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## **Forensic Profiling**

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### **Abstract:**

This review paper brings out technical and legal association between profiling and forensic science. It emphasizes on trace evidences used as valuable information in perspective of forensic science and criminal justice system. The aim of forensic profiling is to interpret and investigate with reasoning purposes. It explains available forms of data, data processing methods and technologies, and obstacles to data treatment. Proceeding with reconstruction process that formulates a possible hypothesis of profile, different forms of forensic profiling with judicial perspective are discussed. Other factors such as crime perpetration, crime series, and tactical, operational and strategic analysis etc. that can help in developing of profiles are also argued. It distinguishes the profiles significance into new technologies of DNA databases, digital image forensics, 3D and CCTV surveillance cameras, forensic drug profiling and intelligence based expertise centers. Other fields related to security such as detection, risk analysis and surveillance are discussed in profiling perspective.

**Keywords:** Forensic Profiling, Context and Forms of Forensic Profiling, Profiling Technologies

### **1. Introduction:**

The term 'forensic profiling' refers to the process of assuming information or distinct characters of an entity or a person. This information in the court of law is used as trace evidence resulted from criminal or litigious activities as according to Locard's Exchange Principle that states, that 'every contact leaves a trace' [4]. Therefore, forensic profiling is the process of determining link between traces collated in databases that characterize a person or an object or an individual or a group as a profile. In other words, profiles are applied as sets of interconnected data to identify and represent a subject or an object as a group or class [8,9]. This information as a trace is not only dedicated to the court of law but also brings data facts to a wide range of fields related to security system, risk analysis, inquiry and surveillance [1,4]. Forensic profiling involves use of data mining technology

to discover relevant patterns and generate profiles from an immense amount of data. It is considered that profiling exploits traces to describe those profiles significant to various security tasks of criminal justice system. Profiles used in forensic profiling should be characterized before evaluating data mining technology application [2,3].

Frequently, forensic profiling is assimilated with offender or criminal profiling in context of crime and psychological profiling or investigative psychology in context of violent crimes. Similarly, DNA-profiling is also known as profiling though it is a different term with an unknown accurate scope to most of the people. Another ongoing field of profiling that is less familiar to general public but with great interest for investigators is forensic drug profiling of illicit drugs. Drug profiling systematically extracts and stores chemical features of illicit

drugs that give indication of manufacture technique, distribution process, size and development of the market [6]. Profiling in recent perspective of forensic science applies data mining techniques to databases to identify the blueprint that may be a link to illegal activities. Therefore, profiling has no single use in forensic science and perspective implication leads to various fields. Where psychological profiling is fascinating and attractive, at the same time DNA-profiling, illicit drug analysis and data mining techniques are also highly technical and emerging fields that are commonly inaccessible to general public [5,7].

To avoid these ambivalent perceptions, an enhanced formalization is essential from a forensic angle as the concept of identity and identification is the foundation of field. The development related to identification in association with id-system in an information technology era should be integrated properly. New frameworks are required in forensic science to handle electronic traces and forensic cases in more traditional way through data mining technology [7,8].

## 1. Context of Forensic Profiling

Basic information or data used for profiling purpose is not directly accessible in an appropriate form to the law enforcement agencies. Data processing methods differentiate selective range of traces, data collection from available sources, quality assessment and examination of existing data, and their distribution. This helps to clear out a chain of encompassing complications during visualization of profiling process. Poor use of technologies cause hurdles that slow down the flexibility of information [10,11]. These types of obstacles termed as linkage blindness and lead to limitation of detecting related patterns that actually exist in data. This inability of connecting dots is usually acceptable at the beginning of main intelligence failure. Other alternative obstacles that may cause linkage blindness are of legal, managerial, mechanical, technical and human based as followings: [12,13]:

- In legal context, information/data is spotted into specific files and authority such as two data sets of DNA and Automatic Fingerprint Identification Systems (AFIS) databases are

practiced separately as an outcome of legal policy but both can be consolidated at state level. Databases use special organization method by prevent taking out of piece of data and also exchange of electronic data.

