Low Cost Cadastral Updating Approach: An Alternative for the Brazilian Cities

Guilherme Henrique Barros de SOUZA, Amilton AMORIM, Júlio Kiyoshi HASEGAWA, Brazil

Key words: cadastral systems, cadastral updating, change detection, cadastral database.

SUMMARY

The cadastral database contains all important information about the cadastral unit or land parcel, both physical data and socioeconomic data. The Brazilian cities, in their great majority, don't get to maintain a building cadastre with trustworthy data, mainly in areas of great urban expansion. This fact causes a deficient outturn and in consequence a smaller volume of investments by municipal government in benefit to the local population. Although in Brazil there are mechanisms that allow to the municipal districts to obtain the federal government's resources to implant cadastral updating politics, the results aren't efficient. In many cases, with the obtained resources, practically carry out a new cadastral surveying of the municipal district, that generate high costs and it contributes by updating in short periods of time not be accomplished. That also happens because a lot of cadastral updating methodologies don't make use of new technologies and approaches that can get a fast and effective result with low cost. It also contributes to that situation the fact that there is a lack of qualified professionals in the Brazilian municipal administrations to plan the actions of the cadastral politics. This work presents a new updating technique of building physical data, using the existent concepts in manipulation of images and database. With the use of change detection procedures in images of different times from two test areas of the city of Presidente Prudente, São Paulo estate, were evaluated the changes in the value of built area of each property in a semiautomatic way, because the value of built area is the factor of larger weight in the calculation of the urban tributes in Brazil. With the aid of the cadastral database it was possible to verify if the found change was relevant so that a cadastral updating of the property was executed. If the change was relevant, the cadastral inscription of property in subject was separated, so that together with other properties of the same area, they were ready to have their data updated. Experimental results from real data allowed observing that was obtained a significant reduction of the time spent in the cadastral updating at the used test areas, about 60 – 80 percent, consequently with reducing costs too.

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1. INTRODUTION

The most of the Brazilian cities depend on the property tributes revenue to finance the projects of public interest and in order that give support all the departments of the public administration as education, health, transport, leisure, works and others. In this aspect, the multipurpose cadastre becomes a basic tool for the urbane planning, because it manages the property tributes revenue and supplies the socio-economic data from the cadastral database.

The erroneous vision of which a appropriate cadastral politics is an unnecessary expense will be changed only when the municipal administrations understand that the financing of the implantation or cadastral updating, it is an investment of high return for the city. Conformably it affirmed Vaz (1997), the current technological situation allows invest in cadastral projects and of geoprocessing, because the cost of the equipments and softwares has been falling drastically along the years.

New possibilities also have been presented by the inclusion of software free for the management and making available of the informations in the Internet. These mechanisms contribute to reduce costs, not only of the implementation or cadastral updating, but the computerization of publical administration as a whole.

The principal objective of this work is to show the viability of a methodology that increases the efficiency of the process of change detection applied to the property cadastre. The process has aimed to allow the least relation cost-benefit of the processes of cadastral property updating, for the integration of images and of the cadastral database.

2. CADASTRAL UPDATING AND CHANGE DETCTION

Mapping is a basic tool in the process of taking decision in the public administration. However its existence is very scarce. In agreement with IDB (International Database) 72 % of the municipalities of the Latin America has not maps of its jurisdiction in paper and not even in digital environment (COHEN 2000).

In the urban reality, the problem becomes still bigger, because the change dynamism of is high, that raise different sceneries at the whole moment, due to several factors such as new allotments, new buildings, drainage systems among others. All these changes must be contemplated in the cadastral data.

The informations contained in the cartographical base, of most of the Brazilian cities, are defective in many aspects like lack of updating, lack of geodetic control and non-existence of the net of cadastral municipal reference (CARNEIRO AND LOCH, 2000). This aspect makes difficult a good projection, being able to produce mistakes and delay in the realization of improvements to be executed in the local authority.

The change detection between images of different times has been researched in several areas of the knowledge, like medicine, remote sensing, civil construction, navigation systems among others (RADKE et al, 2005).

