

## Geocoded Image Sequences

**RALF-A. SOOD and CORD FAHRENHORST, Garbsen**

### ABSTRACT

Geocoding via GPS/GLONASS signals is in fact practically within urban/suburban roads and streets. Inside actually driving vehicles short term loss or misrepresentation of the GPS/GLONASS signals are inevitable. This is due to architectural/structural conditions. Such influences are being compensated by the use of speedometer reading and gyro sensors. Customers' reactions and market analyses show a growing demand and potential for geocoded digital city image sequences (ground level imagery).

### 1. INTRODUCTION

#### All of Germany on Screen

#### Electronic Database of Streets and Buildings – A Tele-Info Project with Global Significance

Tele-Info GmbH (Garbsen, near Hannover) is heading for capturing Germany's cities on photos, street by street, house by house. The aim of this ambitious project called CityServer is the creation of a digital data bank containing 12 million of buildings and estimated 44 000 Gigabyte – one of the world's most extensive databases. Various selection methods allow key solutions for users inside economics, industries and authorities.

The CityServer shall come into operation at e.g. civil services like ambulances, police cars and at fire brigades – organisations that need quickest visual access to information about the size of a building, the number of floors and/or the state of the surrounding. Further usage will be seen at building and site management, for banks and insurance companies regarding their risk assessment, at public utility services, for city and traffic planning purposes, for vehicle navigation systems, for carriers and also at TV stations offering real world images for reporting purposes.

The mobile image data capture system representing the technological basis for the CityServer has already been patented. It was developed by Tele-Info in cooperation with the system house iBS GmbH within a period of only two years' time. The system, being installed inside a minivan and equipped with most advanced digital colour sensor and computer technology, provides day by day millions of precisely geocoded high resolution digital colour photographs: houses and all other kinds of buildings, road and traffic information in cities and counties. Hightech allowing all around view by means of simultaneous image archiving. Each street being studied from 6 to 11 different perspectives.

### 2. SEQUENTIAL IMAGING AND PROCESSING

#### 2.1. Applied technique inside the vehicle

Our minivans for geocoded registration of urban information are equipped with 6 to 11 digital CCD sensors which supply images in 24 bit colours. From 25 up to 50 images are made per second which leads to a torrent of data of 31.6 – 63.2 MB/sec. The bordcomputer compromises this data approx. 30fold to be archived in realtime on digital tapes. At an average driving speed of 40 km/h each sensor provides a new image within a distance of 1.8 – 3.6 m. Fuzzy elements (caused by the moving of the vehicle) are minimized by optical and electronical means. The sensors allow a 360° perspective with intersections/overlappings.

The GPS receiver of the vehicle identifies 5 geositions per second. These are then related with the images. On top of this we register time, aerial hight, speed, environmental data and via gyro sensor we recognize changes in driving directions. The information is saved as raw data files to be postprocessed at a later step.

The driver is guided by electronic city maps and registers deviations from the plan. He is supposed to avoid driving along one distance twice or multiple. Any information about the movement of the vehicles are passed to our computer center and ensure optimal real time monitoring of the system.

## 2.2. Processing

Within the post processing the image sequences are linked together with the geositions given by our GPS/GLONASS base in Garbsen. We thereby achieve an enormous improvement of the localisation. Additional information like speed and Azimuth are calculated and the number of satellites and variance values are identified. These steps are important for the following software guided differencial and variance correction.

Following the post processing the position files of the tours have to undergo a plausibility check through proprietary examination software. They are eventually corrected automatically and then reconstructed into digital maps. In general our positioning data is so very precise, that newly built roads can be integrated without change. The positioning file will be checked accordingly. Single position data will be compared with the digital maps, corrections will be effectuated through our special editor software by relating single points/coordinates with the images.

Elimination of multiple tours, idle stand of vehicle, tours into non relevant areas etc. is provided by proprietary software. Positioning files until that time correspond to the original tour planning, i.e. as provided by the vehicle. The next step is a new combination of the data according to street names and creation of respective street image files. This step is done without decompression procedure and therefore without loss of data quality.

According to the demand of image quality the images will be decompressed within the last step of post processing, followed by shrinking and newly compressing them as Wavelet, MPEG or JPEG sequences. Via different databases Tele-Info software products finally take hold on the geositions and finds the respective image sequences.