- Information other than police documented data such as organizational data is not openly available and accessible. A judicial authority in specific situation must interfere to permit the access by the police and to regulate the holder to give the right thus slowing down the whole process. As a result, nullifying the analysis of data for the purpose of problem under examination. For insistence, sometimes it takes several months to acquire specific sets of data.
- Data obtained usually are in multiple forms, rarely paper form. The entire data including police data are strictly structured for administrative purpose instead of profiling purposes.
- Profiles are considered as hypotheses as they are structured with partial and tentative facts, therefore, providing unrelated leads that can be improved by assessing the consistency of data used to depict a hypothesis.

Reasons mentioned above are the obstacles to data treatment that how data are treated such as collation of data and assessment of information. Pre processing stages of gathering information from different sources is generally a significant attempt that should completely lead the analysis and profiling process. Fundamental models are devised to collate data from scattered sources in various set-ups and arrange them in a proper outline for analysis. Normally when criminal data is analyzed, three main analytic dimensions appear relevant such as 1) what are the units either an object or individual or a group in the form of traces, series and incidents etc., 2) what is their relation like specific person owns that specific car, event arrangements such as transaction sequences between bank accounts, and 3) spatiotemporal progress i.e. attention towards activities and their progress. It is a critical aspect of the whole profiling method to circulate the results obtained to an intelligence

organization. Communication quality also influences the appropriate use of profiles in an investigation. At the center of process, systematic element that pursues profiling must be considered carefully within broader process [13,14].

## 1.1. Profiling Data

Generally data accessible to law enforcement departments are of following types:

### 1.1.1. Nominal Data

Nominal data allocate directly to persons or objects and their relations, for instance recidivists who reoffend, intelligence and suspect files, and stolen objects like vehicles etc. Nominal data can also be acquired in construction of specific investigations such as calls list made with a mobile phone covering a certain period of time, list of persons that matches to a specific profile and data obtained through surveillances. These nominal data can be used to depict organization or group of offenders or criminals [15,16].

### 1.1.2. Crime Data

Crime data are the traces obtained from the results of criminal activities such as physical traces, information collected from the crime scenes or witness or victims and some electronic traces. Other information may also come through reconstruction of cases such as modus operandi (working behavior particularly in context of criminal investigation), time intervals, case duration and place, and links between cases or series etc. Crime data are also regrouped to describe the repeated situations that contribute to a typical mechanism such as credit card frauds may be assigned to categories that differentiate skimming, distraction thefts or other thefts etc [16,17].

Data when classified according to legal definitions may mask the real force behind crime problems. Therefore, it is necessary to make distinction between trace sources, activity or situation explaining traces such as immediate environment, victims or offenders, and the offence or crime. This division of data led to difference between areas of crime analysis

mostly carried at region or local level and criminal intelligence analysis at central agencies. This designates two professional communities but both are linked under many forms as traces result from behaviors of individuals. This may provide some descriptions such as the link between a trace and a person and supposing an activity or determining an offence. Forensic profiling in this perception will form a process focusing on the use of traces but may have common characteristics with criminal intelligence analysis [18].

## 2. Reconstruction Process and Profiling

Reconstruction is a central process that starts from the traces and leads to different hypotheses or possible sources that can be explained through the optic of profiling. As every criminal activity is unique thus reconstruction process explains specific situation with specific person such as what, who, when, where, why and how questions as illustrated in figure 1. This process occurs in general environment that should be considered such as demographic, economical, sociological, criminal and physical etc. so therefore, similar events previously occurred in the same region during the same period can be of significance for judicial process [19,20].

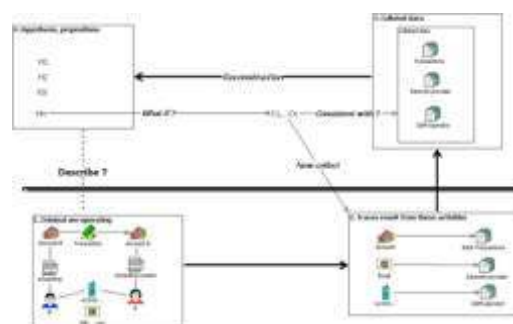


Figure 1: Description of reconstruction process [19].