In remote sensing, the change detection uses a couple of images registered between themselves, of the same geographical area, where the principal objective is to identify the changes of vegetable covering between two times (BRUZZONE; PRIETO, 2000). Interesting applications of the change detection are found in the computational vision like intelligent interfaces, vehicles traffic management, segmentation of movable objects (MILLER; PIKAZ; AVERBUCH, 2005).

Olsen et al (2002) had affirmed that the task of change detection to mapping is not one of the easiest. Even when one intends to obtain the images of interest in the same season and to try to find the same conditions, it is practically impossible of getting it.

Besides the climatic conditions and natural phenomena that can take place in the interval of a time other one, the images produced in general have not the same parameters of direction, when took place still regions that do not appear in all the images that to compare wishes. However, the biggest problem is same in the seasonal differences in the capture of the images.

3. METHODOLOGICAL DEVELOPMENT

The basic premise of the proposed method is the increase of the efficiency of the process of updating of the cadastral urbane system, through the reduction of time and consequently of the cost, providing better conditions so that the town halls can carry out this type of action with more frequency.

For the objective of reduction of time and cost giving work was it reached, there was proposed the development of a technique that predicts the identification of new constructions or buildings what significant changes suffered in his area built in the last years.

It suits to emphasize that there was developed a work which objective principal era to carry out a feasibility study, to allow to draw the strategies for the execution of the above-mentioned integration of the systems, which allows a semi-automatic identification of the real estate (AMORIM AND SOUZA, 2005).

There were implemented algorithms of change detections that allow visualizing the changes of built area of the real estate. The method was opted to use anaglyph for detection of changes. This method consists in using the channels G and B of the most ancient image and the channel R of the newest image. When the superposition of these channels is done, a new

image is produced what leaves the changes in I redden. That can be shown up in the Figure 3.1 following.

Figure 3.1 – Anaglyph model by Amorim (2000)

The calculation of area approached the change was done by using the Gauss's formula for the calculation of areas using the coordinates of the vertexes of the changes. Do not exist legislation specifies of Cadastre in Brazil that it defines in which surface there must be found the value of area of the construction. Since the intention of the work is to use the value of area found like an indicative of change, it is possible to use the value of area in the projection UTM without bigger damages to the process of cadastral updating.

For the calculation of the value of area through the Gauss's formula, it used anaglyph model produced by the developed applications. When the rectification of images happens, the parameters of direction are lost, when a new transformation of parameters is necessary for the model anaglyph. That can be gone when corresponding object is adding to an extern archive the couple of coordinates in the system of reference of the space to a first pixel, since the size of the pixel is known. Nevertheless, since the images are not orthorectified, even this proceeding will not be sufficiently, when dislocation is taking place in any forms in the image.

After the import of the archive of ground points, the collection of the points is done in the image, so that can applied a Yesilar two-dimensional transformation the system of coordinates.

When the process of transformation of parameters was ended, the user can collect the coordinates of the vertexes of the changes emphasized by the model anaglyph produced, being enough to click with the mouse on them. To the end of the process, the area of the

calculated change is stored in a temporary text archive together with the coordinates of the vertexes of the change. This archive is used then for the consultation in the database.
When the value of the area of change was found a consultation is effectuated in the cadastral database on the ancient value of area of the respective property. This consultation is only possible when there are in the characterization table of the parcel the informations of the central coordinate's pairs of the parcel in the reference system used. As the image must be in the same reference system that the coordinates stored in the database, the coordinates of the change are stored and there consults the database for what knowledge the nearest property of the considered change.

One opted for the couple of coordinates of the centre of the parcel, because in general the constructions are principally in this region, and it allows the ray of search to find the change that is collected to the already existent construction. Also it is worth emphasizing that getting the couple of coordinates of the centre of the parcel is quicker than that of the vertexes of the parcel, which also would demand a bigger precision. Such a proceeding is exemplified by the figure down.

