

Field surveying inspection using tablets

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Key words: Field Surveying, Cadastre, Mapping Procedures

SUMMARY

The article presents new mobile procedures to perform field surveying inspection for cadastral work. These procedures were developed at the Survey of Israel in an effort to optimize the current workflow. The Survey of Israel (SOI) is the government agency for mapping, geodesy, cadaster and GIS. SOI is responsible for the national infrastructure in these areas as well as for a number of official functions. In the realm of cadaster, the SOI leads activities of land registration and is responsible for defining boundaries of blocks and parcels in terms of coordinates.

Field surveying inspection is a critical task in the approval of cadastral maps. The inspection checks and verifies the quality of the geodetic control, the completeness of the topographic mapping and the correctness of the cadastral boundary determination. This work is done in the field. Considerable advances towards modern technology have been studied and tested recently resulting improvement in both organizational and professional procedures in the area. This paper explores the potential of using tablets and mobile devices technology as an alternative method of the traditional paper-based maps and coordination charts.

A new completely digital methodology has been developed that includes:

1. Receiving the cadastral data through an on-line form including field computation, maps, original documents, geodetic control and more
2. Integrating all the forms and documents into one project.
3. Processing the project and converting it to the mobile device
4. Using a field editing tools to verify detail and highlight problems
5. Management of the work and the different projects.

The new tablets based field surveying inspection procedure proved to be a mean of shortening procedures, minimize time and saving resources.

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1. INTRODUCTION

The geomatics profession has regulated in Israel since 1929 when the British Mandate enacted the Survey Ordinance of 1929. According to the Ordinance "No person shall engage in the surveying profession unless he holds a license". The Ordinance also states that "Any map, chart or diagram of land shall not be accepted by the Register Office or approved as an evidence in any court, unless prepared and signed by a licensed surveyor". The strong statements of the Ordinance requires proper definition the surveying profession, its work, and the appropriate standards that surveyors should follow.

The Survey Regulations is the official document that defines and regulates the surveying work in Israel. The regulations are signed by the Housing and Construction Minister following a comprehensive legal and procedural review.

While, the Survey Regulations defines the basic principles and quality requirements of surveying and mapping work, it is the Director General Instructions that provide the technical details about the methodology and technologies.

The Survey Regulations are being updated once in about a decade to meet the new technological, legal, and administrative changes and developments. The update is made according to the following principles:

- New regulations are developed as a joint cooperation between the Survey of Israel, Government Offices, public agencies, academia, surveying companies and the private sector.
- The new regulations require high quality but one the same time promote efficient processes that maximize the utilization of technologies. The regulations should place emphasis on critical requirements and "separate the wheat from the chaff" to expedite cadastral work (one of the national goals).
- The new regulations should create uniformity in the requirements across different governmental offices and districts in the approval process of mapping and cadastral documents
- The new regulations should be simple, easy to understand and follow standard working procedures in surveying and engineering.
- The new regulations strengthen the link between planning processes, development and building permits, surveying and cadastre, and land registration.

In the following sections, we will describe the three chapters of the Survey Regulations, namely; the Geodesy, Cadastre, and Mapping and Geographic Information Systems chapters.

2. CADASTRAL REGULATIONS

The current cadastral system was established in 1926 by the British mandate in Palestine, and is based on the Torrens principles (registration of titles). The country's registered area, which includes 21,000 square km (about 5% of the area still is not registered), was divided into approximately 15,000 registration blocks; each contains an average of 50 parcels (about 750,000 parcels accumulated). Each block was assigned a unique number and was surveyed and drawn on a parcel map, along with a table of areas and parcel numbers. Surveying measurements and field notes were generally recorded in field books. The methods and the accuracies in which the boundaries were defined were heterogeneous. In some areas the boundaries are accurate to within a few centimeters but in some areas the boundaries are poorly defined and can be estimated to one or two meters accuracy.

Thus, every modification of land division (cadastre) requires massive amount of work that include the search and identification of the original boundary monuments, the reconstruction of the obliterated monuments, the establishment of the correct boundary lines, the design of the new division and the submission of a subdivision plat. Since there are about 1,400 land modification (subdivision plats) every year, this process had to be improved.

