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Dannie Ray Horner was found guilty in the Sarasota Police Department’s investigation of a suspect identified as Dannie Ray Horner in 2014 while The Department of Homeland Security was investigating a man from Argentina for the distribution and transmission of child pornography.

In 2014, while The Department of Homeland Security was investigating a man from Argentina for the distribution of child pornography, Sarasota Police received a tip from the Internet Crimes Against Children (ICAC), the Sarasota Police Department developed a suspect, Dannie Ray Horner. Once the suspect was arrested, a thorough examination of the digital media was performed by the Sarasota County Sheriff’s Office Intelligence Digital Forensics team led by Expert John McHenry. Through this investigation, a unique fingerprint detail was found on the sides of the fingers or extreme edges was identified. After taking these more thorough known prints, two more fingerprints were identified in the examinations of child pornography. These examinations showed that the images were taken on different days at different times. The photographs of child pornography were used to secure a conviction, but they also highlighted the importance of fingerprint detail in media and work.

This case demonstrates how still images of an offender’s hand can be used to secure a conviction and how the examination of the digital media can be used to identify the suspect. This case also demonstrates how the examination of the digital media can be used to identify the suspect.

In this particular case, a direct comparison was requested to determine if the prints were the same as the prints of the suspect. This type of imagery was less challenging to work with than the traditional latent lift card. By having a latent lift card, it was possible to work with the print in the photographs. The examiner would then look at the print and identify any areas of friction ridge detail that examiners have to be mindful of. When these prints were compared, the examiner was able to identify the same areas of friction ridge detail that the examiner was able to identify in the photographs. The examiner then compared the known prints to the photographs and identified the same areas of friction ridge detail that the examiner was able to identify in the photographs.

The examination of the digital media was performed by the Sarasota County Sheriff’s Office Intelligence Digital Forensics team led by Expert John McHenry. Through this investigation, a unique fingerprint detail was found on the sides of the fingers or extreme edges was identified. After taking these more thorough known prints, two more fingerprints were identified in the examinations of child pornography. These examinations showed that the images were taken on different days at different times. The photographs of child pornography were used to secure a conviction, but they also highlighted the importance of fingerprint detail in media and work.

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Introduction

Randomly acquired characteristics (RACs), are random markings on a shoe sole, such as scratches or holes, that are used by forensic experts to compare a suspect’s shoe with a print found at the crime scene. This research investigates the relationships among three features of a RAC: its location, shape type and orientation.

Previous studies assume that the features of a given RAC are independent of each other, as are the RACs themselves and therefore the Degree Of Rarity (DOR) of a single RAC is calculated by multiplying the probabilities of its features and the DOR of the entire shoe is calculated by multiplying the DOR of all RACs. If these features, as well as the RACs, are independent of each other, a simple probabilistic calculation could be used to evaluate the rarity of a RAC and hence the evidential value of the shoe and print comparison, whereas a correlation among the features would complicate the analysis.

The goal of this research is to statistically test the independence assumption using a database collected by the Israeli Police DIFS. It includes about 13,300 RACs from 380 test impressions.

Data

Three features of each RAC were defined as follows:

1. Location: The normalized shoe sole was divided into 14 subareas.

2. Orientation: Determined by the angle of the RAC with respect to the x axis of the shoe. The orientations were divided into 9 groups (20° each).

3. Shape type: Based on the definitions determined by the Israeli Police DIFS for classification purposes.

Dependence between shape type and location

The p-value of the Chi-square independence test indicates that the shape type and the sub-area are not independent (p-value < 0.001). In order to investigate for which categories the observed and expected differ the most, Pearson residuals were calculated.

The nature of the shoe sole element can explain the dependency between sub-location and shape type:

Schalama Rachs are micro tears of the borders of elements (resulting from wear). Thus, it is reasonable that in areas where there is less pressure caused by the foot (2, 9) there will be less RACs of that type.

A possible explanation for the abundance of Rifts in areas 3 and 8 is that most shoes do not have a contact surface in these areas, and those shoes which do, have patterns that contain lines, the only elements in which the Rift type can appear.

Holes can occur on almost every element which may explain the small absolute value of its residuals.