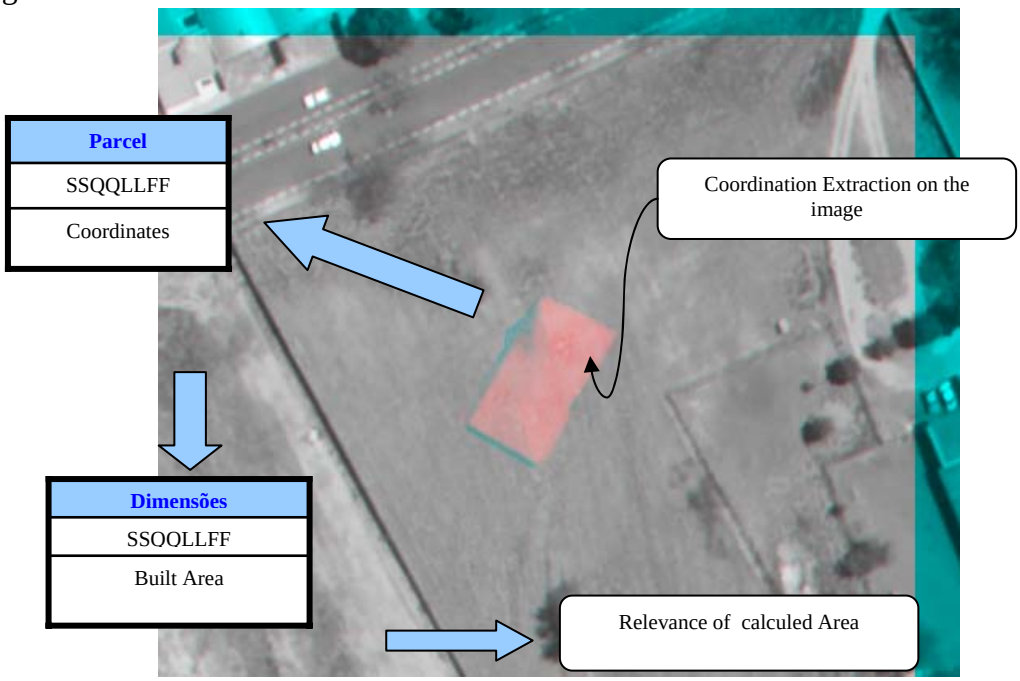

Figure 3.2 – Procedimento de consulta ao banco de dados

A threshold was defined to check if the value of area found is relevant that an updating is carried out. That because residues can take place in the image and eventual mistakes of the algorithms. The threshold was determined in the empirical form. That because it had to be when an investigation was effectuated is left how if they hold the constructions that will present the eaves. With the algorithms of change detection an outline will be able to be realized around the principal construction. This problem also will be seen when the type of

covering of the construction to change, producing a spectral answer in the recent image different from the spectral answer of the ancient image.

By this identification, a report is produced with a list of real estate, with necessity of cadastral updating. With the data obtained in the report, there is produced the Report of Cadastral Information of the real estate that suffered changes. This proceeding will allow that local missions of cadastration are done, with reduction the cost of this operation.

4 EXPERIMENTS AND RESULTS

The area of study of this work is in the city of President Prudente located in the western region of the Sao Paulo estate. The available images is near of the FCT/UNESP in the residential quarter Garden of the Roses (It appears figure 4.1) and also areas near to the cemetery Saint John Batista and to the Highway Raposo Tavares SP-270 in an examination in the district Pines' Garden (Figure 4.2). The choice of these areas happened to the fact of the availability of images of these regions and also since they were areas consolidated inside the local authority, or be, that they do not suffer significant changes along the time.

