

## QUICK INSPECTION METHOD FOR WORKING FACES IN OPEN PITS USING GIS/GPS TOOLS

### SZYBKA METODA KONTROLI CZOŁA ZABIERKI ZA POMOCĄ NARZĘDZI GIS / GPS W KOPALNIACH ODKRYWKOWYCH

Ramona Elena Kiss, Stela Dinescu, Florin Faur, Izabela Maria Apostu - University of Petrosani, Romania

*Lignite open pit mines have large extent, the excavating and stacking equipment are far one from other, the conveying equipment are very long, so, the face / mine managers have to record a big amount of data when making daily/weekly/monthly inspections. Also, they are critical inspection points, which are moving with the face's advance. The paper deals with a method and procedure of using smart phones with GPS for taking photos, which are after inspection geo-referenced on the mine plan and on the maps. The authors propose a cheap method, for assist the managers to record and process these digital, image, graphic data and information in their inspection / reporting activity. This enables them to follow the same path, to record state of art, to remark and record the normal modifications and unwanted ones. Also a rough estimation of overburden and lignite excavating progress, slope stability, occurrence of hard intrusions, ground water situation, stock of raw material and spare parts, state of equipment, degree of occupation of staff, a.s.o. Using the classical Smartphone, Google maps, Geotagging and ArcGis correlated with existing digital schematic mine plans, is useful for making reports and prepare the next decisions of process control.*

**Keywords:** GIS, GPS, open pit, inspection, referencing

*Kopalnie odkrywkowe węgla brunatnego zajmują duże powierzchnie terenu. Stosowane maszyny podstawowe urabiające oraz zwałujące, jak również ciągi transportowe osiągają znaczne rozmiary, dlatego osoby zarządzające kopalnią muszą rejestrować dużą ilość danych podczas codziennych/cotygodniowych/miesięcznych inspekcji. Ponadto, maszyny tworzące układ technologiczny kopalni są krytycznymi punktami kontrolnymi, które przemieszczają się wraz z postępem frontu roboczego. Artykuł omawia metodę i procedurę wykorzystania smartfonów z GPS do robienia zdjęć w terenie, które następnie nakładane są na plan kopalni oraz na mapy. Autorzy proponują tani sposób, aby pomóc osobom dozoru w rejestrowaniu i przetwarzaniu danych cyfrowych, graficznych oraz informacji w działaniach inspekcyjnych i sprawozdawczych. Dzięki temu mogą zapisywać wytyczone trasy, zgłaszać i rejestrować stan planowanych działań jak i zauważone zmiany niepożądane. Umożliwiają między innymi: przybliżoną ocenę postępów frontów nadkładowych i węglowych, stabilności skarp, zarejestrowanie występowania intruzji skalnych, stanu wód gruntowych, stanu i obciążenia zasobów maszynowych oraz ludzkich. Korzystanie z klasycznego smartfona, map Google, geotagowania oraz ArcGis i ich skorelowane z istniejącymi cyfrowymi schematami kopalni, jest przydatne do tworzenia raportów i podejmowania decyzji dotyczących kontroli procesu wydobywania.*

**Słowa kluczowe:** GIS, GPS, kopalnia odkrywkowa, nadzorowanie, referencja

## INTRODUCTION

The inspection of open pit lignite mines requires acquisition of a large amount of factual data in critical points (mainly in proximity of excavation or conveying and stacking equipment), which must be stored and reported in non numeric form, in a narrative natural language form.

These statements, regarding the state of the face/equipment in different imposed locations which must be inspected regularly is very difficult to be written on field during the inspection. For this reason, using photographs taken in imposed locations and geo-referencing these images are useful for performing the written reports later. Two major aspects are in discussion, the repeatability of location and the differences of state determined, on which the only human visual memory is not sufficiently accurate.

The paper proposes a way to solve this problem using photo

cameras of smartphones with GPS facility by the so called geo tagging and cheap (or free) processing software capable to exploit the metadata contained in EXIF.

More than this, it is possible to obtain not only location (positioning) information, but also quantitative data, such as distances, surface areas and volumes.

Geo-tagging is the process of adding geographical identification in a metadata usually consists of latitude and longitude coordinates to the most geo-tagged digital media like photographs. However, limitations were considered such as having a GPS without a built-in camera making it difficult to capture a spatially referenced photo. [1].