Dependence between shape type and orientation

The dependence among the features of a RAC may be caused by the differences among shoe soles. In order to test this assumption, Three relatively frequent patterns in the database: Nike Shox R4 (NSR4, n = 36), Nike Shox NZ (NSNZ, n = 27) and Classic Timberland (CT, n = 22) are presented. Preliminary analysis was performed in order to test independence between RACs on similar shoes.

Results:

1. Scratches are more likely to appear on CT shoes than on NSR4.
2. Schallamach shapes appear more on NSR4 shoes and less on CT.
3. There are no shapes of type Rift in CT shoes, as would be expected since this pattern contains no thin lines.
4. Pattern NSR4 has less RACs in area 3 than would be expected under the independence assumption, and pattern NSNZ has more.
5. Pattern CT tends to have less RACs in area 9 and more in areas 11 and 12.
6. Orientation and pattern are found to be independent, that is, the distribution of orientation in these three patterns is similar.

Dependence among randomly acquired characteristics on shoeprints and their features

Conclusions

- • The assumption of independence among RACs and among the features of RACs was rejected.
- • DOR cannot be calculated by a simple multiplication of the characteristics’ probabilities.
- • The dependence is caused by the shoe-sole pattern.
- • In order to calculate the DOR, the mechanism of dependence is needed.
Introduction
The 2009 NAS report (Strengthening forensic science in the United States: a path forward) which evaluated and set required standards for the various forensic fields, caused an earthquake in the forensic community. Its important recommendations include the standardization of the terminology used in reporting, lab accreditation and personal certification, including estimated probabilities and measures of uncertainty in reported results, minimizing potential bias and human error. Some of these aspects standards were addressed in the 2016 PCAST report (Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods) as well.

A survey concerning some of these aspects was distributed among shoeprint labs worldwide. The participating labs were contacted in several methods. A personal request was sent to experts with personal acquaintance with the authors. They were requested to forward the survey to other labs they are familiar with as well. In addition, a link to the survey was posted on a professional oriented social networking. Anonymousness of the answers was promised. The distribution of responses for the various questions was analyzed.

Characteristics of participating labs

Accreditation and quality assurance

Training

Exposure to bios information

Conclusion scale used

Conclusions

- The variability among the participating labs is great but the survey shows that most of them maintain high professional standards:
  - Much effort is invested by most labs in recruiting educated personal and training them. The personal recruited to most labs have at least a bachelors degree and the training is exceeds one year. On the other hand, most shoeprint experts didn’t receive international certification.
  - Most labs have written working procedures and are accredited.
  - Most labs perform some kind of verification of the case work.
  - The vast majority of labs performs at least one proficiency test a year.
- Stricter rules should be set for the background information the examiner are exposed to in order to minimize bios.
- Only a minority of the labs participating in this survey use likelihood ratio to present the comparison results.
In the fingerprint community, the common rule of “thumb” is the amount and severity of creases within the skin structure. The Right Little Finger is the most affected, with creases appearing more prominently in women. Hormone levels (Shuter 1975) and age (Shuter 1975) are factors that contribute to the development of creases. Increased age results in thinner skin and increased wrinkling. Collagen content drops 1% per year.

During the study period, a significant amount of data was collected. These records were born taken with Low Vision devices during an applicant interview. Both taken with routine recordings. These records were taken with a total of 6 months, 1 day, and 1 month after each other. The first record was taken in September 2017, the second in October 2017, and the third in December 2017.

The study found that individuals with higher quality ridges and lower crease depth had a more significant impact on fingerprint sensitivity. These individuals were more difficult to identify, and their fingerprints tended to be more disrupted by environmental factors.

The study also found that repeated handling of coarse objects and certain dermatological conditions can exacerbate the condition, affecting fingerprint detail. This was particularly evident in individuals with skin conditions such as eczema or psoriasis, which can cause loss of fingerprint detail. Divided ridge analysis and other techniques were found to be less disruptive to fingerprint detail in these individuals.

Genetic factors also play a role in the development of creases. Celiac disease (David 1970) and other genetic conditions can lead to changes in skin structure, affecting fingerprint detail.

Fingerprints have become a critical tool for identification in various fields, including biometric system challenges. As fingerprint technology is used more frequently, individuals with difficulty in skin face challenges in verifying their identity. White lines can cause artifacts in digital technology and obscure valuable ridge features. The broader and longer the white lines were, the worse the ability of the system to identify (Lee 2013).