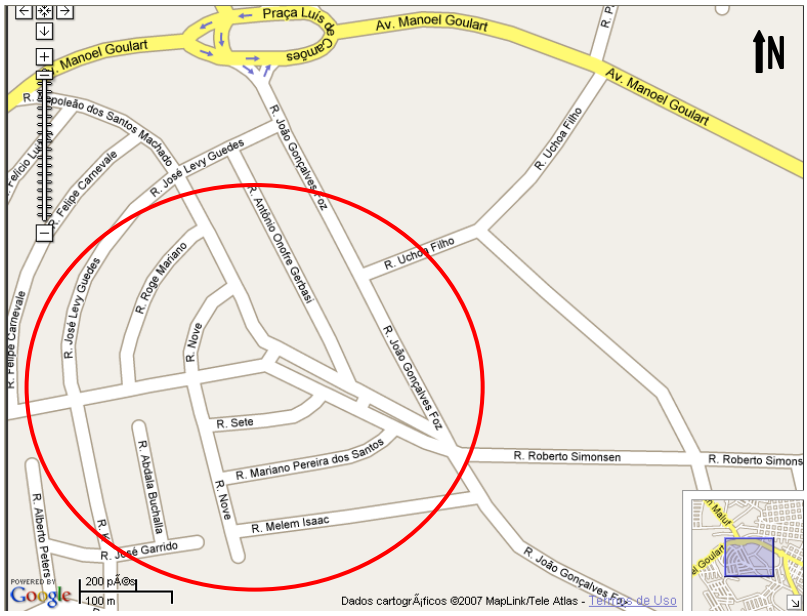

Figure 4.1 – Test area 1 Rose's Garden FONT: www.maps.google.com

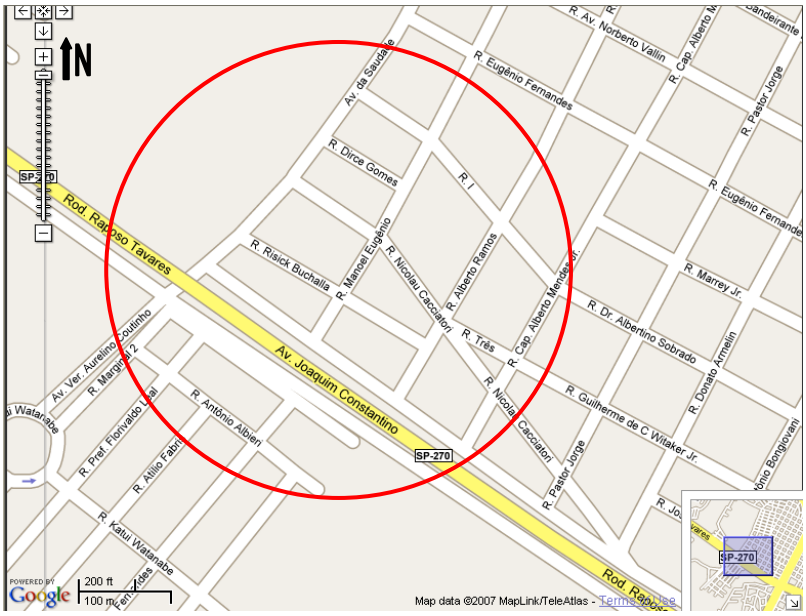

Figure 4.2 – Test area Pines' Garden FONT: www.maps.google.com

The images used for the area test 1 were obtained of different sensors. The image of 1995 was obtained by a analogical photogrammetric camera in 1995. The image of 2003 was obtained of a non-meter digital camera. The difference of sensors is an important factor being detached because it interferes in the radiometric quality of the results, consequently in the model anaglyph produced. The figure 4.3 shows the anaglyph model produced from these two images.

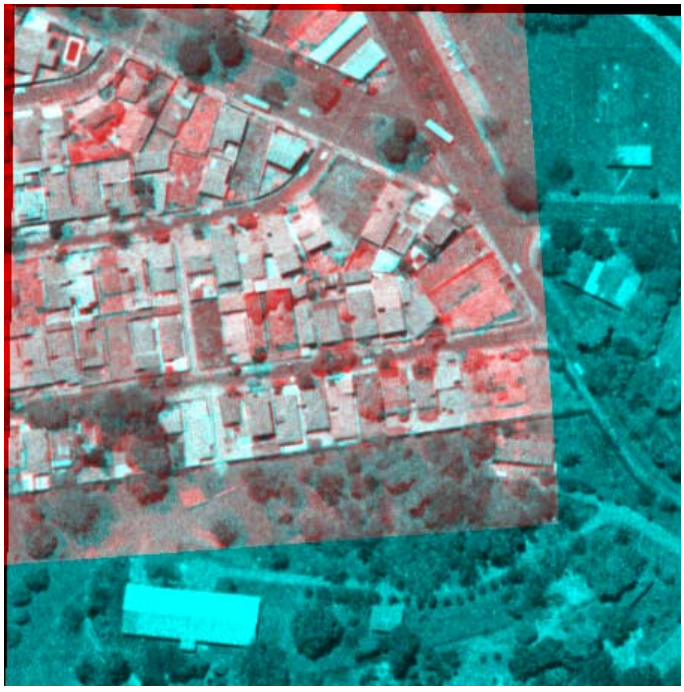

Figure 4.3 – Test area 1 anaglyph model

For the test area 1, the values of built area that were found for change detection procedure are presented in the Table 4.1. The criterion when establishing the threshold of relevance adopted, was if change was above to 10 % of the value of the area set up in the database. Case was a positive, the property is separated for surveying of the informations.

