Forensic GIS: The Role of Geospatial Technologies for Investigating Crime and Providing Evidence

The purpose of this book is to explain the nature of geospatial technologies, demonstrate a variety of geospatial applications used to investigate and litigate civil and criminal activities, and provide a reference of current acceptability of geospatial technology in the production and presentation of evidence. The format will be an introductory overview designed to appeal to researchers and practitioners across disciplinary boundaries. The book will consist of three sections: 1) an overview of subject matter knowledge, 2) applications, 3) theoretical and applied challenges. The examples below illustrate possible contributions, but submissions are encouraged on any related topic:

Section One: Overview

1. Introduction: Geospatial information technologies in a forensic role.

2. Uniqueness of Geospatial Information Technology:
   a) Geovisualization: Reduction of complex datasets to informative maps; providing coherent visualization of large volumes of data from diverse sources.
   b) Geodatabases: Linking spatial records with attributes
   c) Embedded information: hyperlinks / multimedia
   d) 3-D: Visualize and analyze a third dimension of data.
   e) Dynamic vs. static: Examine effects of changes, sensitivity analysis.

3. Types of geographic analysis using Geospatial Information Technology (GIT).
   a) Theory testing: Is theory testing possible in a spatial context?
      a. Statistical probabilities and alternative hypothesis generation. The benefits and problems of scale and spatial autocorrelation.
   b) Spatial analysis: Examples of types of spatial analysis.
      a. Map algebra
      b. Network analysis
      c. 3-D analysis
      d. Space / time, spatio-temporal analysis
      e. Tracking analysis: Adding a fourth dimension.

4. Related technologies and forensic roles:
   a) GPS / spatial tracking / geo-tagging.
   b) Ground penetrating radar (GPR).
   c) Remote sensing: Aerial and satellite imagery.
   d) Thermal imagery: Discuss its characteristics and use.
   e) High-Density Laser Scanning (HDLS) and LiDaR.
   f) Radio-Frequency Identification (RFID).

5. Crime Scene Investigation (CSI) and spatial technologies: Discuss geospatial applications at the scene of the crime.
   a) HDLS: High resolution data acquisition.
   b) Crime scene / accident representation, reconstruction and simulation: Preserving and making information understandable and presentable in court.
   c) Shoe print analysis and other emergent applications.

6. GIT and the crime analyst: Moving from the crime scene to the lab.
   a) Working with GIT.
   b) Collecting and analyzing spatial data.

7. GIT in the courtroom.
   a) Evidence/rules of evidence.
   b) Chain of custody: preserving the digital CoC.
   c) Metadata: Scale, accuracy, producer, creation date, modification, suitability, etc.
d) The test of relevance: To protect the accused.
e) Expert witnesses: Who, when, why?
f) Reproducibility: Methods and techniques used.
g) Demonstrative and scientific evidence.
h) Hearsay and public records.
i) GIT in the courtroom.
j) Privacy/warrants.
k) Current state of GIT acceptability/precedent.
l) Civil vs. criminal case aspects.

Section Two: Applications

8. The use of geographic analysis in forensics/criminology: Discussion of established and emerging applications.
   a) Environmental monitoring and prosecution: Providing evidence in pollution, erosion, and flood cases.
   b) Geo-forensics: Spatially distinct soils and pollens; reference database development.
   c) USDA crop fraud program.
   d) Buffer/distance analysis from facilities (schools, etc.).
   e) Fingerprint analysis – Topology
   f) GPS: Washington DC serial killer
   g) Remote sensing: Disturbed soils/stressed grass
   h) Body recovery using GIS models
   i) People for the Ethical Treatment of Animals (PETA) vs. fisheries.

9. Case Studies: Court reports demonstrating the use of spatial technologies in crime investigation and litigation

Section Three: Challenges and Conclusions

    a) Accurate/reliable data and validation.
    b) Learning curves, technological skills, and lack of skilled analysts.
    c) MAUP/ecological fallacy: Geographic pitfalls applicable to forensic science.
    d) Geo-profiling weaknesses (e.g., displacement theory): Acceptance and denial of a theory.
    e) Blending theories and practices from different disciplines: Maintaining distinct identities, increasing burdens, integrating oil and water.
    f) Privacy, ethics, constitutional rights and liberties: Social/technological debates
    g) Financial considerations: Software, hardware, data, training, lab maintenance and salaries. Rewards: Social return on investment, reduced crime, public trust, cost savings.
    h) Reliability of digital data and means to ensure integrity.
    i) Research frontiers.

11. Summary and Conclusions