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Digitalisation of Crime Scenes Investigation Using Geographic Information System Photogrammetry in South African Police Services

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Abstract

Contemporarily, technology is predominantly used during crime scene investigations in form of forensic and digital methods. As consequence, criminals are seen to be more advanced in techniques of committing various crimes, calling for the local police to advance their skills to be equivalent to the related tasks. The purpose of the article is to analyse the use of Digital Geographic Information System (GIS) Photogrammetry in the investigation of crime scene.This article takes the form non-empirical research design: Systematic review, following predetermined steps. For data collections; documentary sources were used qualitatively, coupled with personal experience. The non-probability: Purposive sampling was adopted to outline keywords/phrases to filter information relevant to the article purpose; restricted to (theoretical framework) Textual Analysis (TA) was used for data analysis. The results of this article suggest that crime scenes should be measured accurate to avoid its questionability and inadmissibility of evidence in Court of Law. The application of Geographic Information System (GIS) and Photogrammetry as the modern way of conducting contactless measurements of crime scene aided with complaisance with the International Standard Operation (ISO) can adequately help this process. This article concludes that the application of GIS and Photogrammetry demand more scientific and technological in nature and the investigation of the crime scenes need to be advanced as such. This technique is not yet fully applied in South African context; the researchers relied heavily in the international literature and personal training experience about GIS and Photogrammetry. It is recommended that technological advancements and digital applications in the investigation of crime scenes should be enhanced in South Africa as per international standards refers and the Fourth Industrial Revolution (4IR) adaptations.

Keywords: *Geographic Information System; Photogrammetry; Crime Scene Investigation and Crime Scene Processing*

Introduction

Fourth Industrial Revolution (4ir) changes how people should practice their duties in the worldwide. To add this, 4ir is the process of transforming how the forensic and crime investigators should practice their duties from manual to robotics style as submitted by (Watts 2020:np).This transformation process it is the advantage to forensic and crime investigators to teach themselves on how to operating their work in the use of technology. In the discussion of the advantages for 4ir, Oster burg, and Ward, (2015:20) states that currently technological practice its easier for investigators to store more crime data and photos on computers in the investigation of the crime scene. According to Oliver (2017:321), in the analysis, collection, and identifying of perpetrators of Crime, the investigators can use technological aspects such as GIS and photogrammetry to solve the crime. Additionally, Becker, and Dutelle, (2018 :194) emphases that in the crime scene investigation and processing of the crime data the technology it is of more advanced. Technology assists investigators in the measurements of the evidence at the crime scene before collection process. Further, researchers suggest that in the measuring of physical evidence at the crime scene skill is of significance as McGuire and Holt, (2017:19) mention that the technology used to investigate the crime need science and mathematics in order to be useful.

Elliof (2006:5) states that "there is a lack of details of the training of police officials and case studies that include science and relate to remote sensing and GIS". According Konecny (2014:13), the perform of Photogrammetry and GIS the computer screen can be used to produce manual maps that present vector, raster pictures for crime investigation purpose. Shekhar, and Xiong, (2008:865) are of the opinion that photogrammetry has produced both hardcopy, and softcopy maps that crime data that would be processed into the GIS. Buckles (2007:276) states that Photogrammetry used digital images to measure crime scenes and evidence that used to for crime investigation. Different fields, such as geography, maths and science have more influence on the essential development of crime scene investigation. (Aziz, Majid & Setan, 2010:02). The researcher's statement is supported by ESRI (2008:1) after stating that in the understanding of geography and making bright decisions investigators can use Geographical information system technology. In the use of Photogrammetry and Geographical information system, crime scene investigator must be familiar with the Geography and mathematical as Luhmann, Robson, Kyle and Boehm, (2014:621) mention that Photogrammetry can be used to measure and documented the crime scene without alarming of search of physical at the crime scene.

Research Methodology

The paper has adopted qualitative research as the logical plan to reply to demands about the individuals in the specific social context as submitted by (Lockey, Spirduso and Silverman, 2000:98). Article has implemented merely literature study as it helps researchers to understand the title and the matters included and how the processed research has linked to these matters as submitted by Goddard and Melville (2001:19). Also, De Vos, Strydom, Fouché and Delport, (2011:302) state that the understanding cracks and also errors in the previous research would be attended in the use of literature. In this paper no interviews were conducted since the first researcher is a former South African Police Service member at the Criminal Record Center as photography, where he has more potential knowledge and skills in the use of Photogrammetry as a crime scene data collector. Secondly, research is currently data capture in the use of GIS technology at the community safety network community engagement at the university of South Africa. Both researchers are going to use their own personal experiences in this paper. To end this, both researchers are familiarized themselves with the current literature that are related to 4ir as the umbrella of the technological aspects.