Table 4.1 – Area values obtained by Gauss' formula to test area 1.

Cadastral Inscription	Cadastrated built area (m²)	Detected built area (m²)	Relevancy
01010201	0	208.28	Yes
01020101	0	277.93	Yes
01020701	0	107.07	Yes
01020702	0	107.75	Yes
01020703	0	107.49	Yes
01021701	183.45	62.58	Yes
01022001	0	84.14	Yes
01022101	0	206.04	Yes
01031001	0	143.36	Yes
01031101	0	201.72	Yes
01031401	0	142.93	Yes
01040401	0	176.90	Yes
01040701	82.61	131.38	Yes
01041901	0	239.67	Yes
01050601	0	196.66	Yes
01060201	0	152.90	Yes
01061001	0	140.06	Yes
01061301	0	300.60	Yes
01070301	0	109.86	Yes

As it can be noted, 19 of 100 real estate of the area test selected presented relevant changes in the value of built area. The relevance happens checking if the value of the area found in the model anaglyph is bigger than 10 % of the value of the area stored in the cadastral database.

It is noticed that in the cadastral inscription 01021701 there is an change bigger than the value of area set up. That takes place because in the cadastral database there are stored the informations of area of the principal construction of the parcel and the value of the change found by the method is of the so-called area of dependences, in other words, of the areas that even not being the principal construction, they make part of the built total area (service areas separated of the house, among others).

The images used for the test area 2 were obtained by the same sensor in 2003 and 2005. It is noticed in the anaglyph model produced that the radiometric conditions are not coherent between two images, due to the conditions of lighting and possible errors in the sensor. The figure 4.4 shows the anaglyph model produced from these two images.

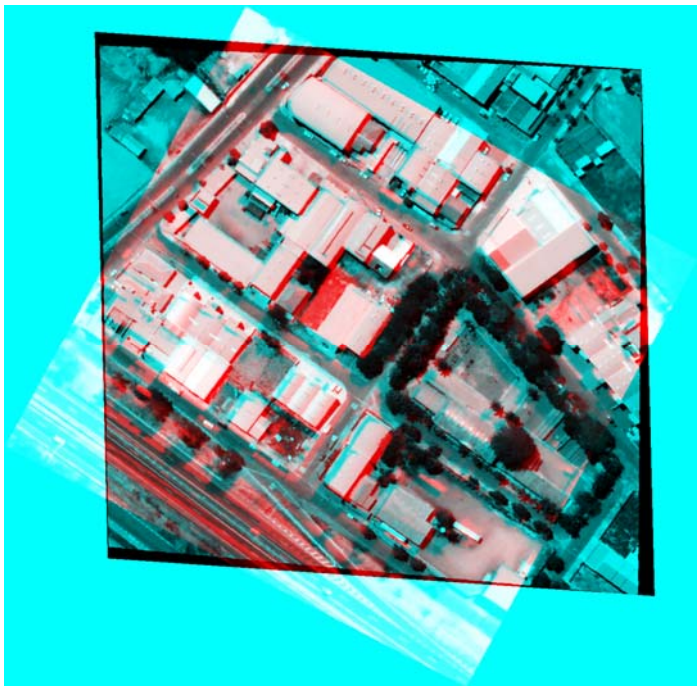

Figure 4.4 – Anaglyph model generated to test area 2

Table 4.2 – Area values obtained by Gauss' formula to test area 2.

Cadastral Inscription	Cadastrated built area (m²)	Detected built area (m²)	Relevancy
02022301	0	318.03	Yes
02044801	0	480.01	Yes

In case of the area test 2 there were no many changes, though there are empty parcels that can still have some significant change in the future.

4.2 Analysis of Cost and Time

After all the stages were carried out, there was done the analysis of the time spent for the cadastral updating. It was considered the time of preparation of the reports of cadastral information, as well as the quality control after each stage of surveying, so this time is the same in any methodology, except when the methodology is in use with optical reading of the reports of cadastral information (AMORIM et al, 2004). So, this value of time enters in the analysis of cost and time, but the principal focus here is in the spent time in all the stages in which it refers to the quantity of real estate to be updated.