The location where a photo was shot is important, thus, advancements in technology have made it feasible to add coordinates specifically latitude and longitude as well as time information to digital photographs (ESRI, 2002) through its EXIF information. [2].

CASE STUDY

Our application refers to Husnicioara Mine, an open pit lignite mine operated by the Complexul Energetic Oltenia (CEO) of Romania.

It is situated in the southwest of the country, as can be seen in Figure 1. The coordinates of its approximate centroid are N 44.6702778° E 22.7600000° at an elevation of 320 m above sea level. The nearest prominent locality is the city of Drobeta – Turnu Severin. The mine covers an area of 1287 hectares.

Excavations started in 1985 and currently 1.2 million tons of lignite and 7 million m<sup>3</sup> of overburden and waste are excavated annually. The reserves are estimated to be 26 million tons of lignite which is used for the generation of electric power and heat by lignite-fired thermal power stations.

The Husnicioara Mine is situated in the Mehedinti coalfield of the Oltenia Mining Basin. It was formed in a Gilbert-type fan deltaic depositional environment. Its lignite ranks in the ASTM classification as lignite B. The deposit is of the multi-layer type.

Selective excavation is performed in order to deal with the multi-layer nature of the deposit. Five BWEs are available in the mine for excavating lignite and overburden rock [3].

One of the main problems is the unexpected occurrence of hard inclusions, so called boulders in the overburden layers. They are usually sandstone with a density of 2340 kg/m<sup>3</sup> and a compressive strength of 40 MPa. They are encountered at the excavation level I (and sporadically at level II) with no development up to the surface. Their size, consistency, and hardness are variable. Some can be eventually excavated by the BWE, while others require blasting.

Currently rare encounters of small size boulders are observed in the working face. The range of their characteristic size is wide, reaching up to 10-15 m. They are sandstones, formed under certain conditions by cementing of sand by water of high calcium content. Their shape varies. Those of large dimensions were either monoliths or flat packs with layers of separation.



Fig 1. Location of Husnicioara Mine in Romania  
Rys. 1. Lokalizacja kopalni Husnicioara w Rumunii

The presented problem requires periodic inspection of the faces, in order to take the necessary decisions for conducting the operation of BWEs. The authors have used the geo-tagging method of photograph shots information processing as a tool for rapidly assess the state modifications of the faces.

One of the first tasks to be performed is geo-referencing on the map the location from where the picture has been taken. This can be easily realized using Kuso Exif Viewer 3.0 which allows to use EXIF metadata to locate on map the location of photo tacking. (Figs. 2 and 3) [4], [5].

Another method is to use BR’S EXIF extractor, which save the EXIF data from .jpg photo files into a CSV file which can be exploited using MS Excel (Fig. 4).

The CSV file can be used in ArcGis (ArcMap) package and converted in .shp (shapefile). [6] Once the locations are marked on the map, the next step is to link them to the photos stored on computer, using the tool HTML POPUP as in fig. 5 [7]. The task is finished when we add the basemap, as in fig. 6. By adding Hyperlinks, we may visualize other information