The new Survey Regulations aim at improving the cadastral process by the following means:

1. Transform the Cadastral process **from a paper based** and manual one **to a digital workflow** enhanced by internet technologies (Felus et. al 2013). The new regulations do not require the submission of paper maps, paper field books but prefer digital maps signed digitally using digital signature technology, electronic field books and calculations submitted using electronic portal according to standard computer formats and protocols.
2. Accurate and country wide consistent **surveying procedures, which are based on GNSS technology**. The new regulations require that boundary point coordinates will be determined to an accuracy of 5 cm (CEP 95) using the Israel CORS network.
3. **Developing the Boundary Documentation Plat (BDP)**, an instrument that will provide planners, architects and designers with accurate boundary coordinates. The BDP coordinates will be served as an accurate framework to support modern design procedures. Moreover, since the new zoning plans will be based on approved and accurate boundaries, the conversion of the zoning plans to subdivision plats is direct which will expedite registration.
4. Defining the **National Cadastral Database (NCDB) as the dominant source of Cadastral information**, this NCDB will be the only source in the future. Currently, Cadastral information is retrieved from a variety of heterogeneous resources including Block maps, field book, technical description, subdivision plats, existing monuments, land surveying etc.

5. **Setting the principles of Coordinate Based Cadastre (CBC)**. The concept of CBC was developed by Steinberg (2001) and was implemented in Singapore in 2004 (Andreasson 2006). Nevertheless, the complex setting Israeli Cadastral system (as presented in Klebanov 2009) required a more sophisticated solution.

The solution that was developed is a new classification system for boundary points, which ranks them by quality and by their legal status. The new ranking is listed and described in detailed by the Director General Instructions.

3. PREVIOUS PROCESS

Field inspection must be preceded by preparation at the office which includes printing all ancient maps containing coordinates, data based field sheets, downloading different coordinate files related to border points and parcels, print of ground coverage values and other files needed for field inspection.

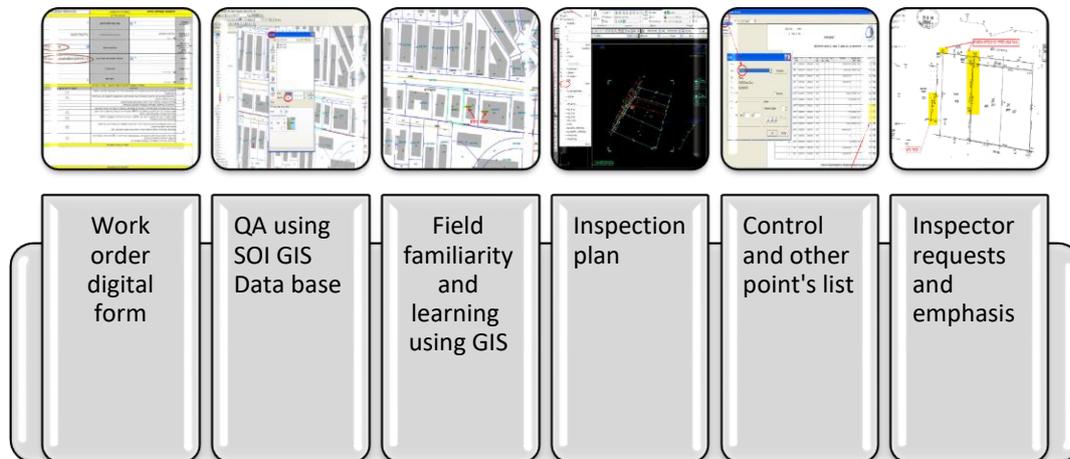
In addition, maps and coordinates of the inspected project must be prepared beforehand by the office inspector along with detailed list of the specific requirements relevant to inspection process. These requirements might include: specific measurements, authentic marks etc.

The preparation process is lengthy and time consuming since it includes involving several inspectors in the office and at the field.

