

Resource Description Framework Schemas for Fingerprint Image

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Abstract

The aim of this paper is to describe the fingerprint image using metadata. Fingerprint image was using in Automated Fingerprint Identification (AFI) system to recognize the person. There are many difficulties in using this system. AFI system is a central system in addition to that there are no metadata for fingerprint image. Describe the fingerprint using metadata and Resource Description Framework (RDF) embedded in fingerprint image should make it more flexible to detecting of individuals wanted at any times using metadata. This paper led to new method to retrieve the person by using metadata instead of matching fingerprint image.

Keywords: Fingerprint, Metadata, RDFS.

Introduction

The fingerprint is defined as an image taken from fingerprint's person and used to recognize the person[1]. It used in Automated Fingerprint Identification system to compares between submitted fingerprint image and the candidate in fingerprint image database. There are some difficulties when using fingerprint image for comparison:

1. No metadata about fingerprint are available.
2. Fingerprint image comparison does not have facility to select fingerprint image by data.
3. Large fingerprint image database, takes a long time to find the exact one.
4. Fingerprint image comparison is a central but not distributed system.

Using metadata about the fingerprint image allows solving these difficulties, more effective in finding the proper one and simplifying access to it.

In this paper certain form of RDF schemas were used to describe fingerprint that can be embedded in the fingerprint image.

1. Fingerprint features.

These features can be added to metadata of fingerprint image. There are two types of features illustrated in figure (1) can be extracted from fingerprint images[2]:

- a. The low level or local features: These features which are illustrated in table (1) are ridge characteristics, and called the minutiae. They are the points of ridge endings (terminations) and bifurcations (branching). A set of these points constitutes the characteristics feature set of the fingerprint image and is unique for each fingerprint.

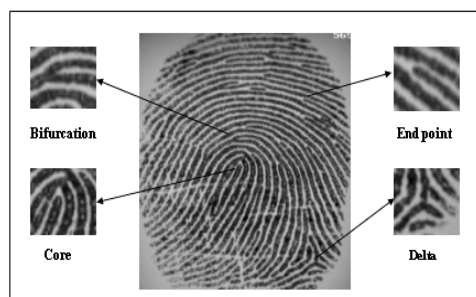














Fig. 1 The types of features

- b. The high-level or global features: the important high-level features are the core and delta regions. The core is approximate center the

finger impression. Different fingerprint patterns have different number of core and delta.

Table 1. Ridge Characteristics

ridge ending		Bridge	
bifurcation		double bifurcation	
dot		Trifurcation	
island (short ridge)		opposed bifurcations	
lake (enclosure)		ridge crossing	
hook (spur)		opposed bifurcation/ridge ending	

2. Finger Print Classification:

Fingerprints are the result of ridges valleys found on the finger of every person [3]. It can be divide into four types[2,3]:

- a. **Arch:** In arch a ridge enters on one side, rises in the middle and flows out on the other side. Arch type can be subdivided into two types:
 - i. **Plain Arch:** The plain arch is the simplest pattern. The ridge enters on one side, rises to form a wave in the center, and exits smoothly on the opposite side. In this sub-classification core point can be rendered the as the point in the middle of the more curved fingerprint line.
 - ii. **Tented Arch:** The tented arch is a variation of the plain arch. The ridge near the center has an upward thrust, arranging themselves on both sides of a spine or axis. Impressions of tented arches are not of very frequent occurrence, and the core appearance that can be found is by the determination of the height of the ridge enveloping the pattern.
- b. **Loop:** The ridges about the center arrange themselves in the form of hairpin. There is one core and one delta. Loops can be subdivided to left loops and right loops.
 - i. **Left Loop:** In this type we see that the direction of the loop is on the left and the delta point is on the right side.
 - ii. **Right Loop:** In this type the direction of the loop is right and the delta point is on the left side.
- c. **Whorl:** Whorl is a pattern with two deltas and at least one recurving ridge. There are two types of whorls:
 - i. **Plain Whorl:** This type presents a well-defined spiral formation, while others possess more or less elongated cores.
 - ii. **Central Pocket:** In this type a few ridges about the core possess features of the whorl type and the remainder of the ridges conform to the loop type.