Generally, traces may be fragmentary, visible, latent or sometime hidden following irrelevant data. For example, to search out for any

important file on a hard disk, specific search tactic must be formulated for detecting, identifying and collecting relevant traces as the file can be hidden within directories in the form of logically deleted file or partially replaced by new data. Possible sources, behavior and the offence must be described from the collected traces. A modern approach used for restructuring process can describe the offender, victim, instant surrounding and available safety. This approach describes the conditions of a crime that are specific and depend on offender's motivation and ability, and victim's characteristics within specific surroundings making her vulnerable. Consequently, forensic profiling will focus both on offenders and victims, and their background to identify the origin that can cause repeated victimization. Further studies of this prospect can be helpful in defining application of crimes in time and place, continuation and progression of these clusters [21,22].

## 1. Forms of Forensic Profiling in the Judicial Process

Criminal justice system has many personnel who investigates for answers of what, where, when, why and how questions depending on their tasks, roles, capabilities and work understandings. Each of them has different purpose for specific reasoning structure, for example judges and juries are responsible for taking the definitive decisions at the end of the process, police and forensic scientists together support the defendant and his lawyer in preparation of file. The victims and witnesses are interviewed to give their views about offenders and their activities. Lastly, criminologists test their hypotheses or develop crime theories by understanding the offence mechanisms. Specific knowledge of each expert may be helpful to the whole reconstruction process and their contributions may differ within each system. The role of forensic scientists on the whole may vary from providing expertise in confidential situations to direct contribution in the investigation process with scientific approach to study traces. Scientists from general perspective and forensic viewpoint have debated that different forms of investigations with their own plans or logic are available in the judicial process i.e. to find the problem by following identification and localization of suspects, to prove the problem by structuring evidence and trial of the problem where traces are present in

the form of evidence as explained below [23]:

### 1.1. Forensic Profiling and the Interpretation Process

The interpretation process begins with dealing of proposal based on traces collected that represent a trial and defense position. For example, electronic trace A was generated from computer B vs. may be generated by computer C that is selected from a related population or in terms of movement; traces of a person computing on internet during that particular time vs. traces of another person operated computer that perused traces [24]. Therefore, in profiling a trace may be assimilated to a component of a person or an object that imposes assessment of profiles collected from crime scenes and of an accused person. Mostly it involves comparison of traces with reference substance obtained from the origin such as comparing finger marks lifted from a scene with fingerprints obtained from an accused, results a match. During interpretation process, relevant questions are based on probability i.e. chances of profile trace to match the accused profile if the source of the trace is the accused person. Alternatively, the same match can be possible one or more than one person was also present at the located source of respective trace. Therefore, assessment of profiles from other related population is important that may cause traces with similar match. The whole process of interpretation using profiling is capable of defining identities and clarifying attributes for comparison as shown in following figure 2 [25]:

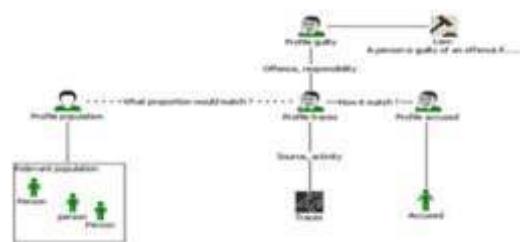


Figure 2: Description of interpretation process using profiles [25].

### 1.1. Profiling and Structuring Evidence

Forensic scientists advise the respective authority with dealing of traces that may direct

towards collection of new traces when a suspect has been arrested. At this point of investigation, reliability of the available trace is tested by assuming the suspect at the activity place that resulted traces. It is not adequate to take a reliability test to the court with a hypothesis as it may lead to hypothesis refusal if traces illustrate unsolved differences. For example, it is not possible for a person to use credit card at one place and mobile phone at another remote place at the same interval of time. In context of profiling, unity or consistency of person profile under inspection must be tested from different directions to identify possible contradiction or to support the hypotheses that how those coincidence may occur. For example, assuming a mobile phone as modus operandi may link to a serial offender when operating. Therefore, information related to mobile localization and crimes must demonstrate spatiotemporal consistency. The link between different origins of data or traces are used for testing of hypotheses [2,4].

