Міністерство освіти і науки України НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ «КИЄВО-МОГИЛЯНСЬКА АКАДЕМІЯ» Кафедра математики факультету інформатики

Проблеми пошуку по мультімедіа даних у приватному фотоальбомі

Курсова робота за спеціальністю «Інформаційні управляючі системи та технології»

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„____”_____2020 р.

ІНДИВІДУАЛЬНЕ ЗАВДАННЯ
на курсову роботу

студента Нікуліна Дмитра Миколайовича факультету інформатики 1 курсу
ТЕМА Проблеми пошуку по мультімедіа даних у приватному фотоальбомі

Зміст ТЧ до курсової роботи:

Індивідуальне завдання
Календарний план
Анотація
Вступ
РОЗДІЛ 1: Definition of the user needs in Multimedia IR systems
РОЗДІЛ 2: Overview of the Private Multimedia IR systems
РОЗДІЛ 3**:** Identification and prioritization of the issues in IR multimedia systems
РОЗДІЛ 4: Addressing the issues in private IR multimedia systems
Висновки
Глосарій
Список використаної літератури

Дата видачі „___” _____ 2020 р. Керівник _____
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Тема: Проблеми пошуку по мультімедіа даних у приватному фотоальбомі

Календарний план виконання роботи:

№ п/п	Назва етапу курсової роботи	Термін виконання етапу
1.	Отримання завдання на дипломну роботу.	15.03.2020
2.	Огляд технічної літератури за темою роботи.	22.03.2020
3.	Аналіз існуючих досліджень за темою роботи.	29.03.2020
3.	Написання вступу та плану роботи.	15.04.2020
4.	Програмна реалізація алгоритмів.	01.05.2020
6.	Написання основних розділів роботи.	09.05.2020
7.	Створення слайдів для доповіді та написання доповіді.	10.05.2020
8.	Коригування роботи відповідно до вимог щодо оформлення робіт.	12.05.2020
9.	Остаточне оформлення пояснювальної роботи та слайдів.	12.05.2020
10.	Коригування роботи згідно із зауваженнями керівника.	13.05.2020
11.	Здача роботи на перевірку щодо плагіату	14.05.2020
12.	Захист курсової роботи	22.05.2020

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Contents

Annotation

This paper describes the IR Multimedia Systems and their subjects. First of all, it gives the definition of the needs in Multimedia IR systems from user point of view. It further provides the overview and comparison of private IR Multimedia Systems such as Google Photo, Apple photo, Synology Moments. Basing on the overview and comparison, it provides the identification and prioritization of the issues in those systems. Taking three most important issues, it outlines the approaches, algorithms and tools to address those issues. The paper ends up with conclusion, glossary and references list.

Introduction

We live in the digital data era, and growing of the Internet gives us a possibility to find the information really easily by one click. We are allowed now to search the information from anywhere. Rapid growth of the digital data during the last 25 years is caused by the emergence of the various types of data, called multimedia data. Generally, multimedia data is divided into two subclasses: static and dynamic content.

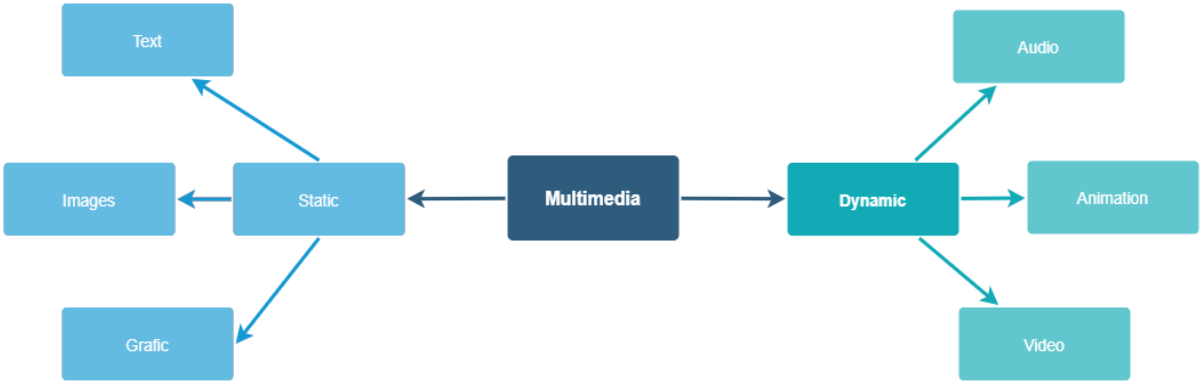

Figure 1. Multimedia data types

Static content data types are:

- Text;
- Graphic;
- Images.

Dynamic content data types are:

- Audio;
- Animation;
- Video.

The text information has been the dominant one as a way for communication between people. But other media types such as audio, image, and video are getting importance in context of growing the computing capabilities like the disk and memory space, growing processing power, etc. [1].