Certain fingers which have more clear ridge detail should be used when possible, but dry skin conditions may require a different biometric technology or numerical password as a backup. This condition affects latent fingerprint examiners. Studies have shown that individuals with more clear ridges have a more significant impact on the ability of the system to identify fingerprints.

Hand Dermatitis (Lee 2013) and other skin conditions can cause loss of fingerprint detail. These conditions can affect the ability of the system to identify fingerprints, making it more difficult for examiners to identify individuals.

ChemoTherapy (Al-Ahwal 2012) and other medical treatments can lead to changes in the skin, affecting fingerprint detail. These treatments can cause loss of fingerprint detail, making it more difficult for examiners to identify individuals.

Fingertips have become an important tool in biometric systems, allowing for a more secure and reliable way to identify individuals. However, certain conditions can affect the ability of the system to identify fingerprints, making it more difficult for examiners to identify individuals.

References


ABSTRACT

PolyCase ammunition has some novel design features, specifically the construction and unique shape of their ARX bullet. Several studies have shown that traditional bullets have predictable interactions with many yielding and non-yielding intermediate substrates (Haag). The newly marketed ARX bullet behaves quite differently than previous bullet designs. Not only is the bullet lead free, it is comprised of copper spheres in a polymer matrix manufactured using an injection molding process. This manufacturing process does not lend itself to a traditional hollow point design, however the bulletsmiths at PolyCase have devised a unique alternative to a cavity in the form of three large “flutes” in the bullet’s ogive. These flutes create characteristic triangular perforation holes in automobile sheet metal.

METHODS

Several calibers of PolyCase-brand ammunition were test-fired at various barriers, including drywall, paneling, windshield glass and sheet metal of different gauges. Automobile sheet metal provided the most characteristic bullet holes when perforated by the ARX bullets as compared to traditional hollow point or full metal jacket bullets. The results were replicated using firearm barrels with both left-hand and right-hand twists.

RESULTS

Fig 1. The cartridges tested: 380 ACP, 9mmL, 40 S&W, 45 ACP.

Fig 2. The components of a PolyCase Inceptor ARX bullet deconstructed, revealing copper spheres and polymer.

Fig 3. Interior of a PolyCase bullet, imaged with scanning electron microscope (SEM), showing matrix of copper spheres in polymer binder.

Fig 4. Holes in 22 gauge sheet metal (0.028” or 0.71mm) made by PolyCase Inceptor ARX bullets. Note triangular shape of holes. Caliber 45 ACP on left fired from Kimber 1911, 9mm L on right fired from S&W 5946.

Fig 5. "Punchouts" recovered in ballistic gel from 22 gauge sheet metal perforated by PolyCase Inceptor ARX bullets.

Fig 6. Entry hole in 22 gauge sheet metal made by 40 S&W PolyCase Inceptor ARX bullet fired from Glock 22. Punchout placed in center for size comparison.

Fig 7. Exit hole in 22 gauge sheet metal made by 40 S&W PolyCase Inceptor ARX bullet fired from Glock 22. Punchout placed in center for size comparison.

Fig 8. Side view of exit hole in 22 gauge sheet metal made by 40 S&W PolyCase ARX bullet. Note 3 sharp points and 3 peeled back petals.

CONCLUSION

Reproducible triangular holes were made in sheet metal by the PolyCase Inceptor ARX bullets. Traditional bullet designs from other manufacturers do not produce triangular shaped holes. Triangular “punchouts” were recovered from the recovery medium positioned directly downrange of the sheet metal, along with witness panels to keep track of secondary missiles and post-impact bullet fragments.

The fluted ogive of the PolyCase ARX bullets produces characteristic holes in sheet metal. The style of bullet hole morphology can be readily distinguished from traditional hollow point and full metal jacket bullet types. Recognition of this unique style of perforation may provide useful information for shooting scene reconstructions.

ACKNOWLEDGEMENTS

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Mr. Paul Lemke, CEO of PolyCase Ammunition
IPTES 2018 Host Committee

REFERENCE

A laterally reversed latent print is a mirror image of a friction ridge skin impression from a finger, palm or foot.

