so to have
the best interpolation.

2.4 Line follower mode

This procedure is particular suited for
digitalization of contour line maps.

After that the operator picks a line on the
raster drawing, DIGIRAST starts to look for the
poly-line that best interpolates it.

A set of parameters are to be initialized before
running the line follower. Among them there are
the minimum vector size, the blanc space size
(interrupted line) and the code.

These are parameters that the software must know
to manage decision where to stop the following or
where to proceed even if the line is interrupted.

Another parameter is the type of interpolation
that can be: by tangent, point by point, best
fitting etc.

3. THE ROTOTRANSLATION OF DIGITALIZED DATA

The digitalized data are stored in several files.
These files are structured to fit, at the best,
the procedures implemented by DIGIRAST. After the
digitalization the coordinates of the digitalized
data are in the reference system of the scanner
plate..

DIGIRAST allows to assign to each image
coordinate the homologous ground coordinate and,
at the same time, it allows to correct the
deformation of the original paper sheet drawing
by means of appropriated rototranslation
operations case by case.

To perform the rototranslation the operator must
first find on the raster drawing some known
points and then collect them in plate
coordinates.
Then the rototranslation can be performed by
these three following modes:

- Rototranslation with deformation check of paper
- Rototranslation with scale factor
- Projective Transformation and rototranslation

Each mode needs a minimum number of points. If
this number of points is bigger of the minimum
requested, the residuals will be showed so that
the operator can check the quality of the job.

3.1 Rototranslation with deformation check of paper

It is called also AFFINE Rototranslation. It is
used when the deformations of paper sheet can be
considered linear but different in X and Y
directions.
At least three known points are necessary. The
procedure is based on the following relations:

$$Xt = (A1*X + A2*Y + A3)$$

$$Yt = (A4*X + A5*Y + A6)$$

where
- Xt and Yt are the coordinates oriented in the
  map sheet reference system
- X and Y are the image coordinates
  A1,A2,A3,A4,A5,A6 are the unknown parameters
  for rototranslation

3.2 Rototranslation with scale factor

With this procedure it is possible to calculate a
Translation, a Rotation and a Scale Factor
between the ground coordinates and the
digitalized image coordinates.

At least two known points are required. This
method is used when we need a best fitting

maintaining the shape of features, as well
referring in the all job to a different reference
system.

In this case the relations are :

$$Xt = [M*\sin(R)*X] + [M*\cos(R)*Y] + dX$$

$$Yt = [M*\cos(R)*X] + [M*\sin(R)*Y] + dY$$

where
- Xt and Yt are the coordinates oriented in the
  reference system of the map sheet
- X and Y are the image coordinates (digitalized)
- R rotation
- M scale factor

3.3   <u>Projective   Transformation   and
rototranslation</u>

This procedure requires a minimum of 4 points. It
is used when we need to correct a bi-axial non-
linear (polynomial) deformation of the image.
This could happen using a commercial scanner to
acquire the raster image of the map sheet.
The transformation is based on the following
relations:

$$Xt = \frac{A1*X + A2*Y + A3}{B1*X + B2*Y + 1}$$

$$Yt = \frac{A4*X + A5*Y + A6}{B1*X + B2*Y + 1}$$

where
- Xt and Yt are the coordinates oriented in the
  reference system of the map sheet
- X and Y are the image coordinates (digitalized)
- A1,A2,A3,A4,A5,A6,B1,B2 unknown parameter for
  rototranslation

By means of rototranslation all the coordinates
collected by the digitalization are transformed
in the map sheet reference system.

At this point it is possible to manipulate the
file coordinates for the final editing through
the GALILEO SISCAM software packages (GPM,
OVERMAP/C) or to convert them in any other format
(DXF).

DIGIRAST will be available for demonstration on
site at the '92-ISPRS exhibition in the GALILEO
SISCAM booth (# 812).

Additional information as well as data about
performances, precision and comparison with
traditional hand digitalization will be provided
inquiring directly to GALILEO SISCAM, Via
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