- d. **Compounds:** For the more complicated combination of whorl, loop, and arch. This type can be subdivided into four types:
 - i. **Twinned Loop:** Two separate loop formations are present and may surround each other.
 - ii. **Lateral Pocket:** also discloses two loops and two deltas. Both deltas are on the same side of the ascending loop.
 - iii. **Composite:** They are the more complicated combinations of the whorl type. They possess three deltas, sometimes four, and even five have been met.
 - iv. **Accidental:** is used to describe those patterns that do not conform to any pattern previously described (arch, loop or whorl) and yet possess characteristics common to all three types.

3. Metadata Concept:

Metadata is structured information that describe, explain, locate, or otherwise make it easier to retrieve, use, or manage an information resource. It is structure document about document, object and image when properly implemented metadata can unambiguously describe information resource enhancing information retrieval and enable accurate matches to be done[5]. Without common structure and standards for metadata, there can be no interchange and translation between systems, without consistent interpretation metadata has no value. Metadata used to speed up and enrich searching for resources. It can either describe the resource itself or the content of the resource.

Metadata can be stored in two ways[6]:

1. **Internal storage (embedded):** metadata is store in the same file as the data. It allows transferring metadata together with the file it describe. Metadata is always at hand and can be manipulated easily.
2. **External storage:** metadata is store in separate file. It allows bundling. There is no

redundancy and metadata can be transferred simultaneously when using streaming.

4. Metadata and RDF

RDF has been developed as part of w3c's metadata activity[7].RDF provides a generic metadata architecture. RDF captures metadata about externals of document-in this paper the document is finger print image.

RDF is based on a mathematical model that provides a mechanism for grouping together sets of very simple metadata statements know as triples. Each triple is made up of a resource (or node), a property type and value. RDF property types can be thought of as attributes in traditional attribute-value pairs. The model can be represent graphically using node and arc diagrams.[8]. Metadata can be representing either as triples (Resource, Property type, Value) or as a graph:

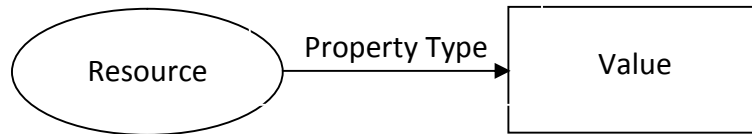


Fig. 2 RDF Graph

A graph can be used to represent structure of concepts of fingerprint metadata. For example:

the resource is finger print, property type is pattern and value is arch. The graph is become like the figure below:

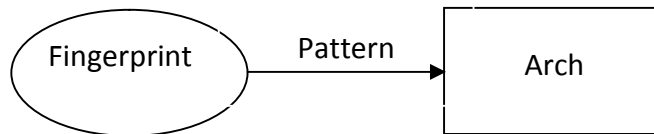


Fig. 3 Fingerprint RDF Graph

move seamlessly between different systems and environments.

The fingerprint image metadata divided into:

- a. **Fingerprint pattern:** It is a method of classification that enable fingerprint bearing differing patterns to be placed in certain order[1]. There is a variety of patterns. In Henry system, they are divided into four main group and each group divided into many sub patterns- as seen in fingerprint classification
- b. **The ridge characteristics:** The identity of fingerprint is not fixed on the type of pattern alone; it depends upon the result of comparison of finger details of the print which are called ridge characteristics. The fingerprint identification rests upon the order in which ridge characteristics appear. The various types of characteristics do not occur with the same degree of frequency, islands, lake, ridge ending, dot, bifurcation, hook, bridge, double bifurcation, trifurcation, opposed bifurcations, ridge crossing and opposed bifurcation.
- c. **Person information:** It is additional information about person's fingerprint, like the name, birth date, job, address. . etc.