4. NEW METHOD WORKFLOW

About a year ago, there was decision at the SOI to combine the tablet as a TOOL for a field check and to integrate the measurement off the GPS instrument to create a new method at the fieldwork:

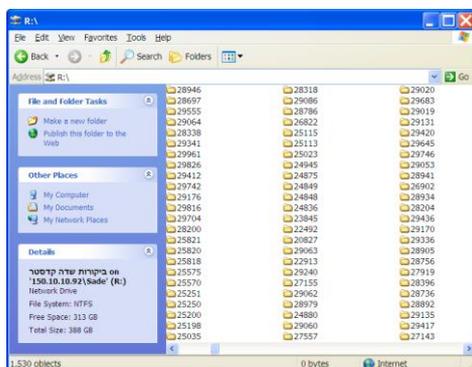
1. Work order digital form.
2. QA using SOI GIS Data base- Implementation QA (quality assurance) methods related to SOI.
3. Field familiarity and learning using GIS.
4. Inspection plan- including required aids for establishing plans and maps from the database of the SOI's database, the material prepared by the inspector at the office and saved as a digital format in a specified directory intended for field inspection.
5. Control and other point's list- ground coverage values and coordinates of the surface features and entities that to be saved in the tablet device as a digital files. Include descriptions and values of control points that extracted from the SOI database. SRV files containing the border coordinate values.
6. Inspector requests and emphasis – aids that include instructions and requirements for the field inspection prepared at the office. Learning the work and understanding the requirements. Receiving special instructions and explanations by the inspector at office.



- The following step requires arranging all above in the project directory and saving in the tablet for the executing field survey inspection. Saving the project digital files using "FELL GENIUS" software or by a disk on Key device or via e-mail to the tablet.

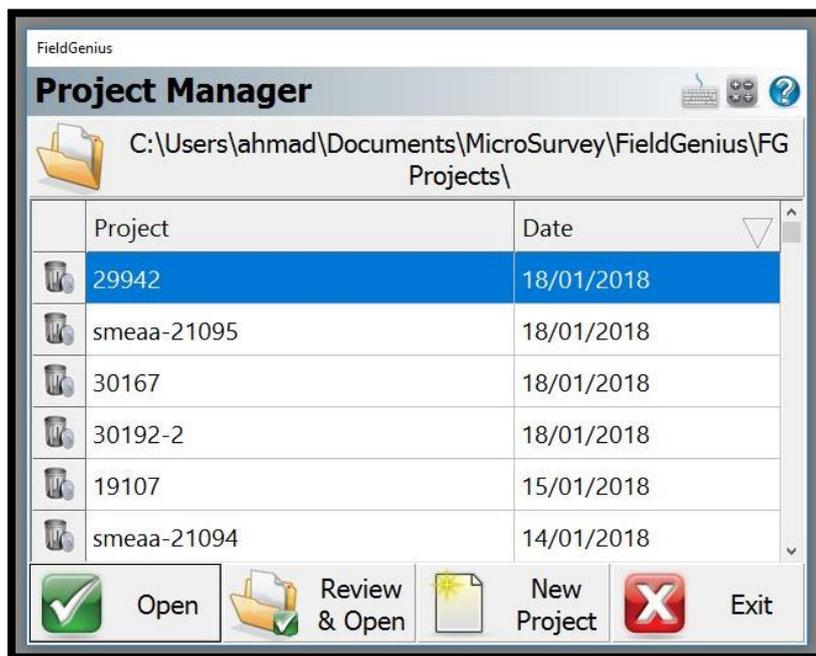
5. EXECUTING THE FIELD WORK

- Preparing the tablet and other equipment for field inspection





- 2- Browsing different materials and attachments including switching among different measurement modes.