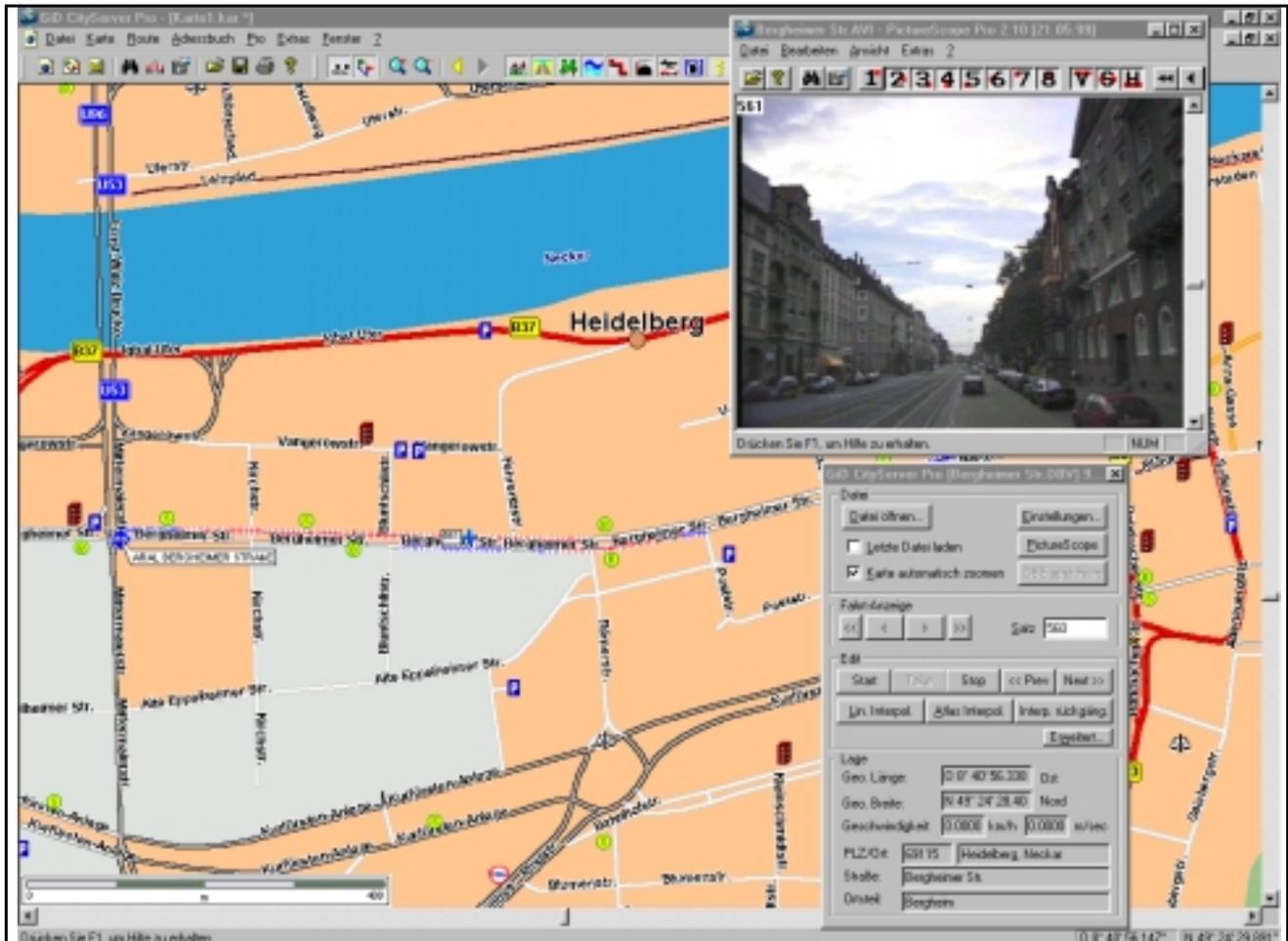


Figure 1: Samples of City Server applications.

### 3. PRODUCTS

So far (summer 1999) the registration and processing of the greater areas of 10 German cities has been finalized. On a medium term basis we will register all of Germany's big cities down to 20 000 inhabitants, as well as european areas of touristic interest.

Completed are: Hamburg, Hannover, Berlin, Leipzig, Weimar, Düsseldorf, Frankfurt, Heidelberg, Stuttgart and München. Our minivans actually operate at: Bremen, Schwerin, Potsdam, Magdeburg, Dortmund, Kassel, Köln, Würzburg and Nürnberg.

Regarding the multimedia market segment especially the front and rear view are of interest. Additional important information and therefore additional application options for authorities, emergency services, service providers etc. are delivered by the side sensors. Target groups do in fact differ very much especially in regard to their necessity of different image quality degrees, as well as regarding the amount of data needed.

For multimedia and prosumer segments we have planned to produce a combination of geocoded city views and routing information.

Potential partners for the professional use of the CityServer are especially the different administrative departments of municipal authorities and emergency services. As „CityServer“ images together with further information may quickly be integrated into electronic city maps. Also search via geoposition or via streetname is possible.

For carriers and fleet management Tele-Info has developed certain interfaces to our software products. Another service segment is the documentation of certain objects (industrial plants, ...) or

questions (environmental documentation, ...). For all those necessities we provide additional services.

For scientific purposes our data may be used in architectural and structural city planning, traffic studies, additional information for 3D ground models and a large number of further disciplines.

#### **4. EXPERIENCES WITH THE ACTUAL GERMAN LEGAL SITUATION**

Legal expert reports on the permissibility of the operation of the system within the context of the BDSG (federal data privacy law), UrhG (copyright law) and other legal matters has been verified in the meantime. The complete accordance of the CityServer with the BDSG was confirmed by the Ministry of Internal Affairs of Lower Saxony.

#### **5. FURTHER DEVELOPMENTS**

First priority has the optimization of the GPS/GLONASS receiver precision and the improvement of the registration of the images in order to reduce the necessity of manual post processing. Especially through the gyro sensor we are able to automatically evaluate critical route passages (high tree stocks, narrow streets, ...). These steps essentially make regular data capture and actualization of the database easier.

Further image processing allows the supply of topic oriented and traffic relevant information, such as width of street, number of lines, traffic signs, etc.

#### **6. CONCLUSIONS**

Geocoding of city views via GPS/GLONASS signals is in fact practically within urban/suburban roads. Variance values for latitudes and longitudes ascertained by the post processing were in general less than 1 meter difference. For difficult passages with signal loss the advanced inertial system has proven its worth. Municipalities and service providers proclaim a huge demand of up to date, geocoded city views. Also for multimedia and prosumer segments our market analyses show considerable demand and potential.