6. RDF Schemas

RDF is flexible language capable of describing all stars of information and metadata. RDF was developed by W3c's candidate to provide a

And the RDF/XML document is:

```
<rdf:RDF>
<rdf:Description about="Fingerprint">
<Pattern>Arch</Pattern>
</rdf:Description>
</rdf:RDF>
```

5. Fingerprint Image Metadata

Due to the fact, that the fingerprint is defined as an image taken from fingerprint's person. The fingerprint metadata is non-pixel data associated with digital image. Metadata provide additional information to the users of the data it described. This information may be descriptive. Metadata can include basic information about fingerprint such as pattern, ridge characteristic and data about person belong to it. The reason for adding metadata to fingerprint image is to allow more effective search.

Throughout the search in this paper, it was founding that, there are four principles for fingerprint images metadata:

- a. Metadata are essential to identify and track digital fingerprint image.
- b. Ownership metadata must never be removed.
- c. Metadata must be written in formats that are easily understood.
- d. Metadata are essential to ensure maximum image quality and image handling efficiency.

If all application writes metadata using open standards that are fully consistent and interoperable, then information will be able to

It is a personal metadata. It contains metadata about the person of the fingerprint. It is a personal detail about name, address, birthday and job. The elements that used to describe the personal schema are:

- i. **Name:** The name of the person of the fingerprint.
- ii. **Address:** The address of the person.
- iii. **Data:** The date of the fingerprint image.
- iv. **Job:** The job of the person.
- v. **Birthday:** The date of the person birthday.

The RDF person schema is in appendix (B).

c. Characteristics schema:

It includes all properties about the fingerprint ridge characteristics. These keywords are island, bifurcation, double-bifurcation, trifurcation, hook, dot, lake, crossing, bridge and ridge-ending. The range of these properties is integer number. Each fingerprint has many of these properties. See appendix (C)

d. Content Schema:

This schema contains the keyword used in pattern, sub pattern, hand-type, and finger-digit. These properties should contain one of the following keywords as are applicable. These keywords are:

- i. The keywords arch, loop, whorl and compound which are used in pattern property. Each fingerprint has one of these patterns.
- ii. The keywords plane-arch, tent, ulnar, radial, nutant, plan-whorl, central-pocket, double-loop, accidental, twinned-loop and lateral-pocket are used in sub pattern property. Each fingerprint has one of these sub patterns.
- iii. The keywords left and right are the hand-type. These are used in hand-type property. Each fingerprint has one of the keywords.
- iv. The keywords thump, index, middle, ring and little are the hand digits. These are used in finger-digit property. Each fingerprint is for one digit.

The RDF content schema is in appendix (D).

8. Example of fingerprint metadata

This is an example of the metadata in RDF format. In this example illustrated how can be described fingerprint image using RDF schemas.

```
<?xml version="1.0"?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-
rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf
-schema#"
  xmlns:fp="http://fingerprint#"
  xmlns:per="http://person#"
  xmlns:chart="http://characteristics#"
  xml:base="http://example.org/fingerprint/">
<rdf:Description rdf:about="fingerprint">
  <fp:pattern>Arch</fp:pattern>
  <fp:subpattern>Plain Arch</fp:subpattern>
  <fp:hand>left</fp:hand>
```

standard way to model, describe, and exchange information metadata about a resource [9], as long as it is specific metadata about specific photo.

RDF schema is built on top of RDF [9][10]. It is a universal language that lets users describe resource using own vocabularies[10].

RDF user communities also need the ability to define the vocabularies (terms) they intend to use in those statements, specifically to indicate that they describe specific kinds of classes of resources and will use specific properties in describing those resources [10].

RDF schema facilities are themselves provided in the form of an RDF vocabulary. Vocabulary descriptions (schemas) written in RDF schema language are legal RDF graph [10].

7. RDF Fingerprint Image Schemas

In this paper, the RDF schemas to describe the fingerprint image separated into three different schemas. All these schemas are validated by W3C validation serves URL: <http://www.w3.org/RDF/Validator/>.

These schemas are:

a. Fingerprint schema.