## **1.2. Forensic Profiling from Investigative Perspective**

Every forensic scientist should extend his role to the whole investigation from hypotheses formulation to collection of forensic information and suggesting for collection of new data. As a result, it develops more investigative attitude in forensic scientists towards whom/what questions. For example, what is the source of a trace, availability of this trace, what offence or crime is, what evidence may indicate collection of new data, what supporting leads may be provided and where could be the offender who perpetrated that offence [26,27]. It entirely depends on evidence and reasoning process by developing other possible hypotheses that interpret traces accessibility rather than matching probabilities to provided suggestions/proposals. During investigation, the forms of forensic profiling are Sand come together with individual and group profiling [28,29]. The basic process is generating a profile from available data set and then searching for all relevant persons with objects that match the profile. Profiles are exemplified as groups by limiting the search in selected population [30,31]. In general, an individual may be represented through traces as follows:

Traces directly reflect some physical features of

the sources more clearly, for example, finger marks or extraction of DNA type from biological evidences or capturing an image from a camera.

Similarly, traces with their sources are used to indicate physical characteristics in the form of cloths or accessories. For example, earmarks on a door with specific height or size of shoe marks describe the height of source, and snap taken describes bodily appearance including cloths or accessories.

Traces also describe the make and model number of the sources such as a recovered printed document describes specific printer, a bullet found at a scene indicates a firearm's features, and collected paint traces describe the suspected/accused car that intern point to a related profile. Alternative possibilities are such as fibers describing clothes, tool marks describing the tools used and DNA profiles describing gender.

Global analysis of spatiotemporal allocation of traces, for instance a sequence of shoe marks, sequences of card withdrawals with specific banks at different ATMs and navigation traces with an internet browser are used to interpret activity and behavior in instant surroundings.

Different theories are applied to describe situations that may interpret the behavior or other traits of the person such as geographical profiling mostly in serial crimes provide clues to localize a person or psychological traits or person may be defined as object of classification process in different categories as computer crime or arson offender or rapists etc [32].

The main investigative query is the detection of sources and their relations with the activity such as hypotheses development by using DNA databases or Automatic Fingerprint Identification System (AFIS). These have traces from a source as data subject, transfer the traces into digital form as a virtual person, measure them with reference material collected and recommend a possible output candidate(s) or virtual person(s). This final profile as a result is evaluated and then included in the investigation process that may be more or less generalized with identified or unfamiliar, assured or mostly doubtful attribute [31].

The process can be generalized by using dual

concept of frame and form that holds a set of relevant features from the available evidence and differentiates different area of the frame as more or less potential, respectively. The frame is constituted from a list of candidates extracted from a system such as AFIS sharing a common profile, while the form is provided as outcome from scrutinizing the content. It is considered as a non-distributive group profiling approach where a group of individuals built is based on different sets of data and insertion of an individual into the frame depends on characteristics with diverse nature. Frame can be developed in many ways based on the case and available traces. One of the direct and simplest methods is comparison of trace with reference material such as comparing images extracted from surveillance system or CCTV footages with photos obtained from known source. Another possible comparison is assuming offender's modus operandi with those of known recidivists. Doing so extracts a profile from series recidivist movements, which is used to process comparison. For instance, burglar typically operates at night by entering the location/property through an open way and select credit cards most of the time [26,31,33].

Such profiles can be built by applying different approaches that suppose a specific characteristic occurring in each or in majority of cases or occurring not etc. The relevancy of these profiles is determined by the use of profiles: how databases are searched to link cases, how specific surveillance is organized and how perpetrators are interpreted. Other important form of profiling are geographical and id-system profiling. Geographical profiling is carried out by assuming mobility of a person and data obtained from GSM operators for hypothesizing the resided place by the offender when he operated [31,32]. In id-system new frames may be built by developing offender profile and interpreting his activities. For example, details of all the calls made can be obtained from the operator by detecting the card or mobile phone used during operation in a building which is controlled through id-system. Data obtained from the mentioned forms may be used in combination through cross-referenced to construct a group of persons that best corresponds to a criminal sketch with a list of important relevant identities for further investigation [26,34].

### 1.3. Categorical Elimination

Once the frame is built, it leads the investigation to categorical elimination using DNA screening method where trace profile is compared with DNA of suspected persons and irrelevant profiles are then eliminated [7]. The sort or elimination process with application of DNA provides guaranties but with an inaccurate profile, results to an unfair elimination such as in investigation of Yorkshire Ripper during the 70s. Yorkshire Ripper is the given name to Peter William Sutcliffe, a prolific English serial killer. He was convicted of 13 women and 7 other murder attempts. Police despite of interviewing him nine times, failed to catch the Ripper due to handling of exceptional amount of information [26,34]. Some of this information such as recorded tape messages and letters that pretended to be the Ripper was misleading the case. Persons who did not correspond to this profile were eliminated due to an inaccurate profiling but later on the actual perpetrator who had apparently no connection with the Ripper was arrested in 2005 through DNA screening. The Ripper was finally arrested by following routine check of street as he was driving car with stolen plates. The database of stolen plates was aided by the use of systematic control process. This example illustrates the importance and necessities of different forms of profiling in serious criminal investigation and further formalization [34].