The results for two areas test are presented in the tables following 4.3 and 4.3, comparing several methodologies that can be used for the cadastral updating.

Table 4.3 – Test area 1 – Roses' Garden

Used approach	NTI	NIA	NIAR	NISL	TGIC	TGIED	TTGM
Conventional	100	19	19	100	20 min	6 min	2,600 min
Conventional + Reading Optic	100	19	19	100	20 min	0.017 min	2,001.7 min
Change Detection (CD)	100	19	19	19	20 min	6 min	494 min
CD + Reading Optic	100	19	19	19	20 min	0.017 min	380.323 min
CD + Relevancy	100	19	19	19	20 min	6 min	494 min
CD + Relevancy + Reading Optic	100	19	19	19	20 min	0.017 min	380.323 min

where:
NTI is the total number of real estate of the area test;
NIA is the number of real estate where changes of built area were detected;
NIAR is the number of real estate where changes of built area were detected;
NISL is the number of real estate to be lifted in field;
TGIC is the time spent by property in the surveying field;
TGIED is the time spent by property in the entry of data for the updating of the cadastral database;
TTGM is the total time spent by the employed methodology.

Table 4.4 – Test area 2 – Pines' Garden

Used approach	NTI	NIA	NIAR	NISL	TGIC	TGIED	TTGM
Conventional	50	2	2	50	20 min	6 min	1,300 min
Conventional + Reading Optic	50	2	2	50	20 min	0.017 min	1,000.034 min
Change Detection (CD)	50	2	2	2	20 min	6 min	52 min
CD + Reading Optic	50	2	2	2	20 min	0.017 min	40.034 min
CD + Relevancy	50	2	2	2	20 min	6 min	52 min
CD + Relevancy + Reading Optic	50	2	2	2	20 min	0.017 min	40.034 min

When the results are compared it is possible to observe that there is a quite considerable reduction in the time of surveying in field, considering two approaches of surveying, in other words, conventionally and using change detecion. The proceedings will be still added metodological approachs sugested by Amorim et al (2004), that it uses the automatic insertion of data through optical reading, the variable time suffers a reduction still bigger in the cadastral updating campaigns.

When there are added the times of preparation of the reports, separation, filling out of basic informations as location of the property, inscirption among others; and still the spent time for the checking of the informations contained in the report, there has been a real idea of the time spent in the cadastral updating. In field, in the studied areas, there was a significant reduction of time, which implicates a reduction of costs.

From some informations obtained with enterprises, it is appreciated that the cost of a cadastral updating is of R$ 16 to R$ 20 for property in Brazil. By the middle value from these values in the areas tests used in the work, there has been the frame described in the table 4.5.

Table 4.5 – Present costs in the cadastral updating form each approach

Areas	Approach	NTI	NISL	Cost by property	Approach total cost
Area 01	Conventional	100	100	R$ 18,00	R$ 1800,00
	CD	100	19	R$ 18,00	R$ 342,00
Area 02	Conventional	50	50	R$ 18,00	R$ 900,00
	CD	50	02	R$ 18,00	R$ 36,00

As it is showed, there is a significant reduction of costs in the process of cadastral updating when there is in use the change detection process, in already respected areas consolidated in the urbane space. That demonstrates what can be reached better results in the process of cadastral updating of the city, by concentrating the efforts in regions that exist urbane expansion and allocating resources (human, financial and logísticos) of optimized form. This results a cadastral efficient and current system for several ends what the public administration needs.

Observing X one checks that the method of detection of changes for anaglyph highlights well the changes, almost without mistakes, since depending on the conditions of the used images, the red can still be highlighted more. Besides, the visual evaluation of the result allows that the user discards regions what they show to be changes, but they are not.

Table 4.5 – Anaglyph method efficiency

Test area	Found changes number	Real changes number	Error detected changes
01	19	19	0
02	02	02	0

5. CONCLUSIONS

By the data analyze of reduction of time and costs, it is possible to affirm that the method here proposed is efficient and a favorable scenery allows an economical resources optimization for the public administration, as well as favorable administration to cadastral updating periodic campaigns, which undoubtedly will allow a better projection of the actions of urban planning.