The fingerprint schema includes properties about fingerprint such as pattern, sub pattern, hand, and finger digit .etc. The content of fingerprint schema is defined by the following vocabularies:

- i. **Pattern:** it is a primary classification of the fingerprint. It could be one of the keywords. It is described in content schema. It could be one of the following words (Arch, Loop, Whorl and Compound).
- ii. **Sub pattern:** it is sub-classification of patterns. Each pattern is divided into many sub patterns. It could be one of keyword that is described into content schema.
- iii. **Hand:** It could be left or right word that is described in content schema.
- iv. **Finger:** It is the names of finger belong to the fingerprint. It could be one of the words that described in the content schema. Normally human have five fingers at each hand.
- v. **Delta:** It is a high-level feature. Each fingerprint has certain number of delta.
- vi. **Core:** It is another high-level feature. Each fingerprint could have zero or more number of cores.
- vii. **Part:** This property divides the fingerprint into four parts (part1, part2, part3, part4). Each part is a resource. These resources have information about fingerprint minutiae. Each part has a certain number of characteristics property is defined in the characteristics schema.

The RDF fingerprint schema is in appendix (A).

b. Person Schema

fingerprint minutiae. Fingerprint metadata is non-pixel data associated with digital fingerprint image. It can include base information about fingerprint features and embedded it in fingerprint image.

RDF is a formal language used to represent metadata as subject, object and relation between them. There are many special vocabularies using to describe the fingerprint minutiae. These vocabularies are described into four schemas. Using these schemas can build a big repository of fingerprint image. And retrieve any one using the metadata about fingerprint.

10. Reference

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11. Appendix A: The RDF Fingerprint schema.

```
<?xml version="1.0"?>
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xml:base="http://fingerprint">
<rdfs:class rdf:ID="fingerprint"/>
<rdfs:property rdf:ID="pattern">
<label xml:lang="en">pattern</label>
```

```
</fp:finger>thump</fp:finger>
<fp:delta>2</fp:delta>
<fp:core>1</fp:core>
<per:name>Ahmad</per:name>
<per:Birthday>22/5/1960</per:Birthday>
<fp:part>
<fp:part rdf:resource="part1"/>
<fp:part rdf:resource="part2"/>
<fp:part rdf:resource="part3"/>
<fp:part rdf:resource="part4"/>
</rdf:Description>
<rdf:Description rdf:about="part1">
<chart:island>2</chart:island>
<chart:bifurcation>1</chart:bifurcation>
<chart:double-bifurcation>1</chart:double-bifurcation>
<chart:trifurcation>1</chart:trifurcation>
<chart:hook>3</chart:hook>
<chart:dot>2</chart:dot>
<chart:lake>1</chart:lake>
<chart:crossing>1</chart:crossing>
<chart:bridge>1</chart:bridge>
</rdf:Description>
<rdf:Description rdf:about="part2">
<chart:island>2</chart:island>
<chart:bifurcation>1</chart:bifurcation>
<chart:double-bifurcation>1</chart:double-bifurcation>
<chart:trifurcation>1</chart:trifurcation>
<chart:hook>3</chart:hook>
<chart:dot>2</chart:dot>
<chart:lake>1</chart:lake>
<chart:crossing>1</chart:crossing>
<chart:bridge>1</chart:bridge>
</rdf:Description>
<rdf:Description rdf:about="part3">
<chart:island>2</chart:island>
<chart:bifurcation>1</chart:bifurcation>
<chart:double-bifurcation>1</chart:double-bifurcation>
<chart:trifurcation>1</chart:trifurcation>
<chart:hook>3</chart:hook>
<chart:dot>2</chart:dot>
<chart:lake>1</chart:lake>
<chart:crossing>1</chart:crossing>
<chart:bridge>1</chart:bridge>
</rdf:Description>
<rdf:Description rdf:about="part4">
<chart:island>2</chart:island>
<chart:bifurcation>1</chart:bifurcation>
<chart:double-bifurcation>1</chart:double-bifurcation>
<chart:trifurcation>1</chart:trifurcation>
<chart:hook>3</chart:hook>
<chart:dot>2</chart:dot>
<chart:lake>1</chart:lake>
<chart:crossing>1</chart:crossing>
<chart:bridge>1</chart:bridge>
</rdf:Description>
</rdf:RDF>
```