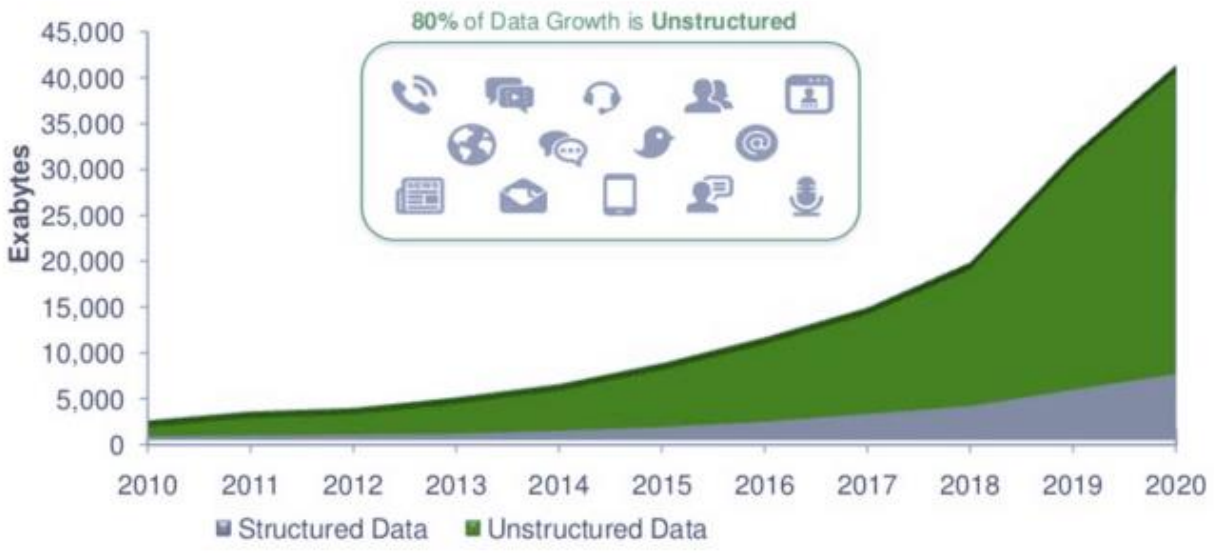

Figure 2. Worldwide Corporate Data Growth

Figure 2 above demonstrates that 80% of data growth is predicted to be unstructured data – text, images, video and audio multimedia data by the end of 2020 [2].

Moreover, it is expected that there will be 1.43 trillion of photos taken annually by the end of 2020 [3].

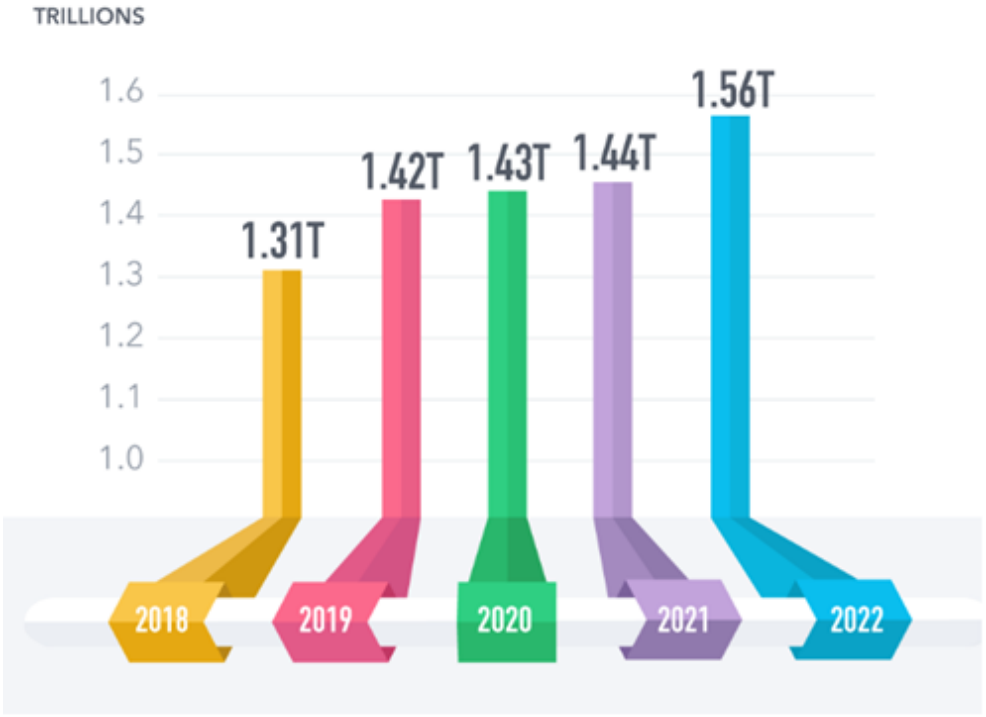

Figure 3. Total photos taken annually

It takes into account that more than 4 billion of people will have a built-in camera in a phone, so if one person takes 10 photo per day (it is 3650 per year) - it will add 1.4 trillion photos annually.

So, there is a need in Multimedia Information Retrieval (Multimedia IR) systems to search thought different types of media. Many aspects require such search engines that are able to find the data inside of textual and also non-textual information.