## 2. Repetition of Crimes Aiding to Forensic Profiling

Crimes with high degree of criminality show an extensive serial element. A series of criminology studies concluded that small number or groups of offenders are responsible for a number of cases where certain types of victims are repeatedly victimized by showing specific patterns. Identifying the activity of groups of serial offenders and recognizing the patterns of victimizations are critical from both repressive and protective sides [35,37]. Strategic perspective is also of great interest where organizations of some forms of criminality are analyzed such as offenders' mobility, specialization, progress of criminal profession, quality of the activity, criminals association, victims' classification with their vulnerabilities and crime occurrence etc. [36]. Modern policing approaches require the execution of analytical

means for the understanding of crime dynamic and intelligence provision for taking decisions. Therefore, forensic profiling plays a great role in providing physical material and traces with verified potential to connect dots or link cases as following [20]:

### **2.1. Crimes Repetition: series of crime**

Crime series are the results of repetitive individual linked crimes operated by the same offender and constituting a graph structure. Based on offender activity, graph structure represents different groups of criminals linked to different organizations and responsible for different types of crimes in different compositions. Three forms of forensic profiling in context of crime series that depend on police recorded data are as follows:

Group profiling: reconstruction of a graph structure of a crime series that corresponds to the activity of single group of offenders or a graph structure constituting a profile that explains crime types and offender groups.

Individual profiling: extracting a profile from a crime series that best describe the series with its or their creator(s) [12,13].

Crime series can be detected using police data but largely incomplete or uncertain as most of the crimes are not reported by victims and traces collected from crime scenes may be limited. Legal and technical obstacles can limit the possibilities of detecting links that actually do exist and lead to linkage blindness as discussed earlier [38]. The basic role of forensic science is to focus on crime linkage through physical evidence where the crime causes exchange of physical traces. For example, series detected through DNA databases are useful as traces are collected through systematic and reliable organizations. Similar approach can be used to detect connection of arson series or even bombing through analysis of seized illicit drugs [6,20].

On the other hand, there is chance to detect crime series through combination of other traces such as tool marks, earmarks and shoe marks [8]. In the same way, electronic traces can be used to detect or link the crime series. For instance, detecting mobile phone or smart card for

organizing crime event, connecting withdrawal sequences of stolen bank cards by the same person recorded in surveillance cameras or linking series of withdrawals with same stolen cards, and relating series of unwanted e-mails using mechanical details such as header of the message [39,40,41]. Another approach is psychological based that focuses on behavioral aspects of cases adding different point of assumptions and uncertain reasoning. This method is counted as get through as it got efficient and organized linking makeup for sadistic offense but with number of difficulties ranging from filling long forms to supply databases that lack assessments of international competence. The main mechanism for detecting crime series other than type of data used rests on spatiotemporal, modus operandi and resemblance between traces [42,43,44].

### **2.2. Crime Repetition: problems and phenomena**

Crime repetition forms are relevant to take appropriate preventive and repressive measures such as hot-spots or crime clusters beyond the serial activity of single offender, which may motivate to focus police surveillance on a particular area within certain duration. Potential victim, location/habitant or particular environment despite of numbers of offenders operating is appealing for crime concentration. Here, spatiotemporal profiling technique is referred to crime cluster analysis with related patterns obtained from criminal databases [45]. The idea of problem scrutiny may help in determining a situation where offenders get the right target within a particular location in the absence of a proficient protection. This approach follows a set of rich theories termed as 'opportunities theories' in criminology where the crimes or problems are analyzed based on situations as the object of profiling [15].