The occurrence of laterally reversed friction ridge skin impressions detected on porous and nonporous substrates has been observed. As the ability of the chemical reagents used to develop latent print impressions becomes more sensitive, an observed increase in the development of latent prints will occur. Such is the case with the reagent 1,2-indanedione and its ability to develop numerous latent prints, some being laterally reversed. Therefore, due to the increased use of 1,2-indanedione in the field, issues regarding the recognition of potential laterally reversed latent print images needs to be addressed.

The two types of laterally reversed latent print images which have been observed are the "surface to surface" transfer and what we will refer to as the "bleed through" transfer. The "surface to surface" transfer occurs when two items come in contact with one another and the friction ridge skin impression transfers from one surface to the surface of the other item. The "bleed through" transfer occurs when the matrix passes through from one side of the porous item to the opposite side of that same item.

This poster presentation demonstrates and discusses the two types of laterally reversed prints; the "surface to surface" transfer and the "bleed through" transfer.

**Synopsis**

Recognition of laterally reversed prints should be included in training modules and procedural protocols for examiners, photographers, technicians, and others involved in the examination or documentation of latent print impressions. Research and Quality Assurance Measures should also be addressed regarding the recognition, frequency and mechanics of these types of prints.

- **Education**
  - Hodge Podge podcast
  - NIST Error Management Symposium
  - NIJ Impression, Pattern and Trace Evidence Symposium
  - Articles in professional journals

- **Training**
  - Need to include examples of “bleed through” prints in ACE training
  - To examiners, technicians, photographers and others involved in latent print detection

- **Research**
  - How often does this happen?
  - Why does this happen?
  - Almog et al. examined the Fingerprints’ Third Dimension: Depth and Shape of Fingerprint Penetration into Paper – Cross Section Examination by Fluorescence Microscopy

- **Quality Assurance Measures**
  - Should prints be searched in two positions when using amino acid reagents?
  - Competency/proficiency testing?
  - Re-examine unidentified latent prints in unsolved cases?

Notes:
1. Lane, Patrick A; Hilborn, Martha; Guidry, Sibyl; Richard, Carol E. Serendipity and Super Glue: Development of Laterally Revered, Transferred Latent Prints, J. Forensic Ident., 1988, 38(6), 292-294
3. Hodge Podge podcast – Episode 117, #6
4. Articles in professional journals – manuscript under review for publication
Identifying Human Touched Objects by Reverse Fingerprint Lifting
Suitable for Microbiome-Based Forensic Applications

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Abstract

Latent fingerprint lifting has been carried out on objects to identify and classify the human touched objects within a workplace, which can be readily applied for both traditional (fingerprint analysis) and microbiome-based forensic identification. Several objects in a workplace environment, such as keyboard, mouse, cell phone, office phone, stapler, cabinet handle, and door knob were selected for this study. Dusting the print in an office set up is not healthy, due to possibility of the fine microscopic dust particles moving around the whole area. Secondly it may disturb microbiome-based forensic analysis. An attempt has been made for lifting the print and then developing through dust lifting and chemical methods, called “reverse lifting”. Alternate light source (ALS) has been used to enhance the observation and to locate the latent print. Visible fingerprints are photographed and traditional methods of dusting with suitable powders have been used to lift the print. The results showed that the reverse lifting method worked well with glazed/smooth surfaces, which will allow investigators to use the microbiome-based analysis as well as the fingerprint lifting on the same object in a crime scene.

Objectives

- To develop a non-invasive fingerprint lifting method that may not affect other forensic analyses including the microbiome-based analysis
- To compare the newly developed “Reverse Lifting” method with the traditional lifting method
- To identify objects that are feasible for the reverse lifting method

Hypothesis

- It may be possible to lift fingerprints first from objects and develop and identify fingerprints later, so the same object can be used for the microbiome-based forensic analysis
- The results from the new method, “Reverse Lifting” can be comparable to those of the traditional lifting on the objects in an office setting
- Some objects commonly found in an office can be readily used for the reverse lifting method

Methods

1. Traditional fingerprint lifting methods were used to lift the fingerprint using magnetic, red, and black powders on objects such as mouse, keyboard, door knob, and computer screen.
2. Reverse fingerprint lifting was developed to lift fingerprints from the objects before the dusting or chemical treatment. This approach may avoid dusting or chemical treatment directly to objects, so the same objects can be used for further analyses including microbiome-based applications.