Key Concepts

Geographic Information System

Murayama and Estoque (2010:7) define geographical information systems as the system used to store, handle, evaluate and record crime data. GIS is the system that is used to visualize data (Zinn and Dintwe (2015:314).

Photogrammetry

Robins (2016:412) states that photogrammetry is the process of using the photographs to find the exact measurement in the adoption of "science or art". The 3-D coordinates tool that uses photographs for measurements is called photogrammetry. (Houck, 2017:103)

Crime Scene Investigation

According to Dutelle (2017:4) "Crime scene investigation is the systematic process of searching for documenting, collecting, preserving, and interpreting physical evidence associated with an alleged crime scene".

Crime Scene Processing

Ramirez and Parish-Fisher (2012:12) state that crime processing is when crime scene investigators recognise evidence at the crime scene. Houck, Crispino, and McAdam, (2017:16) Crime scene processing is the documentation of crime scenes.

The Significance of the Photogrammetry to Support Geographic Information System in the Crime Scene Investigation

Masele and Mayunga (2000:841) state that Photogrammetry is the suitable capturing tool for crime scene data in the support of GIS. Photogrammetry qualifies as the best technique in the support of GIS, because it is flexible in the capturing and measuring of crime scene information. in this study the capturing refers to measuring of the physical evidence at the crime scene. Likewise, physical evidence refers to tools that were used to commit crime and other evidence such as footprint and fingerprint that were left behind by the suspect at the crime scene. The crime investigator should measure all physical evidence at the crime scene for the purpose of physical evidence linkage to one another. Physical evidence linkage will lead to physical evidence analyzation process. To despite this, Hepperle, Dixon-Gough, Mansberger, Paulsson, Hernik, and Kalbro, (2017:212) states that the main importance of using Photogrammetry to support GIS in the analyzation of crime scene information it is because, photogrammetry produces accurate calculations about crime scene. To support this, Montgomery and Schuch, (1993:114) emphases that the most important motive of using Photogrammetry in the support of GIS during analyses of crime scene information it is to ensure the high standards of the results. To add this, the high standards will lead successfully of the crime investigation process, after a crime investigator got correct coordinates during crime scene measurement. However, Both GIS and photogrammetry are what we mean in this study when we deliberate the 4ir dynamics as explained by (Watts, 2020:np)

Visualization of Crime Scene in the Use of Photogrammetry with in Intend to Investigate Crime Scene

The visualization of the crime scene it is the process that performed in the era 4ir, because it is use computer software such as photogrammetry. This process demand skill and knowledge of the science and art as explained in the 3.2. Further, in the 4ir era the practicing of the visualization of the crime scene demands the scale of 3-Demension as (Watts, 2020:np). According to Opitz and Nowlin (2012:49), 3-

demensional makes easier for crime investigator to visualize all poles/corners of the crime scene from north to south and from east to west. Likewise, this is illustrated in Figure 2: below of the study. Ibraheem, Daham and Hussein (2014:1) advice that for visualization of the crime scene to be of quality need accurate crime scene information.

Furthermore, Mancini and Sidoriak (2018:219) advice that in the practice of photogrammetry drones or aircraft can be used in the capturing of crime scene photos for visualization process. For example, in the following image researchers illustrate how crime scene investigators conduct photogrammetry processes in the use of aircraft or drones in order to find the exact position of an object to crime scene.

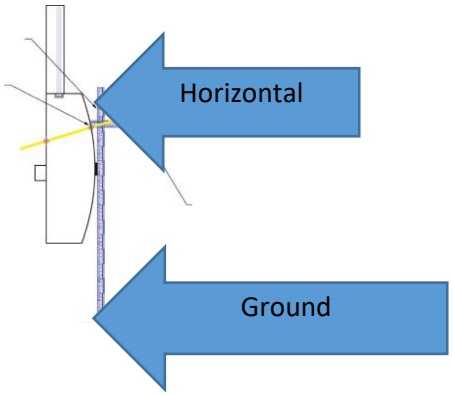

Figure 1: Baxter (2015:196) And Researcher Illustrations

Practical Processing of Crime Scene by Use Photogrammetry for Crime Analysis and Investigation

According to Fish, Miller, Braswell, and Wallace (2014:78), the locating and measuring of evidence at the crime scene can be done in the usage of photogrammetry as the technique. Further, Houck, Crispino, and McAdam, (2017:362) states that Photogrammetry is of significance in the calculating spaces from 2 dimensional "photographic images" at the crime scene. For instance, the following image illustrate how Photogrammetry can be used for processing physical evidence at the crime scene. In the practical processing of crime scene by use of photogrammetry the 4ir has more Impact, because this process needs technological hardware devices such as computer and smartphones as submitted by Fancher (2018:04).