Currently, most of the search engines are text-based [4]. These are search engines such as Google, Bing, etc. They are mostly designed to search for any type of text – structured, semi-structured, or unstructured. But as we have already mentioned, the information is provided in other forms. In everyday life we often need to search the information such as photo, video, etc. The search inside of images, video, animation and sound is still actively discussed and in many conferences as well, so it is still a hot topic [5].

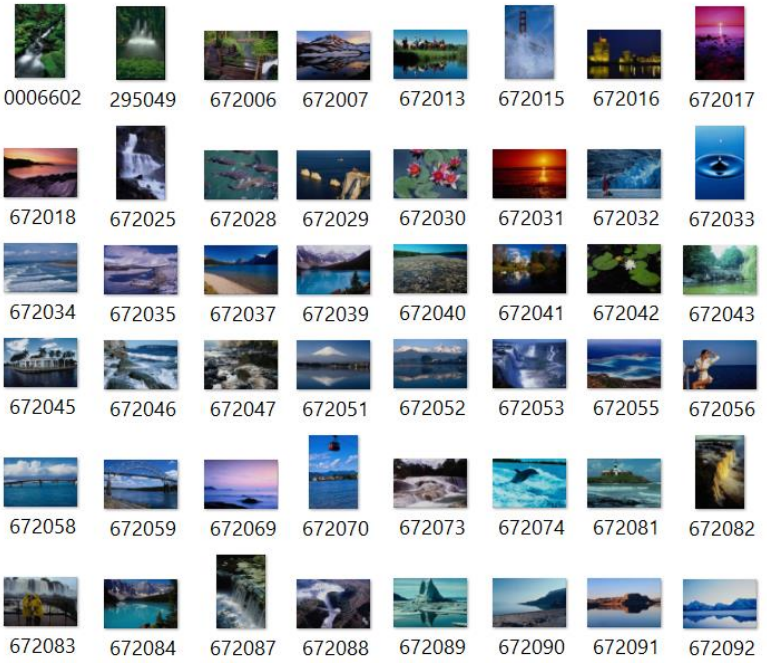

Figure 4. Response example of the IR Multimedia system returning a photo set

Such Multimedia IR systems usually provide such functions as storage, indexing, searching and delivery of multimedia information. They might also include such features as extracting descriptive features from multimedia data. The non-textual information significantly differs from the textual information.

Therefore, different approaches and engines might be used depending on the type of multimedia data.

In this paper we are focusing on searching through the images.

Comparing to the audio and video, image IR multimedia systems are the best growing and so specifically developed systems. There are commercial images IR systems that are able to provide the retrieval basing on the metadata and the tags (image descriptions) [6].

The metadata and the tags might be filled up manually. In such cases, describing images in a non-automated way costs a lot and time-consuming as well. One more issue here is that human description is subjective enough. Those systems are called “context-based image retrieval (CBIR)” [1].

In this paper, we are focusing on a need of Multimedia IR systems that provide a possibility to search in the photo album using the tools and approaches that are accessible for a usual end point user, and not the enterprise. They are hereinafter referred to as “Private Multimedia IR systems” in this document.

1. Definition of the user needs in Multimedia IR systems

This chapter provides a review of the areas of potential intended usage and implementation of Multimedia IR systems (that search through the non-textual information) in different fields. In corporate segment, the target audience might be:

- people of different professions who need access to images, like medical professionals searching for medical images or architects requiring the image examples to create the buildings;
- video content engineers, when looking for special video segments and movies by their titles;
- journalists who work with camera to create multimedia news content;
- photographers that provide their services to companies;
- car engineers who need photographs and sound of car engines.

Ordinary people also might be interested in such kind of engines. For example, let us calculate the size of a photo album for an average family. Here we assume that an average family consists of 3 persons. Also, let us assume a family owns 2 devices with a camera. On average, one person with a photo device can take 5 photos per day, and thus, the entire family takes 10 photos per day (sometimes it might be 0, but sometimes it might be hundreds). It means that one family can take more than 3 thousand photos annually, and in 10 years – more than 30 thousand of photos. And, if such a family does not have a good tool to search through the 30 thousand of photos of their photo album, the process of finding of target photos might be very difficult.

From an average user's point of view, there are the following requirements to be met by the Multimedia IR system:

- it should provide a container to keep different types of multimedia;
- it should be possible to represent any kind of multimedia information (photo, video, and audio);
- it should provide a simple way to edit the multimedia data;
- it should be possible to search through the content quickly and easily;
- it should allow filtering of information by several sets of criteria;

- relevance feedback shall be implemented;
- it should include indexing and cataloguing functions;
- it should be possible to find information by example of image;
- it should include a function of browsing through the search results.

It is clear enough how to keep and represent the multimedia information. However, the question is what kind of search requests are possible in this case.

There are many different technical photo properties/attributes, such as Aperture, Camera make, Camera model, etc. (see the figure below). All of them could be used in the search.