Table 1. Reverse Fingerprint lifting: object vs. lifting parameters

<table>
<thead>
<tr>
<th>Packing Tape w/ red powder</th>
<th>Mouse</th>
<th>Keyboard</th>
<th>Door knob</th>
<th>Computer screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct Tape w/ red powder</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
</tr>
<tr>
<td>Masking Tape w/ red powder</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
</tr>
<tr>
<td>Fingerprint Lift Tape w/ red powder</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
<td>No print</td>
</tr>
<tr>
<td>Adhesive-side developer w/ masking tape</td>
<td>Visible print ridge detail (Figure 2a)</td>
<td>Visible print ridge detail (Figure 1b)</td>
<td>Visible print ridge detail (Figure 1a)</td>
<td>Visible print ridge detail (Figure 1c)</td>
</tr>
</tbody>
</table>

Results

1. Traditional Lifting Method
   - The smooth surface (Figure 2a) presented a more visible print than the rough surface (Figure 4b) because the rough surface on a microscopic level have high and low areas, like hills and valleys that makes the surface uneven, thus causing the ridges in the print to not show fully
   - The Forensic light source (Figure 2a, 4) worked better than the human eye (Figure 3) observation because the light source enhanced the detection of the latent print through the fluorescents of the light magnifying the oils and natural sweats of the fingerprint.

2. Reverse Lifting
   - The fingerprints recovered from the smooth surface using the reverse lifting method can be compared to the fingerprint observed by the forensic light source. (Figure 2)
   - The method of reverse lifting using adhesive-side developer worked well for a mouse, and more work is still in progress.

Conclusions

- Forensic light sources (luma light) enhanced the detection of a latent print using the “Reverse Lifting” method.
- The newly developed “Reverse Lifting” method is promising on the objects with glazed/smooth surfaces.
- In future – plans to use various types of tapes, Reverse Lifting powder technique on various objects.

References


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The Evidentiary Significance of Automotive Paint from the Northeast: A Study of Red Paint

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Abstract

The populations of automotive paints are constantly changing, and thus need to be thoroughly monitored. By investigating these populations, forensic scientists can begin to understand what significance each individual automotive paint may hold. In order to do this, the physical appearance, layer structure and layer chemistry can be analyzed to provide a forensic examiner with more detail, which can be used to give strength to a conclusion made during an automotive paint examination. This population study involved the microscopic analysis of 200 automotive paint samples and the discrimination of red automotive paints using a comparative analysis approach and data analysis.

The red samples were chosen as a target group from the larger automotive paint population based on popularity among consumers and manufacturers; there were 26 red samples within the entire sample population. This comparative analysis approach helped to determine the differentiating power of the analytical sequence as well as analyze the chemical properties of similarly colored paints. Current laboratory methods were used to analyze the red automotive paints, and included ultra-violet-visible microspectrophotometry (UV-Vis MSP) and Fourier-transform infrared (FT-IR) microspectroscopy. In addition, this research used Raman microspectroscopy, an emerging technique for automotive paint analysis that has been demonstrated to provide valuable pigment information (1). This study was conducted to highlight the significance of automotive paint comparisons and the characteristics each sample possesses. The frequency data and the degree of differentiation is important information as it can provide a foundation for determining the significance of indistinguishable samples.

Materials and Methods

The entire population (200 samples) was analyzed with stereomicroscopy (color and surface characteristics), brightfield and polarized light microscopy of cross-sections and thin peals (number of layers, layer thickness and color, presence/absence of effect pigments, effect pigment size and type, extinction and birefringence). The red automotive paint samples were additionally analyzed with FT-IR and Raman microspectroscopy, and UV-Visible microspectrophotometry. FT-IR microspectroscopy was used to obtain chemical information about all of the layers of each sample. Raman microspectroscopy was used to obtain pigment information about the red color coats. Lastly, UV-Vis microspectrophotometry was used to help differentiate between metamers and was also used to obtain absorption information about the clear coat layers.

Results

Results from Entire Population:

Results from the Red Automotive Paints:

Conclusions

This research concluded that after using both microscopical and analytical methods, all red automotive paints from this population were able to be differentiated from each other.