9. Conclusion

In this paper a new method was suggested to describe the fingerprint image using a metadata about

```

</rdfs:property>
<rdfs:property rdf:ID="date">
  <label xml:lang="en">date</label>
  <rdfs:domain rdf:resource="#Person"/>
</rdfs:property>
</rdf:RDF>

```

13. Appendix C: Characteristics schema:

```

<?xml version="1.0"?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xml:base="http://characteristics">
  <rdfs:class rdf:ID="characteristics"/>
  <rdfs:property rdf:ID="island">
    <label xml:lang="en">island</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="bifurcation">
    <label xml:lang="en">bifurcation</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="double-bifurcation">
    <label xml:lang="en">double-bifurcation</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="trifurcation">
    <label xml:lang="en">trifurcation</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="hook">
    <label xml:lang="en">hook</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="dot">
    <label xml:lang="en">dot</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="lake">
    <label xml:lang="en">lake</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="crossing">
    <label xml:lang="en">crossing</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="bridge">
    <label xml:lang="en">bridge</label>
    <rdfs:domain rdf:resource="#characteristics"/>
    <rdfs:range rdf:resource="^^xsd;integer"/>
  </rdfs:property>
  <rdfs:property rdf:ID="ridge-ending">
    <label xml:lang="en">ridge-ending</label>
    <rdfs:domain rdf:resource="#characteristics"/>

```

```

<rdfs:domain rdf:resource="#fingerprint"/>
<rdfs:range
  rdf:resource="http://www.example.org/content-1-0#Keywords"/>
</rdfs:property>
<rdfs:property rdf:ID="subpattern">
  <label xml:lang="en">subpattern</label>
  <rdfs:domain rdf:resource="#fingerprint"/>
  <rdfs:range
    rdf:resource="http://www.example.org/content-1-0#subpattern-type"/>
</rdfs:property>
<rdfs:property rdf:ID="hand">
  <label xml:lang="en">hand</label>
  <rdfs:domain rdf:resource="#fingerprint"/>
  <rdfs:range
    rdf:resource="http://www.example.org/content-1-0#Hand-type"/>
</rdfs:property>
<rdfs:property rdf:ID="finger">
  <label xml:lang="en">finger</label>
  <rdfs:domain rdf:resource="#fingerprint"/>
  <rdfs:range
    rdf:resource="http://www.example.org/content-1-0#Finger-type"/>
</rdfs:property>
<rdfs:property rdf:ID="Delta">
  <label xml:lang="en">Delta</label>
  <rdfs:domain rdf:resource="#finger print"/>
  <rdfs:range rdf:resource="^^xsd;integer"/>
</rdfs:property>
<rdfs:property rdf:ID="Core">
  <label xml:lang="en">Core</label>
  <rdfs:domain rdf:resource="#fingerprint"/>
  <rdfs:range rdf:resource="^^xsd;integer"/>
</rdfs:property>
<rdfs:property rdf:ID="part">
  <label xml:lang="en">part</label>
  <rdfs:domain rdf:resource="#fingerprint"/>
</rdfs:property>
</rdf:RDF>

```

12. Appendix B: The RDF Person Schema.

```

<?xml version="1.0"?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xml:base="http://person">
  <rdfs:class rdf:ID="Person"/>
  <rdfs:property rdf:ID="name">
    <label xml:lang="en">name</label>
    <rdfs:domain rdf:resource="#Person"/>
  </rdfs:property>
  <rdfs:property rdf:ID="job">
    <label xml:lang="en">job</label>
    <rdfs:domain rdf:resource="#Person"/>
  </rdfs:property>
  <rdfs:property rdf:ID="address">
    <label xml:lang="en">address</label>
    <rdfs:domain rdf:resource="#Person"/>