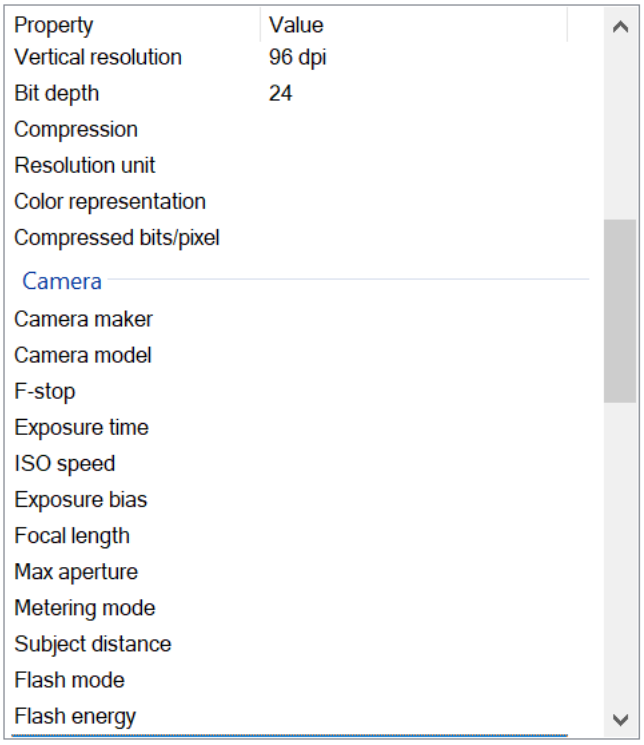

Figure 5. Photo file properties/attributes

In this paper we are focusing only on those properties/attributes that might be used in search by ordinary people. They might be:

- Data and time when the photo is taken (e.g.: 2020/04/20 21:22:21);
- The people in it (e.g.: my father, friend);
- The place where it is taken (for instance, longitude + latitude or “my parents’ home”);
- Objects in it (forests, pets, cars);

- Events description (my father’s birthday, a trip to London);
- Commentary (any text comments);
- Rating or marks (from 0 to 10);
- A combination of color, texture (a lot of blue (like the sky));
- Emotions attached to an event (smiles, etc.)
- Similar photos.

Let us provide the examples of requests based on photo properties/attributes that people might make when searching for certain photos:

- My photos from April 2020;
- All photos when I am at home;
- My father’s anniversaries;
- Photos when I was in Italy;
- Photos where I am in the forest;
- All my cat/dog photos;
- Photos with my grandmother from 2000 till 2010 at home;
- Photos made by my brother.

2. Overview and comparison of the private Multimedia IR systems

This chapter provides an overview and comparison of several private Multimedia IR systems.

There are photo organizers that provide the functions similar to private Multimedia IR systems. Therefore, they are chosen as a subject for the overview and comparison. They currently perform the search in photo set by organizing the photos based on their date, location, categories, etc. They suggest to create a folder structure and put the files on it. The folder name can be something like Date_Shoot-Type_Event Name. It can also include a location or any other information the user wants. In such a way the user can create subfolders based on the number of photographers or cameras. The idea is to avoid photos having the same file name in the folder [8]. This [8] provides the list of Photo Organizer for professional photographer and those organizers can be used by a usual user with a big photo album.

There are even relevant online courses available to guide the user how to organize the photos.

The multimedia IR systems are selected for the overview according to the following set of criteria.

One or several of them:

- should be online;
- should be offline;
- shall be free;
- shall be paid.

Table 1. Comparison of IR multimedia systems by features coverage

Feature description	Feature Priority	Mylio	Google Photo	Apple photo	Synology Moments	digiKam [12]
Keeping and presenting the Multimedia information	10	+	+	+	+	+

Editing the Multimedia information	8	+	-	+	+	+
Indexing and cataloguing	10	+	+	+	+	+
Browsing the filtered information	10	+	+	+	+	+
Search and filtering by date/time	9	+	+	+	+	+
Search and filtering by location	10	+	+	+	+	+
Search and filtering by people (using facial recognition)	8	+	+	+	+	+
Search and filtering by objects	2	-	-	-	+	-
Search and filtering by events	7	Tagging	Tagging	Tagging	Tagging	Tagging
Search and filtering by votes/marks/user feedback	5	+	+	+	+	+
Search and filtering by comments	3	+	+	+	+	+
Search and filtering by emotions	2	-	-	-	-	-
Search and filtering by similar photos	1	-	+	+	-	+
Search and filtering by a combination of color, texture	2	-	-	-	-	+
Search and filtering by a photo author	7	Tagging	Tagging	Tagging	Tagging	Tagging

The comparison table shows the following aspects:

- almost all systems are able to support storage, editing, indexing, browsing and cataloguing the multimedia data;

- all systems are able to search using location data and date/time metadata;
- all systems are able to define a person using face recognition technology;
- only several systems can recognize the objects on the photos;
- searching by event is possible only through tagging;
- search by feedback and by comments ability is provided by all systems;
- all the systems are unable to search by emotions;
- only some systems can make the search by a similar photo;
- only some systems perform the search by a combination of color or texture;
- the search by photo author is successful only by applying tagging.

The more detailed comparison of photo organizers is provided by Wikipedia and available here [9].

3. Identification and prioritization of the issues in IR multimedia systems

This chapter dwells upon the identification and prioritization of the issues found during the overview and compassing the current IR multimedia systems.

The identification and prioritization of the issues was performed based on private needs of the paper's author.