References


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Handling Situation-based Evidence in Identity Cases

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Abstract

- This poster reports on an effort that is formulating a computational framework for identity that is usable in forensic and other contexts.
- Current work focuses on physical crime scenes, but the focus is expanding to cyber space.
- This work captures how evidence in a case involving a crime scene conspires to support various identity judgments.
- Ontologies are being developed to capture a case as a constellation of situations where info is recorded or applied.
- Dempster-Shafer theory is adapted to provide the framework for manipulating and combining information regarded as evidence.

Introduction

The criminal justice system relies heavily on evidence

Dempster-Shafer theory provides powerful mechanisms for determining what confidence one may have in evidence combined from several sources and possibly modified

There is considerable structure in a legal case that makes available information in which we may have various levels of confidence

We capture this structure using a family of ontologies

We adapt Dempster-Shafer theory to exploit this structure

Situation Theory (cf. Barwise & Perry, Devlin)

- A situation supports information, may carry info about another situation
- A basic item of info supported by a situation is an info, involving an n-place relation K, n objects to fill the roles in K, a location, and a time
- Situation semantics (situation theory applied to language) sees the meaning of an expression as a relation between an utterance situation and a described situation
- There are also resource situations to fill out references
- One situation carries information about another by virtue of constraints, e.g., "Smoke means fire"
- The constraints by which an utterance situation carries information about a described situation are the conventions of natural language
- We consider making an identity judgment (as in a CSI) to be an utterance situation (called an id-situation), part of a constellation of situations making up a case (an id-case)
- The crime scene is the described situation
- Resource situations include, e.g., where a fingerprint was filed, where one took a facial image to train a classifier

We define concepts used in representing id-cases in OWL ontologies

Example

- A theft has occurred during a party. We have a list of possible suspects in the form of a guest list. We have
  - a group photograph from a security camera with 1 guest with their hand on the door to the valuables
  - a fingerprint from that same door.
- This scenario is a constellation of situations, centering around 2 id-situations for 2 pieces of evidence: fingerprint and snapshot

- In situation s1 (an id-situation), the analysts compare fingerprints of each suspect with fingerprints from the crime scene to get similarity measures
- This requires (by convention) resource situations s1,p1, p2, s1,1, s1,2
- In s2 (part of the crime scene, the described situation), the culprit leaves their fingerprint on the door knob
- In s3 (a resource situation), the investigators make a copy of the fingerprint for analysis

- This requires (by convention) resource situations s3,p1, p2, s3,1, s3,2
- In s3, a fingerprint camera with mugsheets of the suspects to get similarity measures
- s1 and s2 are coordinated id-situations (supporting the same id-judgment)

- This requires (by convention) resource situations s1,p1, p2, s1,1, s1,2
- In s3 (a resource situation that includes the described situation, s3, the security camera takes the picture of the crime used in s2
- Situation s2 is the described situation for id-situation s2 also described (as dictated by situation theory) by s2, c contains s2
- This is encoded in RDF triples stores using the concept defined in our ontologies. Query the triple stores with SPARQL

- DS theory provides a numerical measure of confidence in our id-situation which assigns mass to sets of elements, with the total mass summing to 1.0
- Any set of elements, including singletons, with some non-zero mass is a focal element
- Mass associated with a non-singleton set represents evidence for some element or other in that set. Unlike with probability theory, mass/probability associated with a non-singleton cannot be distributed to its elements
- The set of all possible elements is the frame of discernment. Uncertainty is preserved by assigning mass to the entire frame
- Frames of discernment can be analyzed to create new, refined frames in refinements
- The belief associated with a set is a lower bound on its likelihood and is determined by adding the masses of all of its subsets
- The plausibility of a set is an upper bound on its likelihood and is the sum of the masses of all sets that overlap with it
- DS theory provides a rule of number of rules to combine mass functions while maintaining uncertainty

- We consider each id-situation and its associated situations to result in its own mass function and provide evidence for the likelihood that each suspect was the criminal
- Our scenario provides a numerical similarity measure between each suspect and the crime scene for each piece of evidence (fingerprint and mugshot)

- These are turned into a mass function and combined to provide a single mass function for all evidence

Combine Mass Functions

- We use Dempster’s rule for combining mass functions
- It divides conflict between the different mass functions evenly among the focal elements and does not assign it to uncertainty
- It works reasonably well for our scenario because conflict among different pieces of evidence is likely not indicating that the suspect is unknown

- Yager’s rule applies all conflict directly to uncertainty,
- It would be fitting, e.g., in a scenario where we believed evidence was planted to blame an innocent