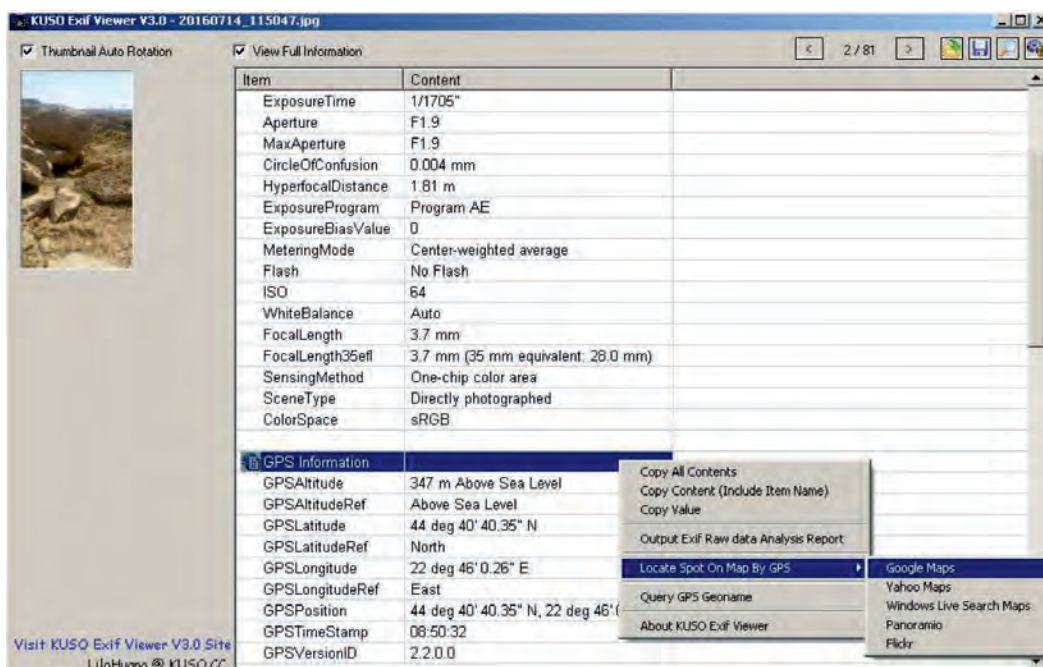


Fig. 2. Screenshot with steps to transfer metadata to Google Maps  
Rys. 2. Widok ekranu - eksport metadanych do Google Maps



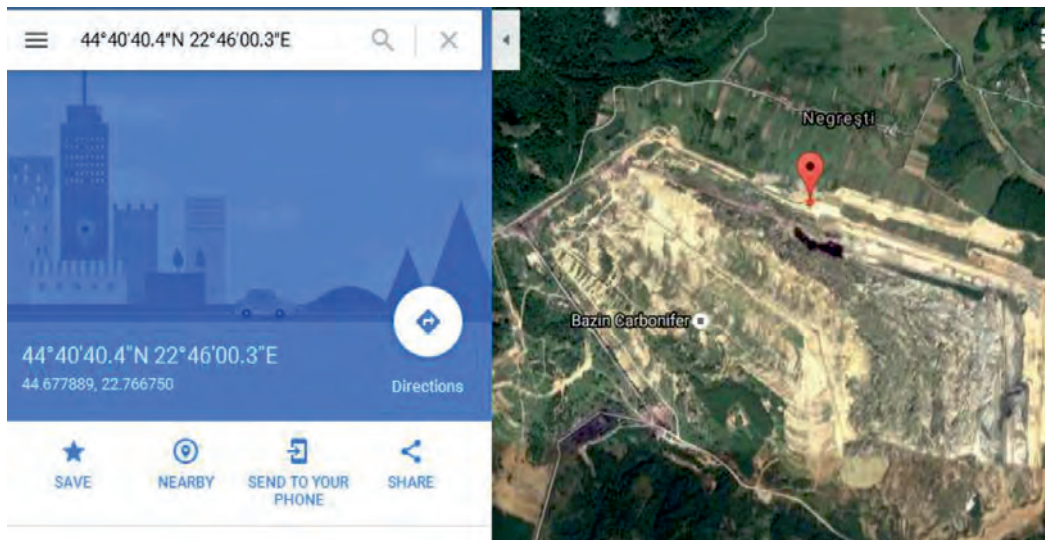


Fig. 3. Screenshot with the result of the procedure  
Rys. 3. Widok ekranu – rezultat przeprowadzonej procedury

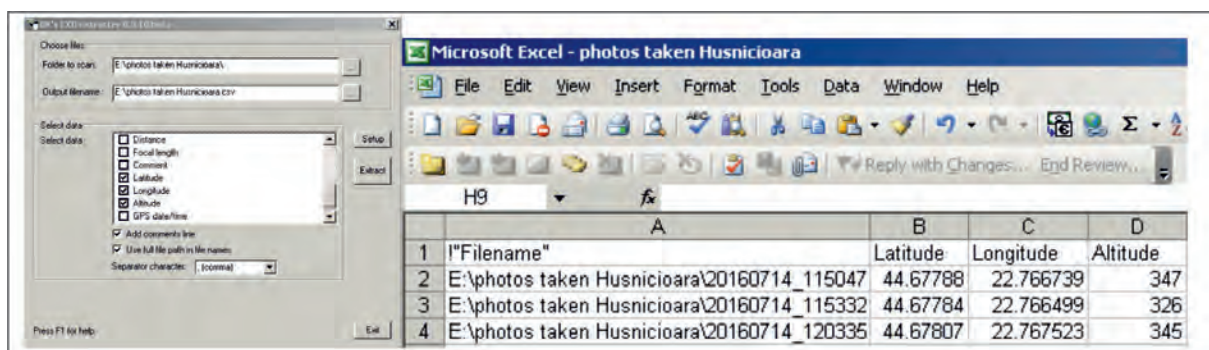


Fig. 4. Screenshot with BR'S EXIF extractor interface (left) and the CSV file loaded in MS Excel (right)  
Rys. 4. Zrzut ekranu z interfejsem BR'S EXIF extractor (po lewej) i plikiem CSV zaimportowanym do MS Excel (po prawej)