Table 2. Identified and prioritized issues in IR multimedia systems

	Description	Priority
	It is undefined how to link the identified faces (thousands) to the person entities that can be used in the search	5
	It is undefined how to link the person entity to heritage tree node	2
	It is undefined how to link a set of photos to the predefined type of event	7
	It is undefined what to do if metadata does not exist	9
	It is undefined how to integrate tagging approach with other systems	4
	Filtering by objects (dogs/cars/trees) is not widely implemented	3
	It is undefined how to link a photo to an author person entity	8

4. Addressing the issues in private IR multimedia systems

The following three issues with the highest priority are chosen to be addressed in this paper:

- It is undefined what to do if metadata does not exist;
- It is undefined how to link a photo to an author person entity;
- It is undefined how to link a set of photos to the predefined type of event.

The issues shall be addressed in the way mentioned above with a toolset available for a usual user and not for the enterprises.

Snippets of pseudo code or tool screenshots examples will be provided to explain the approach in addressing the issues.

The most automated approach possible should be provided. In case there is a need to perform any manual steps, it should be justified and described as well.

4.1. Addressing the issues with not existing metadata

Basing on the metadata inside of photo, the user might perform the search process by date/time and location criteria. So, if location data or date/time does not exist, the user is not able to search in the set of photos by location and date/time requests. Those requests are commonly and widely used, so it is very important to identify if that data does not exist inside the photo.

That metadata is usually kept inside of each file as a header with Exif format. There are several other formats of metadata like IPTC or XMP, but in this paper we are focusing mostly on Exif as the most common metadata header.

The first step is to identify if location or date/time data is not present. That might be done using the tools like Apache Tika or digiKam[12].

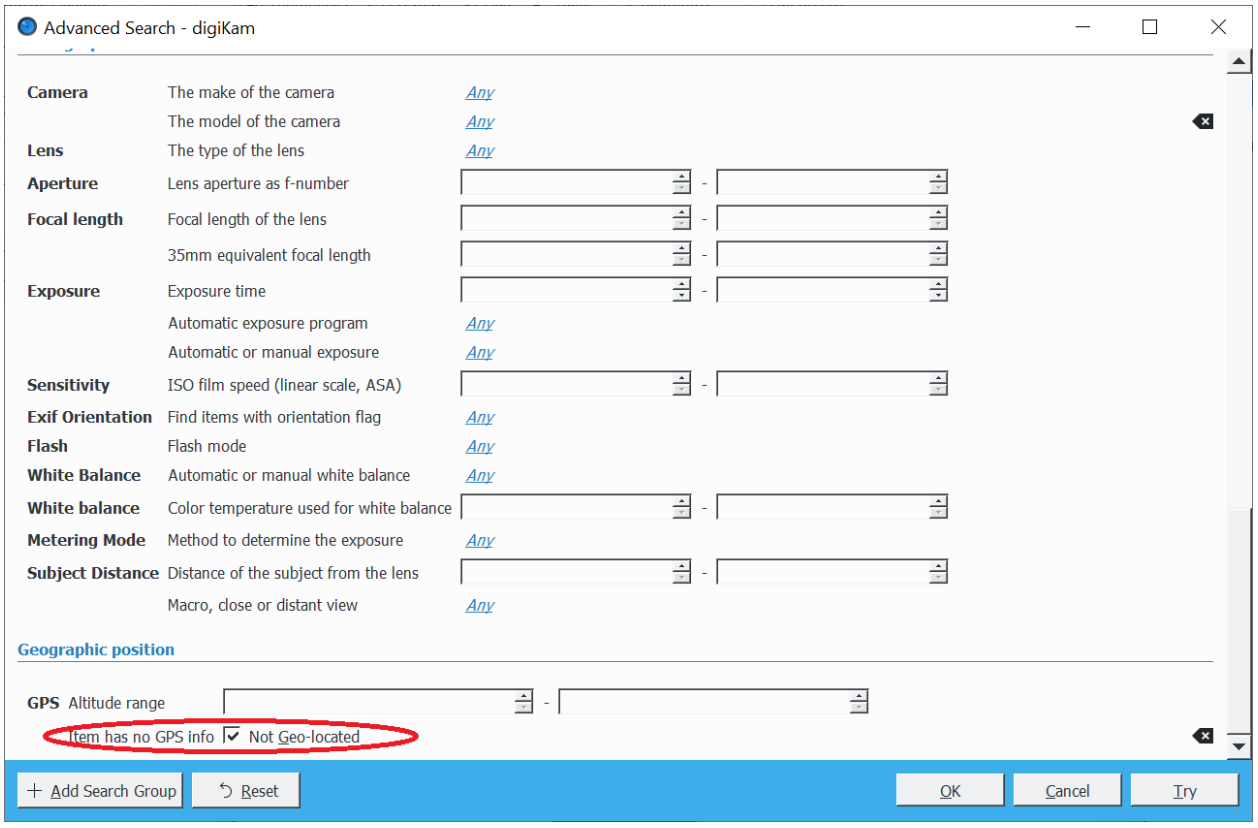

Figure 6. Screenshot of digiKam[12] advanced search screen configured to find the photos without GPS data

As soon as the photos without the GPS and time/date taken are identified, it is necessary to assign the correct metadata to the photos in a manual or automated way. Below is the description of the automated way to update GPS and time/date of the photos.