The present method is efficient since not only the municipalities, but the enterprises and all the members who are important to Cadaster, change their paradigms as for the informations that must be contained in the cadastral databse and the products to be produced in a cadastral campaign.

One of the aspects to be changed is the storage of the parcel coordinates in the cadastral database, because this one allows a series of applications and consultations to the database that can make easy the processes of space analysis inside a local authority. Opposite case, several products of a cadastral campaign become superfluous, in other words, are there, but it has not great usefulness.

There is still in development an alternative that uses image differentiation for change detection, of way to make possible a bigger automation of the process. Also preliminary

experiments are being effectuated by use of images QuickBird of President Prudente. Figure 5.1 hsows a anaglyph model of a new area test of the city, where there is a recent residential quarter in process of urbanization. The use of images of satellite becomes interesting because presents a cost less of which photogrammetric surveying for this application.

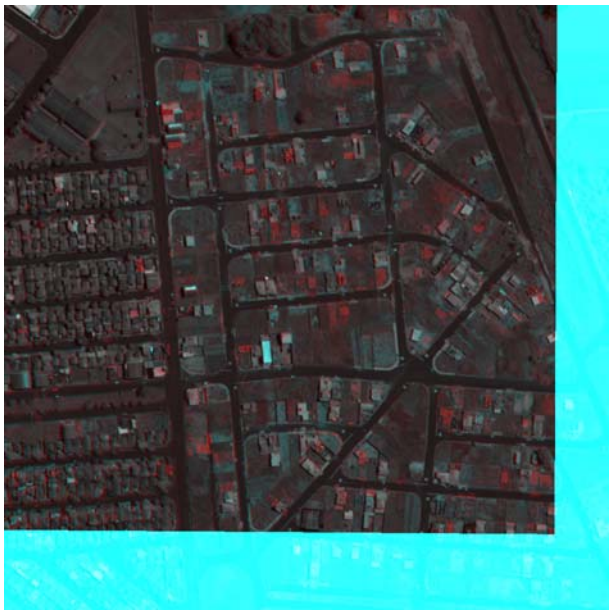

Figure 5.1 – New experiment with QuickBird images

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BIOGRAPHICAL NOTES

Msc. Guilherme Henrique Barros de Souza has graduation in Cartographical Engineering for the São Paulo State University , master's degree in Cartographical Sciences for the São Paulo State University (2007). He has experience in the area of Urbane and Regional Planning. Acts principally in the next subjects: Multipurpose Cadastre, Change detection, cadastral systems, and database.

Prof. Dr. Amilton Amorim, born in 1965. Graduated in 1988 in Cartographic Engineering from University of São Paulo State and obtaining doctorate degree in 2000, from University of São Paulo. Assistant Professor at the Department of Cartography - São Paulo State University since 1994.

Prof. Dr. Julio Kiyoshi Hasegawa, has graduation in Cartographical Engineering for the São Paulo state university (1982), master's degree in Geodetic Sciences for the Paraná Federal University (1991) and doctorate in Electric Engineering for the Campinas State University (1997). At present he is professor in São Paulo state university. It has experience in the area of Geosciences, with emphasis in Geodesy..

CONTACTS

Msc. Guilheme Henrique Barros de Souza
FCT/UNESP
Rua Roberto Simonsen, 305.
Presidente Prudente – SP.
CEP- 19060-900
BRASIL
Tel. + 55 18 32295325
Fax. + 55 18 32231534
e-mail: guilhermesouza@fct.unesp.br

Prof. Dr. Amilton Amorim
FCT/UNESP
Rua Roberto Simonsen, 305.
Presidente Prudente – SP.
CEP- 19060-900
BRASIL
Tel. + 55 18 32295325
Fax. + 55 18 32231534
e-mail: amoim@fct.unesp.br

Prof. Dr. Julio Kiyoshi Hasegawa
FCT/UNESP
Rua Roberto Simonsen, 305.
Presidente Prudente – SP.
CEP- 19060-900
BRASIL
Tel. + 55 18 32295325
Fax. + 55 18 32231534
e-mail: hasegawa@fct.unesp.br