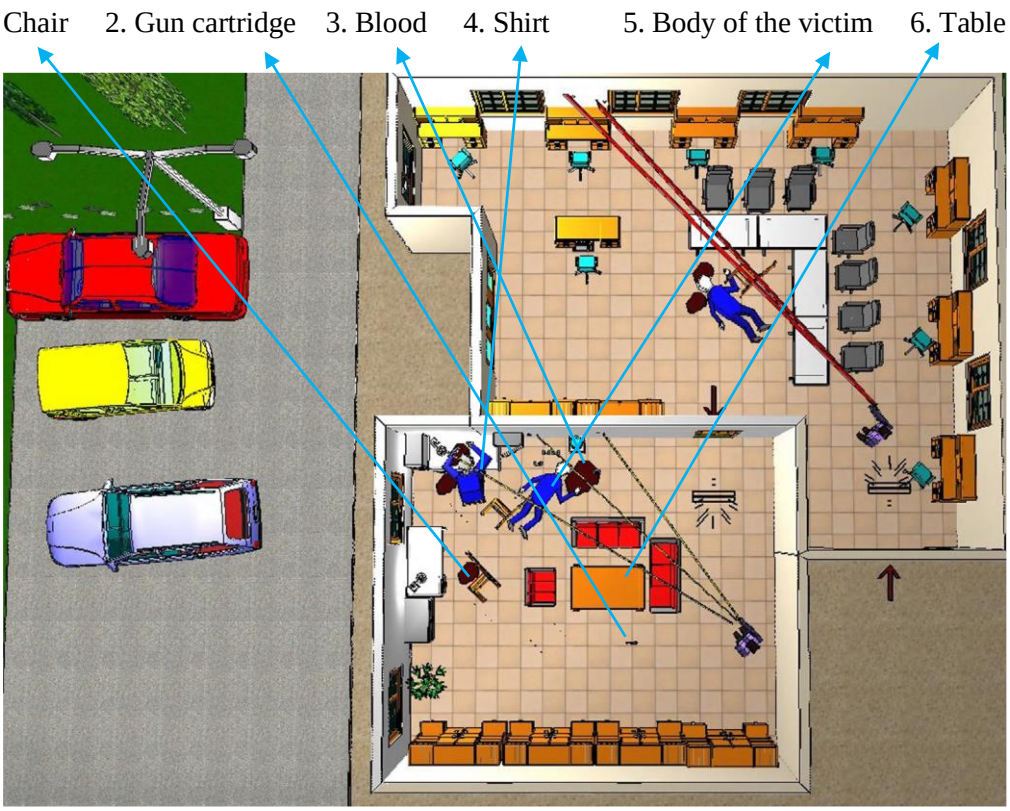

Figure 2: Fish, miller, Braswell, and Wallace (2014:76) and researcher's illustration (2018)

From the above image it is very easy for crime scene investigators to measure the distance of the physical evidence from the deceased body during the Photogrammetry process. The primary researcher underneath illustrate how distance between the deceased's body and physical evidence were analyzed.

Physical evidence	Distance between physical evidence and deceased's body
1. Chair	2 millimeters
2. Gun cartridge	2 millimeters
3. Blood	1 millimeter
4. Shirt	1.2 millimeters
5. Table	1.8 millimeters

Figure 3: Researcher's own Illustration (2018)

The above photogrammetry analysis support investigators in determining the positioning of the suspect and the victim during the commission of crime. From above photogrammetry analysis, it is absolutely correct that suspect was 2 mm away from the suspect during commission of murder. *One can ask* that how investigators determine the distance between the suspect and deceased's body, *the answer* is that, the distance discovered after the crime scene investigator measured the distance between the gun cartridge and deceased's body.

In order to get the exact position of the physical evidence from the deceased's body at the crime scene the coordinate will be of significance. Geographic information systems will assist crime scene investigators with coordinate systems such as X, Y axis.

Practical Steps in Capturing the Photogrammetry Crime Data in GIS for Investigation Purpose

The researcher illustrates the steps that must be followed in the capturing of the crime scene data into the Geographical information system. Blyth and Sutherland, (2007:113) state that the GIS system would be used to "detect" the evidence that is previously captured at the crime scene. According to Schwartz (2006:473) GIS as the data capturing technique can be used to convert lines and points at the crime scene. According to the second researcher's experience, the conversion of points and lines will be controlled by the scale of the map in the GIS system. Gregory and Ell (2007:41) emphases that "the process of *GIS data capture*, as it is known, is slow, expensive and frequently tedious". This very challenging in the 4ir living era.