### **2.3. Crime Repetition: tactical, operational and strategic analysis**

Police projected approaches are used to estimate the capacity of a piece of knowledge that may help in decision making at various level of organizations. Therefore, a profile at a tactical level is resulted from an investigation or from detection of crime series oriented investigation. While target profiles phenomena, vulnerabilities

repetition and break in the defense method are examined at an operational level to organize some certain responses such as crime clusters [41]. Lastly, understanding the capability of criminality structure can support to develop global strategies and decision makings. All of these levels rely on series detection and occurrence of repetitive situations. For example, enormous e-mails i.e. fee fraud, phishing and all types of fake materials etc. sent by scammers are analyzed systematically that provide correct indications of criminal mechanisms for searching a susceptible victim. This process is completed from a tactical to a strategic stage considering infrastructure, localization and organization of the fraud [46].

### **3. Forensic Profiling Technologies**

There are many areas of expertise and several techniques within forensic science that could be used for profiling as followings:

#### **3.1. Digital Image Forensics**

Digital images due to low cost digital image devices with powerful, sophisticated editing software and fast distribution through internet play an important role in our multimedia society. A digital image with forensic profiling perspective may disclose information including image possession, device details and link of the camera holder who took the image. It is of great importance to know that digital image either illustrates an unaffected or altered scene such as analysis of images obtained from surveillance cameras. Identification of image source or securing of image's integrity leads to the notion of image authenticity. Several approaches are projected to concentrate on the authenticity such as digital signatures or watermarking. These must be produced in the device directly as afterward there will be no more surety of the image authenticity. On contrary, new perception of digital image profiling principally relies on specific arithmetic characteristics that are recognized as natural mark. Therefore, previous information of the original image is not required [47,48].

Based on above mentioned concerns, digital image forensic in general is grouped as detection of image origin/source that relies on image

device or technology acquisition and determination of tampering or malicious post-processing of a digital image. This can be obtained by using device specific features that have been introduced in process of image possession or establishment of manufacturing artifacts. Further basic-description such as date of exposure or camera model name can be of forensic value. However, meta-information as compared to device specific feature or manipulation artifacts can be modified or detected easily with image processing toolboxes. In contrast to techniques that are based on device specific features and manipulation artifacts based on forensic methods are applied without digitization of device. For example, it is feasible to disclose pixel reliance which is established at the time of resizing or image rotation. Other methods include detection of recompression by statistics of JPEG coefficients, detection of copy forgeries through inconsistencies in lightening or detection of image splicing/merging through phase congruency analysis [48,49].

#### **3.2. 3D Modeling and CCTV for Tracking People and Cars**

In the field of forensic investigation, CCTV footage may give valuable data about the offence, suspects or eyewitnesses with rapid increase of security cameras. Surveillance images with visible scenes can be more efficient with extension of 3-dimensional model of crime events. This gives more insights into the situation, overview of the scenes and relations between the objects captured on security cameras. It provides awareness about the location of people as the scene can be watched from any position, thus, making it easier to identify special scenarios and testimonies. This method can be easily combined with other spatiotemporal information. For instance, adding a telephone booth to 3D model of a scene and comparing different positions of people with telephone call evidences at the same interval. The result obtained from 3d examination is objective and can be used in contrast with other investigation. Interpretation variations which can be envisioned and accomplished from the information in the 3D graphics are of great value in forensic caseworks [47,48].

### **3.3. Development of Expertise Center on Intelligent Data Analysis**

Centers of expertise are being developed for the analysis of intelligent data in different regions such as expertise center of intelligent data within Netherland Forensic Institute. The center aims to direct the government agencies in selection of software, execution of methods/techniques processes for analysis and merging of exceptional amount of digitally stored intelligent data. The center is taking initiative to provide numerous useful schemes, procedures and software products for data analysis by combining the efforts of agencies to fight against crime, scam and violence. This knowledge can be increased by studying literature and internet research, involving software providers, and consulting university experts. The software, methods and techniques can be practiced for learning, evaluation and discovery trials with official organizations interested in exploring the techniques. The testing methods with real data require a safe setting with influential systems, educated and responsible employees, and the most recent analysis tools. Contact is established between the agency and software suppliers/university experts for sharing of knowledge about the techniques. The purpose of expertise center is to provide more efficient organization and brought up different agencies together that use the same techniques [49].