Constraints and Refinements

- Every piece of evidence used in the id-situation was collected in our ontologies and preserved as a chain of custody
- These protocols are conventions that establish constraints between the id-situation and other, resource situations

Constraints and Refinements

- There are 3 possible interpretations of constraints
- Each (set of) situation(s) is a separate mass function
- Each resource situation is considered a refinement of the frame of discernment created in the id-situation
- A resource situation modifies the mass function of the id-situation

Implementation and Results

- Info on the various situations was retrieved from the RDF triple stores using SPARQL using the Jena Semantic-Web framework
- DS theory implemented in Python
- Matches originally expressed as distances were converted to masses with an inverting sigmoid function (smaller distance gives greater mass) and normalizing

Mass values obtained from fingerprint evidence, along each step of their determination

- Final mass includes 0.228 for the frame of discernment to bring the sum to 1.0

Conclusion and Future Work

- We present a framework of identity based on situation theory that considers id-cases, where a number of situations conspire to support a judgment of identity
- These situations are represented using semantic web resources
- Each id-case provides evidence for forming a mass function as described by Dempster-Shafer theory
- The id-situation gives us an initial mass function, which is modified based on the resource situations
- Future work will consider different combination rules and applications of Dempster-Shafer theory, look at weighting evidence
- Increase our set of scenarios, particularly ones with vague evidence pointing to non-singleton sets
- Our software will be web-accessible, used by students in the Criminal Justice Program at A&T

Acknowledgments

This research is based upon work supported by the NSF REU grant of (Weinstein) and the ARPA (Contract No. W911NF-15-1-0524). The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements of the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright annotation thereon. We shall freely acknowledge Governmental use of the Computer Science Department of Brown University whose work this is based on.
**BACKGROUND**

Duct tape physical matching is defined by AFTE as the method of evaluation whether the pair, or items, are one entity or were held or bonded together through physical, optical, or chemical means which permits one to conclude whether the objects were either one entity or were held or bonded together.

This study examined the accuracy rates observed when four methods of separation were utilized to compare duct tape samples.

Methods of separation

- Paper cutter cut (200 pairs)
- Box cutter cut (200 pairs)
- Hand torn (800 pairs)
- Scissor cut (200 pairs)

**MATERIALS**

- Duct Tape Physical Matching by Various Separation Methods
- Duck Brand Maximum Strength Industrial Grade Duct Tape
- Intertape Polymer Group 9600/AC 29 Utility Duct Tape
- 3M 3939 Heavy Duty Tape
- Nashua 357 Premium Grade Duct Tape

**METHODS**

- False-positive and inconclusive rates observed when four methods of separation were utilized to compare duct tape samples.

**RESULTS**

Accuracy rates, false-negative rates, and false-positive rates over all separation methods

**CONCLUSIONS**

This study showed that stronger grades are less prone to distortion and stretch upon separation. This study showed that the method of separation affects the analyst’s ability to identify duct tape physical matches. This study can also be used to examine the evidentiary value of an individual analyst’s ability to identify duct tape physical matches. Further exploration on the interactions between brand and grade on error rates is necessary. It is also necessary to continue to increase the sample size in order to show the reliability of the physical matching technique.

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Duct Tape Physical End Matching,
Fingerprints on Clothing: Evidence About Fingerprint Visualization on Distinct Types of Fabrics

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INTRODUCTION

- Fingerprints are one of the most common evidence found at crime scenes and can help to get an identification or exclusion of suspects;
- The knowledge on the development of fingerprints in different surfaces (porous and non-porous) is increasing;
- There are few techniques to visualize fingerprints on clothing.

METHODS

- 13 different types of fabrics were tested: cotton, linen, silk, satin silk, wool, polyester, acetate, viscose, nylon, cotton(40%)-polyester(60%), cotton(60%)-polyester(40%), lyca-elastane and cotton(97%)-elastane(3%);
- 5 black samples and 5 white samples of each type of fabric;
- Authenticity of samples was confirmed using Fourier Transform Infrared Spectroscopy (FTIR) and microscope visualization;
- 2 different techniques were used: Ninhydrin and Lumicyano.