First Step 1

According to the second researcher's practical experience in the use of GIS to capture data ArcGIS version 10.4.1 that is in ArcMap that is previously used by Esri. Researcher completed ArcGIS basic course at Esri in 2017, where in this course the Software that was used is ArGIS version 10.4.1 that is in ArcMap.

The researcher's statement supported by Wang (2015:4) who bring good knowledge that:

> "to check the existing projection for spatial dataset in ArcGIS, one may use ArcMap by right clicking the layer> properties> source".

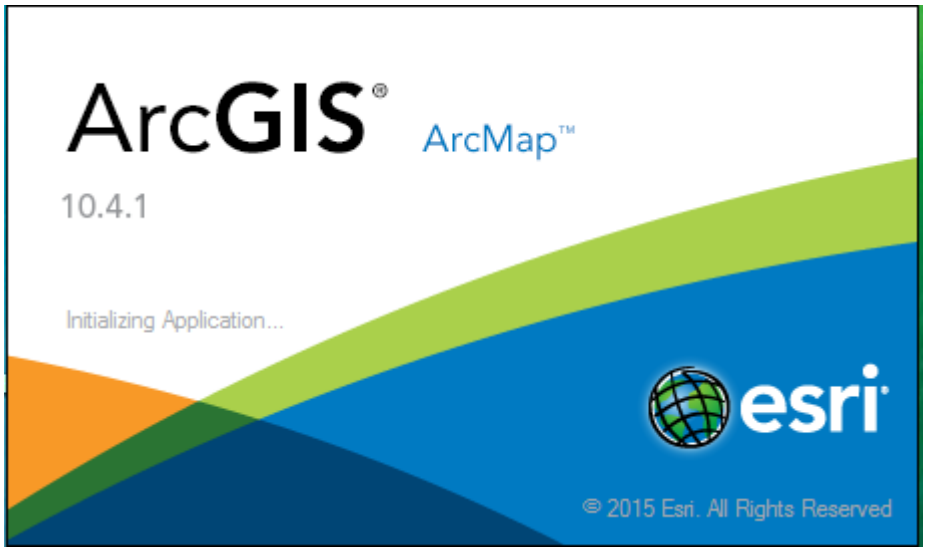

Figure 4: Tosin, (2016) ArcGIS software

Second Step 2

Crime scene data must be added into the ArcGIS software. According to the researcher's experience in the adding of the data in ArcGIS need quality and invalid data to make it easy for GIS experts to easily capture that data. According to ESRI (2017:5) ArcGIS gives crime investigators a major technique to add crime data in order to perform crime analysis for crime scene investigation purposes.

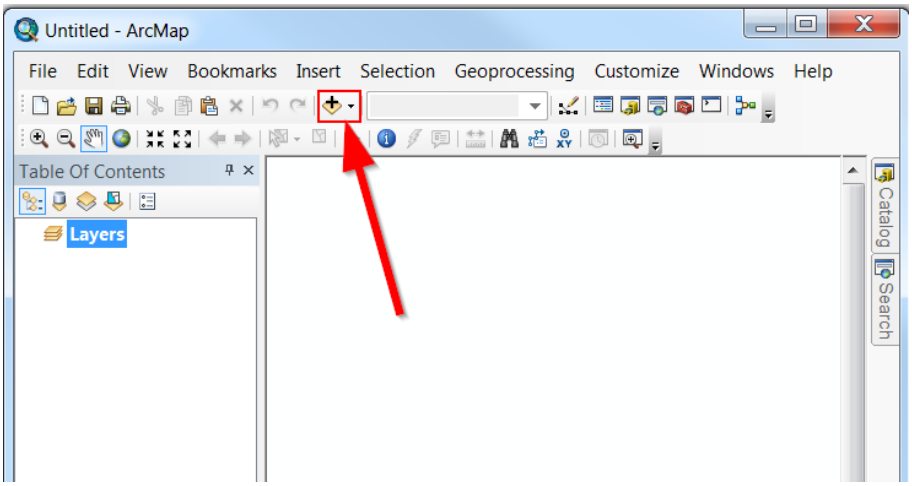

Figure 5: Department of Community Health Sciences GIS Workshop (2018)

Step Three 3

The third step in the application of GIS is where multi-processes must be performed as Fish,Miller, Braswell, and Wallace (2014 :82) state that "GIS software can assimilate and analyze plans, maps, and other informational databases, such as crime scene evidence".