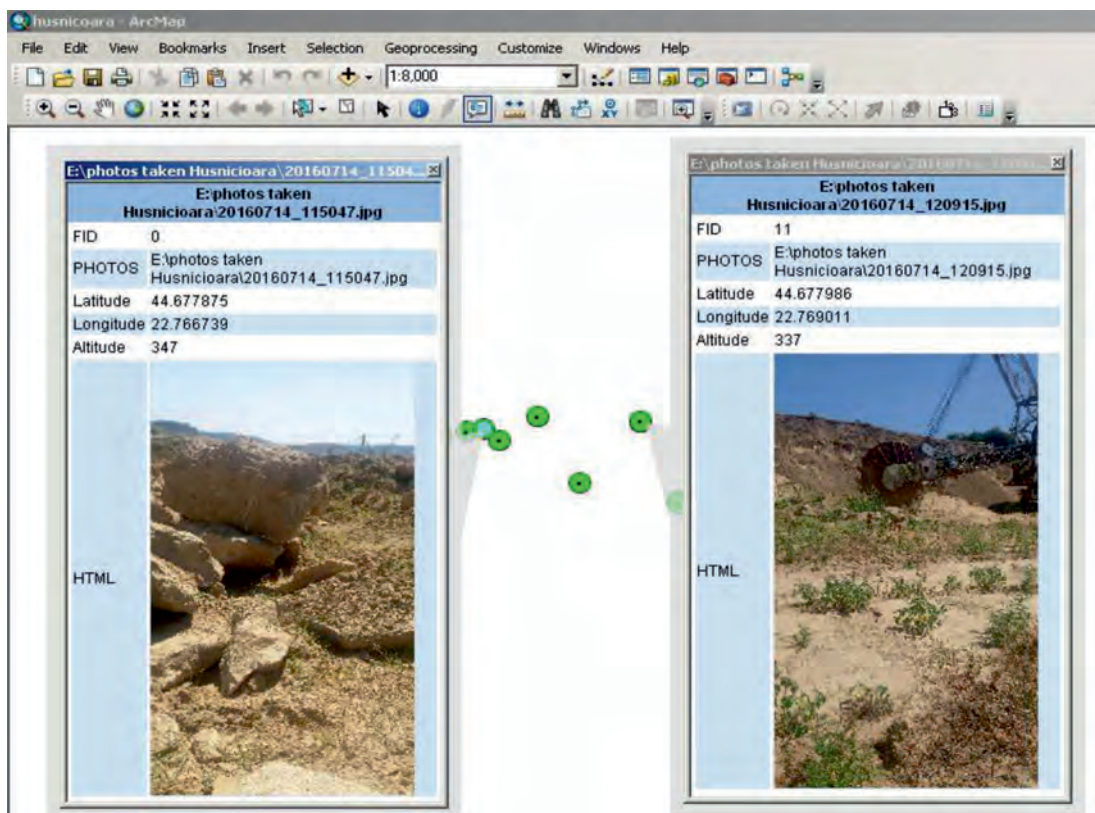


Fig. 5. Viewing photos using HTML Popup  
Rys. 5. Przeglądanie zdjęć przy użyciu okna HTML