To update the time/date of the photos, the following approach might be used:

1. To define the approximate date (not time) when the set of photos was taken. For instance, on 2020.05.11.
2. To put all the photos with assumed date taken to folder with name "2020.05.11".
3. Use the following algorithm to update the Exif time/date taken:
    1. For all photos inside of that folder (in our case it is "2020.05.11")
    2. Do the following:
        a. put current photo file information into variable *info.*
        b. compare *info.lastModified()* with assumed date (encoded into the folder name).
        c. if *assumed_date + 1 day > info.lastModified() > assumed_date*
        Call command line with "jhead -dsft " + *info.fileName()*

If assumption about taken date/time was not correct – no photos will be updated and more attempts need to be performed.

As a result of this algorithm, all photos with modification date/time that is inside of the assumed date will get Exif time/date taken that corresponds to the "last modification time". To update Exif metadata we use "jhead" tool that is free to use. That algorithm assumes that the user performing such action is aware of the assumed date when the photo was taken. As soon as date/time taken is attached to the photos, it will be possible to search those photos by date/time criteria, because almost all multimedia search engines take into account the Exif date/time taken attribute.

The next issue is assigning Exif geo data in automatic way. First, it should be mentioned that there are some Internet tools that allow a user to reverse the images to get, for example, the person identification by the photo or to get the geo

position based on photo details. For example, they include https://serpapi.com/google-reverse-image, https://images.google.com/, https://mrisa.mage.me.uk/, etc. So, they look for the similarity in the photos and they return actually. Most likely the researcher will need to pay a fee to use such Internet engines.

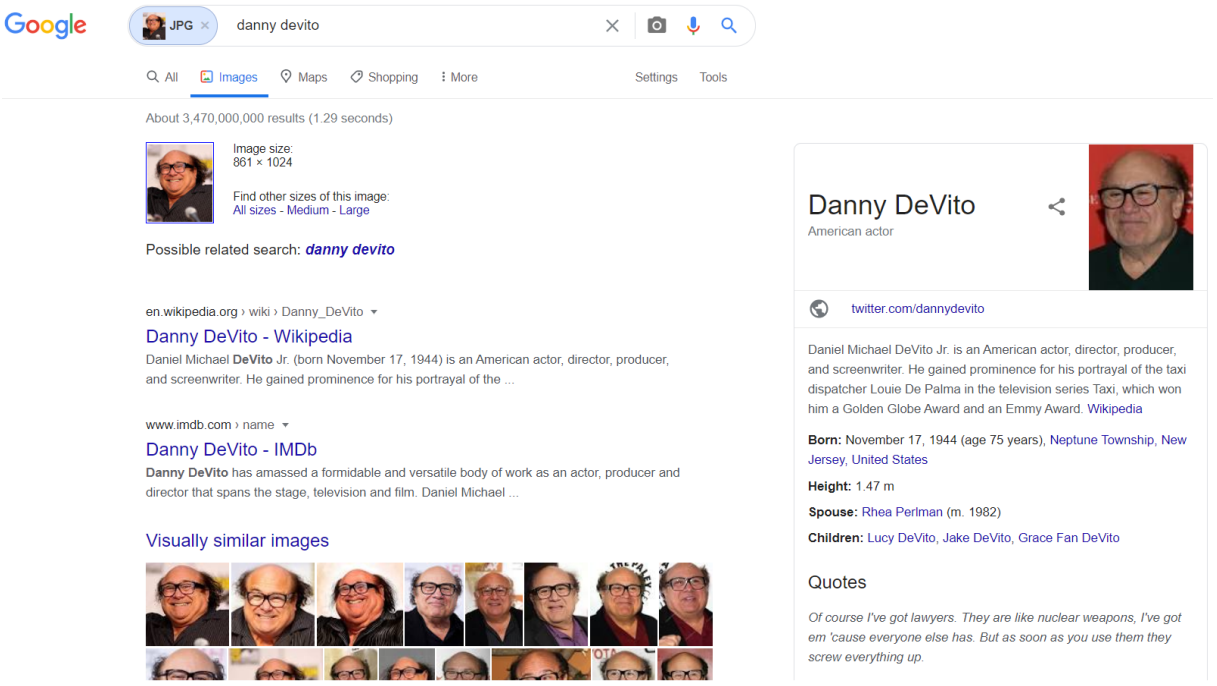

Figure 7. The example of search results by the photo of a famous actor

The local search engines can also provide the same functionality. However, due to much smaller base, they return less accurate results. Still, they will perform the task for the photos in famous and public places.

So, to assign GPS data the following algorithm might be applied for each for photos without GPS coordinates:

1. Decrease a size of photo according to the web requirements.
2. Upload the photo to any webserver and save the link to the photo.
3. Call the Internet Search Engine API to get results. *"curl"* tool might help in this and so the request to Search Engine API will look like – *"curl.exe -G -k https://images.google.com/searchbyimage?image_url=https%3A%2F%2Fi.imgur.com%2FHBrB8p1.png"*. As a result, it will return HTML or JSON with results that you need to parse in the next step.