In the below Figure 6, is where crime scene investigators use GIS to analyze crime scene data by spreadsheet. According to the second author experience as the crime data capture at the Community safety network, the crime data must firstly have to be analyzed in the spreadsheet.

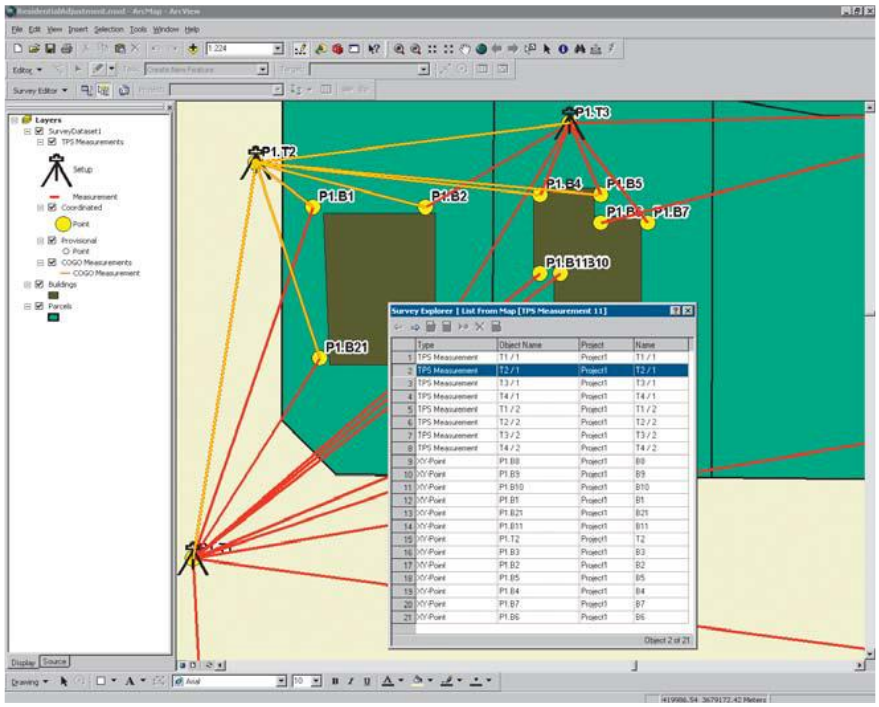

Figure 6: ESRI (2001:56)

The graphic above shows measurement information of the crime scene analysis in the GIS Software called ArcGIS.

At Figure 6, researchers illustrate how GIS used to capture the crime scene data from Figure 3: Researcher's own Illustration (2018). The Figure 3: Researcher's own Illustration (2018) is the crime scene data that was processed by crime scene investigators in the use of photogrammetry. Cole, (2017:25) states that in the crime investigation GIS can used to processing the geographic data from photogrammetry sources. To add this, geographic data are referring to coordinates of the crime scene. the researcher expresses the point of view that need to geocode in the spreadsheet to find the correct coordinates of the crime scene. The geocoded of geographic data is technology related dynamic to 4ir as explained by Watts (2020:np).

Findings and Recommendations

The following findings are founded on the results of this research:

The study demonstrates that in the South African context the use of technological aspects in the criminal and crime scene investigations is still challenging to crime investigators. The collection and geocoding of the crime data are challenging that crime investigators in South Africa are facing recently. Secondly, crime investigators lack skills on how to operate photogrammetry by scanning and measuring evidence at the crime scene. Further, the lack of research on how to use the Geographical information system and photogrammetry in the crime scene investigation in South Africa. Consequently, this causes more misunderstanding in the analyses of the evidence that was collected from crime scenes. The failure in the analysis of the evidence that was collected from the crime scene will delay cases. To end this, the failure of the crime investigators in related to use of photogrammetry and GIS in the crime investigation sphere it is subjected to failure in pursuing 4ir routine.

Recommendations

It is necessary for crime investigators to be trained on how to use technological aspects to improve their skills and knowledge in the crime scene investigation sphere. Training in the use of the photogrammetry and GIS should be subsidized to ensure every crime investigator who is interested in the training can attend. The training should be assessed in both practical experience and academic that is related to the 4ir era. To add this, the academic manuals that are used for assessment should be accredited by South African Qualification Authority (SAQA).

Conclusion

The aim of this article was to explore the use of photogrammetry and Geographical information system in the investigation of the crime scene. The authors distinguished between the use of technological aspects such as photogrammetry and GIS in the investigation of crime within the 4ir routine. Consequently, the authors notice that photogrammetry can be used to measure crime data that will be analysed in the use of GIS.

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