```

```
<label xml:lang="en">Central-
Pocket</label>
</content:Subpattern-type >
<content:Subpattern-type rdf:ID="Double-Loop">
  <label xml:lang="en">Double-
Loop</label>
  </content:Subpattern-type >
<content:Subpattern-type rdf:ID="Accidental">
  <label
xml:lang="en">Accidental</label>
  </content:Subpattern-type >
<content:Subpattern-type rdf:ID="Twinned-Loops">
  <label xml:lang="en">Twinned-
Loop</label>
  </content:Subpattern-type >
<content:Subpattern-type rdf:ID="Lateral-Pocket">
  <label xml:lang="en">Lateral-
Pocket</label>
  </content:Subpattern-type >
<rdfs:Class rdf:ID="Hand-type"/>
<content:Hand-type rdf:ID="Left">
  <label xml:lang="en">Left</label>
</content:Hand-type>
<content:Hand-type rdf:ID="Right">
  <label xml:lang="en">Right</label>
</content:Hand-type>
<rdfs:Class rdf:ID="Finger-type"/>
<content:Finger-type rdf:ID="Index">
  <label xml:lang="en">Index</label>
</content:Finger-type>
<content:Finger-type rdf:ID="Ring">
  <label xml:lang="en">Ring</label>
</content:Finger-type>
<content:Finger-type rdf:ID="Thumb">
  <label xml:lang="en">Thump</label>
</content:Finger-type>
<content:Finger-type rdf:ID="Middle">
  <label xml:lang="en">Middle</label>
</content:Finger-type>
<content:Finger-type rdf:ID="Little">
  <label xml:lang="en">Little</label>
</content:Finger-type>
</rdf:RDF>
```

```
<rdfs:range rdf:resource="^^xsd:integer"/>
</rdfs:property>
</rdf:RDF>
14. Appendix D: Content Schema:
<?xml version="1.0"?>
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-
schema#"
xmlns:content="">
<rdfs:Class rdf:ID="Keywords"/>
<content:Keywords rdf:ID="Arch">
  <label xml:lang="en">Arch</label>
</content:Keywords>
<content:Keywords rdf:ID="Whorl">
  <label xml:lang="en">Whorl</label>
</content:Keywords>
<content:Keywords rdf:ID="Loop">
  <label xml:lang="en">Loop</label>
</content:Keywords>
<content:Keywords rdf:ID="Compound">
  <label
xml:lang="en">Compound</label>
</content:Keywords>
<rdfs:Class rdf:ID="Subpattern-type"/>
<content:Subpattern-type rdf:ID="Plan-Arch">
  <label xml:lang="en">Plan-Arch</label>
</content:Subpattern-type>
<content:Subpattern-type rdf:ID="Tented">
  <label xml:lang="en">Tented</label>
</content:Subpattern-type>
<content:Subpattern-type rdf:ID="Ulnar">
  <label xml:lang="en">Ulnar</label>
</content:Subpattern-type>
<content:Subpattern-type rdf:ID="Radial">
  </content:Subpattern-type >
<content:Subpattern-type rdf:ID="Nutant">
  <label xml:lang="en">Nutant</label>
</content:Subpattern-type >
<content:Subpattern-type rdf:ID="Plan-Whorl">
  <label xml:lang="en">Plan-
Whorl</label>
</content:Subpattern-type >
<content:Subpattern-type rdf:ID="Central-Pocket">
```

مخطط أطار وصف الموارد إلى بصمة الأصبع

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الخلاصة

ان الهدف من هذه الورقة البحثية هو وصف صورة بصمة الاصبع باستخدام البيانات الوسطية. تستخدم صورة بصمة الاصبع في نظام تعريف البصمة الاتوماتيكي لتمييز الاشخاص. ولكن هناك عدة صعوبات تواجه هذا النظام في الاستخدام منها ان هذا النظام هو نظام مركزي بالاضافة الى عدم وجود بيانات وسطية تصف صورة البصمة. ان وصف صورة البصمة باستخدام البيانات الوسطية واطار وصف الموارد التي تكون متضمنة داخل صورة البصمة تجعل النظام اكثر مرونة في تحديد البصمة المطلوبة في اي وقت باستخدام هذه البيانات الوسطية. هذه الورقة البحثية تقود الى طريقة جديدة لاسترجاع الشخص المطلوب باستخدام البيانات الوسطية بدل من تطابق الصورة بصمة الاصبع.