4. Inside of parsers the algorithm has to parse HTML DOM to find special HTML-tag, class or id. To parse JSON it needs to find proper tag by its path.

5. As soon as GPS coordinates from HTML or JSON are obtained, the GPS data should be assigned to the photo file with the help of the already mentioned tool– *"exiftool"*. The command to assign the Exif geo data will look like *"exiftool photoToSetGPS.jpg -gpslatitude=40.25090 -gpslongitude=75.132658 -gpslatituderef=N -gpslongituderef=W"*.

For not well-recognized places like private homes, sea side or forest places (they look very similar), there is another approach to assign the GPS data that requires a bit of manual work:

1. Divide the photos into separate folders by grouping them by the same GPS position.

2. Define the exact geo position using the map service like Google Maps or OpenStreet maps for each photo set inside one folder.

3. For each photo file inside the folder with the same geo position, call the "exiftool" command to set GPS data defined earlier like in step 5 of the previous algorithm.

As a result of these algorithm jobs, all photos will get Exif GPS data. Both the algorithms assume that the user performing such action is aware of the assumed place where the photo was taken. As soon as GPS data is attached to the photos, it will be possible to search those photos by position criteria, because almost all multimedia search engines take into account the Exif GPS attributes.

4.2. Linking the photo to the author

Usually, during the search in the photo album it is important to find the set of the photos taken by a certain person.

It is assumed that there is a predefined set of authors – persons' list in a form of tag set, and each item of the list should be assigned to each photo. For example, "author\dmytro_nikulin; author\vasia_nikulin; author\petia_nikulin".

It is also assumed that each photo file has Exif "Camera Make" and "Camera Model" attributes assigned.

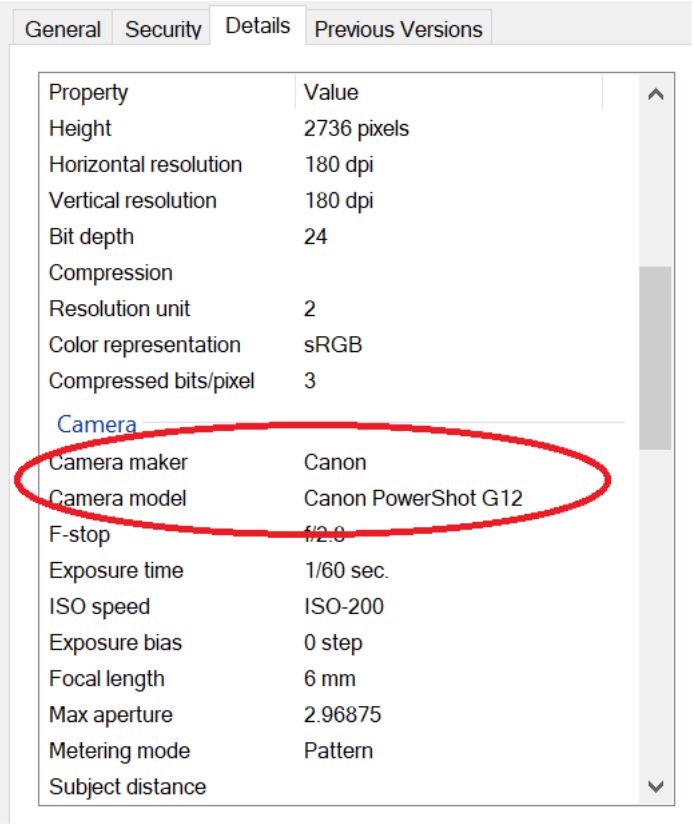

Figure 8. The example of the photo file with assigned "Camera Maker" and "Camera Model" attributes

The string representation of concatenation of "Camera Maker" and "Camera Model" can be a key to link the photo to the author. The following dictionary shall be created to support the linkage:

"Camera Maker" + "Camera Model" to "author\author_name".

For example:

“CanonCanonS3” - “author\dmytro_nikulin”;

“NokiaNokia6260i” – “author\vasia_nikulin”;

“samsungSM-G965F” – “author\petia_nikulin”.

Having that dictionary, the following algorithm can be used to assign the photo to the author:

1. Get the photo file;
2. Extract the “Camera Maker” and “Camera Model“ attributes;
3. Put the extracted attributes to one string variable *CameraMaker&Model;*
4. Try to search in the dictionary *“Camera Maker” + “Camera Model” to “author\author_name”* by *CameraMaker&Model* as a dictionary key*;*
5. If the search is successful – assign current photo file tag to *“author\author_name”*.
6. If the search is not successful –

   6.1. log the error/warning message with photo file name, or

   6.2. show the dialog to user to make it possible to create a new item in the dictionary *“Camera Maker” + “Camera Model” to “author\author_name”*.

It might happen that *“Camera Maker” + “Camera Model”* key is not unique because of different people having the same device model. For example, the dictionary will be as follows:

“samsungSM-G965F” – “author\vasia_nikulin”;

“samsungSM-G965F” – “author\petia_nikulin”.