### **3.4. Forensic Drug Profiling**

Forensic profiling of illicit drugs through efficient chemical and physical analysis has developed since the middle of the 90s. A drug profile is extracted from illicit substances seized by law enforcement agencies and transferred to laboratories for analysis. The record of these profiles is kept in drug databases for the intelligence or investigation processes of connecting prohibited substances detained in particular situations. The data can identify a particular organized network, which earlier has been the object of separated investigations [50,51]. Further details such as manufacture procedure, nurturing/harvesting origin and drug trade distribution can be interpreted by systematic examination of drug databases. The data are stored into a memory device in an orderly manner by collating and grouping

individual seizure into classes based on similar measurements from different profiles. The clusters based on their formation patterns mainly signify connections in different trafficking from cultivation to distribution process [52,53].

Detecting methods other than clustering include spatiotemporal and graph structuring. For example, drug smugglers use combinations of cutting agents before distribution that informs the movements of local market. Drug trafficking networks and laboratories have their own procedures and methods that appear differently during analysis of inherent structure of chemical profiles [54]. Therefore, there is no general method that can identify specificities and reliabilities during measuring connections between samples. Learning process of classifying specific groups of profiles as classes is required to manipulate the classification of new data by showing an inherent structure from solved cases. Clustering is used to train the system that considerably will improve the classification process. The information extracted from drug profiling databases can be integrated with other information sources obtained from investigations such as police are systematically provided the chemical links for investigation process. Equally, chemical profiling can be used to test the investigative hypothesis that will create communication among police departments, forensic laboratories and educational universities during actual practice [55].

## **4. Surveillance, Intelligence, Risk Assessment and Detection in Context of Forensic Profiling**

Repetitive crime investigation can come across a link between the connected fields of surveillance, intelligence, risk assessment and detection. Risk management systems and intelligence-led policing set up are required at country level. Following this, strong analytical aptitude is required for security and policing in terms of risk assessment or problem detection. For example, most of the intelligence-led systems are interested in four areas i.e. locations, object as an individual or group forms, crime series and elevated risk problems.

Forensic profiling is effective beyond the analysis of repetitive crime. New policing strategies are intelligence based with advance

screen methods valuable to discover a range of risk/threats in defense system by exploiting crime data. Analysis of repetitive crime may be more effective in association with risk evaluation and examination. These changes are the results of large use of id-systems in our societies. Risk or danger can be detected in databases potentially used for access controls such as data of credit cards, data controlled by phone operator, computerized detection systems: vehicle plate number, passport recording and biometric data used at the borders, and other types of electronic data. Similarly, surveillance system either computerized or not, is based on identification of individual profiles. For example, profiling of a criminal activity linked to hot-spots area that can target the surveillance [56].

## 5. Legal Implication of Forensic Profiling

New innovation in technology has amplified computing power in context of forensic profiling that resulted in the interconnection of databases i.e. linkage of police databases and risk analysis/profiling. Thus, intelligence is no more isolated from criminal data. The interconnection of databases raised the protection problems of basic human rights i.e. civilian safety and protection followed by data privacy and security. As it is not a fixed situation so the present data security mechanisms are no more efficient. The preventive measurement for data protection and privacy, changes with the progress in technology. A series of safeguards have been ensured by the data protection laws to maximize the expansion of police power in context of personal data processing that could result in harmful outcomes on the rights of individuals. There must be broader lines that should not be crossed to risk one's privacy. The aforesaid changes and progress in the law enforcement techniques and tools introduced by legislation give a picture of the deficiencies in the data safety. Politician and legal personnel should considerate on if these laws are enough to cope up with these new challenges in the technologies [56].

## 6. Conclusion

The mission of forensic profiling is to support the investigative and judiciary department by analyzing traces collected from crime scenes and other criminal activities. These traces contain

information which in the form of databases is used to build an individual or group profile of human or non-human category. Data mining technology is used to discover relevant patterns that intern generate profiles which are significant in criminal justice system. Forensic profiling data aggregates with products of other broader domains of investigations such as security system, intelligence, risk analysis and surveillance etc. to assist in court of law and to reach a conclusion. Associated progress of id-system and information society should be integrated properly. New frameworks are required in forensic science to best utilize the data mining technology and electronic traces in a more traditional forensic approach. The converging of various disciplines of forensic science principally forensic Information Technology (forensic IT) with data mining method for their utilization, appear to make the biggest challenge for the future.

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