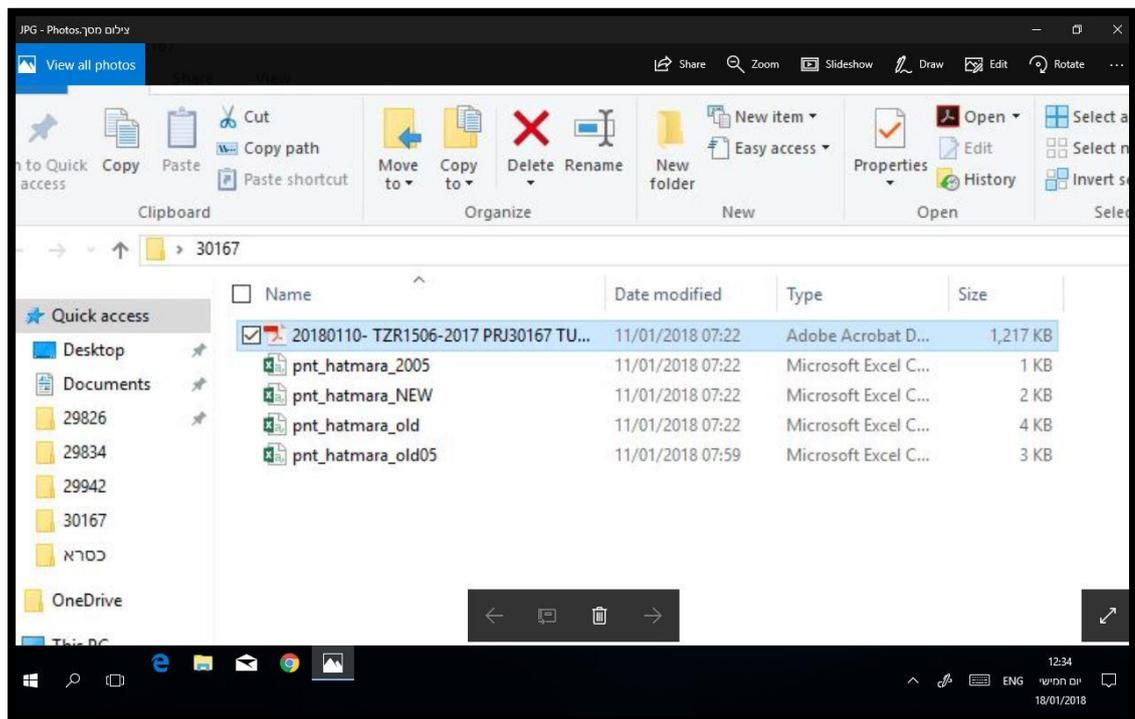


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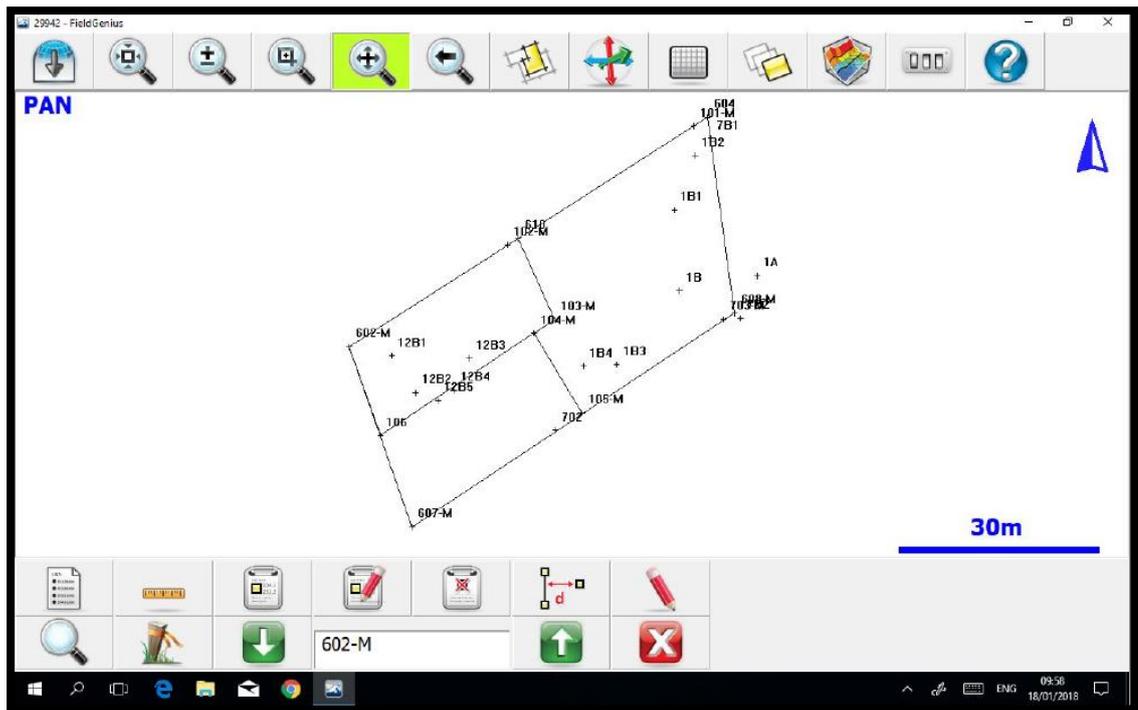
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3- Field inspector can type different observations and comments on the digital file.