RESULTS

- Ninhydrin developed naked-eye fingerprints in white samples but not in black samples (table 1);
- Quality of fingerprints was classified from 0 to 4 as in previous studies, with 4 representing good and detailed marks (Fraser et al., 2011);
- Some samples had better quality fingerprints after 8 days (→), this happened because Ninhydrin is a liquid solution that only develops fingerprints when it is dried and some fabrics take more time to do dry. On the other hand some samples lose quality of visualization due to the spread of Ninhydrin into the fabric.
- Lumicyano developed fingerprints in almost all black samples and in a few white samples (but when visualized using fluorescent light) - table 2;
- Lumicyano manufacturers reported that ultraviolet light was the most suitable for the development of fingerprints, but in fact, this research suggests that higher wavelengths were more efficient.

CONCLUSIONS

- With these techniques it was possible to visualize fingerprints on clothes with some level of detail of patterns and features;
- Ninhydrin developed fingerprints only in white fabrics and Lumicyano developed better results in black than in white samples;
- With these two chemicals, positive results were obtained, which means that these techniques are suitable to be used on fabrics to help criminal investigations.

### Table 1 — Results with Ninhydrin technique

<table>
<thead>
<tr>
<th>Fabric Type - Color</th>
<th>Detail - White light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton - black</td>
<td>0</td>
</tr>
<tr>
<td>Cotton - white</td>
<td>1-2</td>
</tr>
<tr>
<td>Wool - black</td>
<td>0</td>
</tr>
<tr>
<td>Wool - white</td>
<td>1</td>
</tr>
<tr>
<td>Linen - black</td>
<td>0</td>
</tr>
<tr>
<td>Linen - white</td>
<td>1-2</td>
</tr>
<tr>
<td>Silk - black</td>
<td>0</td>
</tr>
<tr>
<td>Silk - white</td>
<td>1</td>
</tr>
<tr>
<td>Satin silk - black</td>
<td>0</td>
</tr>
<tr>
<td>Satin silk - white</td>
<td>1</td>
</tr>
<tr>
<td>Polyester - black</td>
<td>0</td>
</tr>
<tr>
<td>Polyester - white</td>
<td>1</td>
</tr>
<tr>
<td>Nylon - black</td>
<td>0</td>
</tr>
<tr>
<td>Nylon - white</td>
<td>0-9</td>
</tr>
<tr>
<td>Cotton-elastane - black</td>
<td>0</td>
</tr>
<tr>
<td>Cotton-elastane - white</td>
<td>1</td>
</tr>
<tr>
<td>Cotton(40%)-polyester(60%)-black</td>
<td>0</td>
</tr>
<tr>
<td>Cotton(40%)-polyester(60%)-white</td>
<td>1</td>
</tr>
<tr>
<td>Cotton(60%)-polyester(40%)-black</td>
<td>0</td>
</tr>
<tr>
<td>Cotton(60%)-polyester(40%)-white</td>
<td>1</td>
</tr>
<tr>
<td>Lyca-elastane - black</td>
<td>0</td>
</tr>
<tr>
<td>Lyca-elastane - white</td>
<td>0</td>
</tr>
<tr>
<td>Acetate - black</td>
<td>0</td>
</tr>
<tr>
<td>Acetate - white</td>
<td>2-3</td>
</tr>
<tr>
<td>Viscose - black</td>
<td>0</td>
</tr>
<tr>
<td>Viscose - white</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 2 — Results with Lumicyano technique

<table>
<thead>
<tr>
<th>Fabric Type - Color</th>
<th>Detail - White light</th>
<th>Detail - UV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton - black</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cotton - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wool - black</td>
<td>0</td>
<td>0</td>
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<td>Wool - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Linen - black</td>
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<td>0</td>
</tr>
<tr>
<td>Linen - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Silk - black</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Silk - white</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Satin silk - black</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Satin silk - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Polyester - black</td>
<td>3</td>
<td>1</td>
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<td>Polyester - white</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Nylon - black</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Nylon - white</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Cotton-elastane - black</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Cotton-elastane - white</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Cotton(40%)-polyester(60%)-black</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cotton(40%)-polyester(60%)-white</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cotton(60%)-polyester(40%)-black</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cotton(60%)-polyester(40%)-white</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Lyca-elastane - black</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Lyca-elastane - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acetate - black</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Acetate - white</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Viscose - black</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Viscose - white</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

BIBLIOGRAPHY