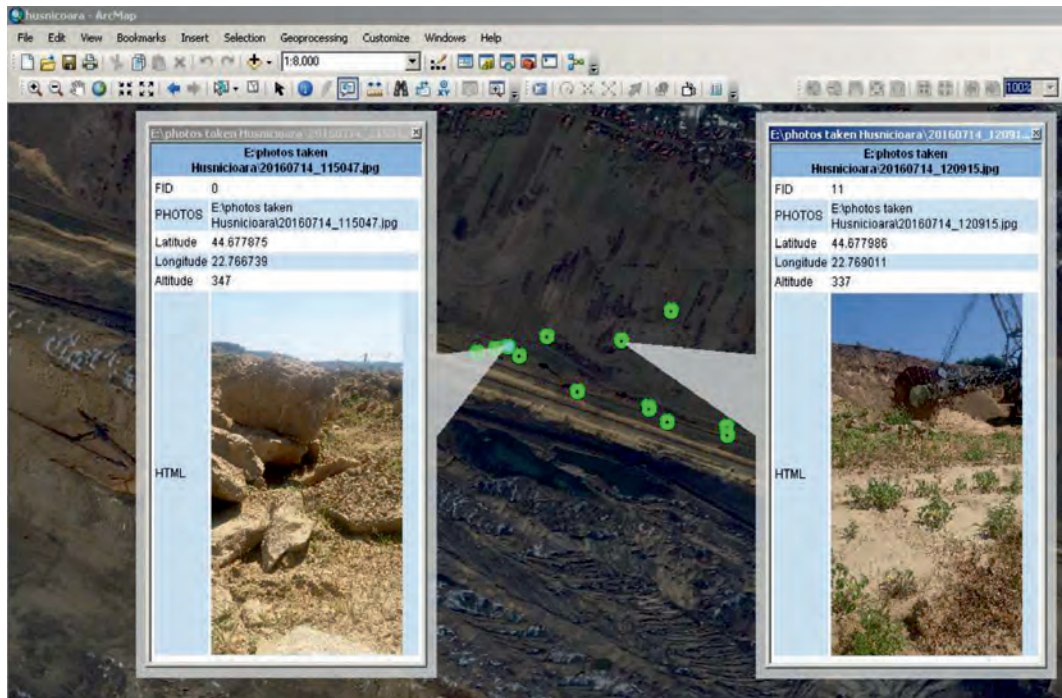


Fig. 6. Viewing photos on basemap  
Rys. 6. Przeglądanie zdjęć na mapie bazowej



Fig. 7. Use of Hyperlink feature  
Rys.7. Korzystanie z funkcji hiperłącza

on the map as in fig. 7.

Another possibility is to import geo-tagged digital photographs into the map and integrate them directly into the existing geo-database using the GeoTagged Photos To Points tool available in ArcMap 10.1. The tool creates a point feature class in the geodatabase and, as an option, attaches the photos to the point feature class so they can be easily managed along with your other data.

In this section, on basis of a case study we demonstrated the utility of using photos taken with a smartphone with the location function activated, in conjunction with free or commercial available software to geo-referencing the information acquired in such way to provide reports about situation and modifications in state of faces and equipment between two inspections.

This is more and more important due to the often occurrence of difficult situations produced by the hard to excavate formations inserted in overburden rocks in order to take decisions regarding the future operations. The proposed

method can be used in any open pit mine because the state of faces are intrinsically changing ones.

## CONCLUSION

The inspection of open pit lignite mines requires acquisition of a large amount of factual data in critical points (mainly in proximity of excavation or conveying and stacking equipment), which must be stored and reported in non-numeric form, in a narrative natural language form.

The paper proposes a way to solve this problem using photo cameras of smartphones with GPS facility by the so called geo tagging and cheap (or free) processing software capable to exploit the metadata contained in EXIF.

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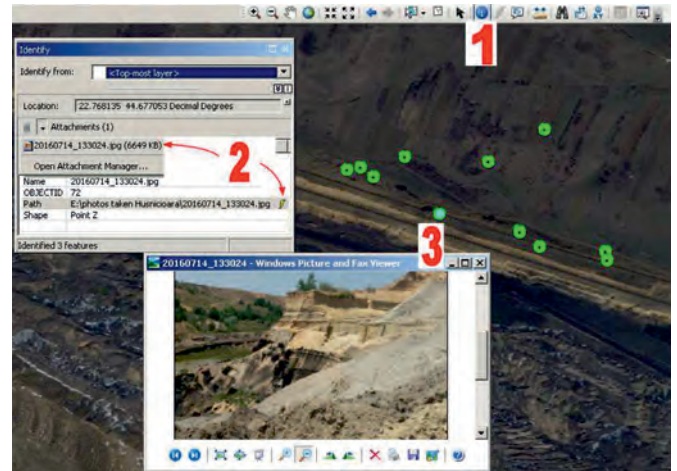


Fig. 8. Screenshot when using GeoTagged Photos To Points  
Rys. 8. Zrzut ekranu podczas korzystania z funkcji GeoTagged Photos To Points

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Architectural details of Wrocław

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