- 4- Documenting the inspection by taking photographs including: buildings, points, control points, etc.. This documentation is especially important in a conflict situation.
- 5- Drawing lines between the measured points to calculate areas and to measure lengths of facades in application.



- 6- Updating the files simultaneously during inspection performance. It is also possible to update and upload the new data into the office database on line.
- 7- On-line connection with database through SOI "TOPOCAD SYSTEM-WWW.topocad.gov.il", " TOPOCAD-a unified system for geospatial data and services". This program can be used for downloading and retrieval of data and point values.
- 8- Expanding the inspection beyond the specific prepared files in any given situation at the field.
- 9- Requires less physical effort since less heavy equipment is required.



6. ADVANTAGES OF USING THE TABLETS

One of the most important advantages of tablets, including digital field books is saving time and resources prior, during and post field inspection. During field inspection, direct communication via SOI database center is possible. Field inspector can maintain ongoing communication with database via direct connection with Topocad.

Immediate saving of data is guaranteed which decreases the possibility of data loss. Raw data and relevant observations are immediately documented and stored resulting more comprehensive and detailed data pool. This direct form of communication ensures more pinpointed results and better performance based on office inspector requirements.

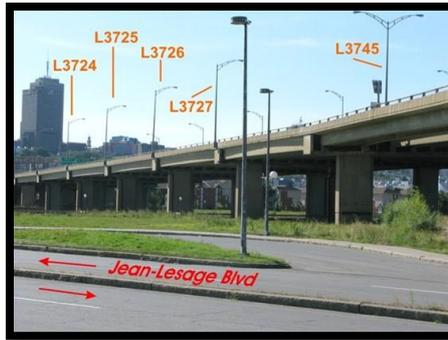
The use of tablets introduces new possibilities including that of integration of more advanced electronic equipment with the purpose of accessing different data pools which enables accessing programs like augmented reality (AR) and virtual reality (VR).

Finally, using tablets for field inspection allows a paper free transfer of material. All transfer of material is channeled via direct access of data pool or e-mail which contributes for a green environment and planet. Last but not least, using tablets has made mobility of field inspector

easier and quicker. Heavy equipment and loads of paperwork have been replaced by a light and efficient technological device.

7. SUGGESTED FUTURE RESEARCH AND APPLICATIONS

- 1- Solutions hacking the system or system crash.
- 2- Integrated technology of augmented reality (AR) and virtual reality (VR).



8. CONCLUSIONS

This paper explored the possibility of replacing the traditional field inspection method with computerized tablets. Using tablets in field inspection is one way of implementing the new Survey Regulations for more efficient geodetic, cadastral, mapping and GIS working procedures. This framework can be used to develop the Director General Instructions, a set of guidelines to certify surveying and mapping equipment, specifications for geo-information projects and so on. It is just the beginning.

However, implementing these regulations requires development of computer systems to support the new requirement, and the development of regulations is related in professional field for example civil engineering, planning, valuation etc.

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