In such cases user might be prompted to select the correct person from the list or a log message might be created to be analyzed after processing.

As a result of that algorithm, all photos will get author tags assigned. The algorithm assumes a user to be involved in the preparation of the *“Camera Maker” + “Camera Model“ to “author\author_name*” dictionary and selection of proper photo author if the algorithm is unable to do it in automatic way. As soon as the author tags are attached to the photos, it will be able to search those photos by author.

4.3. Linking the set of photos to an event

The current private IR multimedia systems can perform the search in photo album by the event if appropriate tags are assigned to the photos. For example, a photo file can be assigned the tag such as “event/somebody’s anniversary”. In this case IR multimedia system can find this photo by user search request: all photos with “event/somebody’s anniversary”.

First of all, there should be a well-defined tags structure. There are several Internet sources [10], [11] that describe the rules of creating a smart and flexible tags structure.

The following tag structure can be used as a reference one:

Event/
- With relatives/
  - Birthday/
  - Wedding/
  - NewYear&Christmas/
- With colleagues/
  - Organization1/
    - Birthday/
    - Wedding/
    - NewYear&Christmas/
  - Organization1/
- With friends/
  - Birthday/
  - Wedding/
  - NewYear&Christmas/

As soon as the tag event structure is defined, the following algorithm to assign event to photos might be executed:

1. Divide the photos in separate folders by grouping by the same event.

2. For each photo file inside the folder with same event, assign the appropriate tag for file – for example, using the digiKam [12] tool.

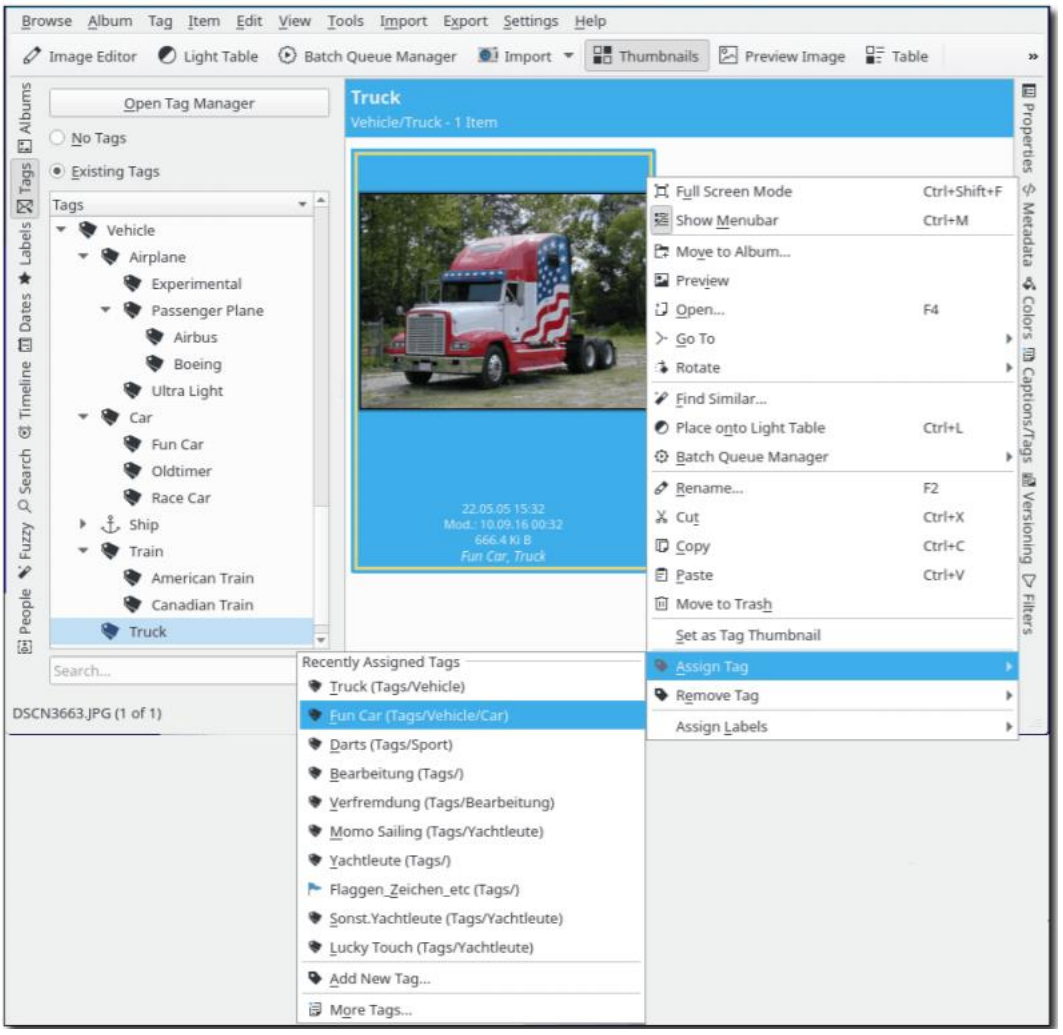

Figure 9. Assigning the tag for a photo file with the digiKam tool

As a result of this algorithm, all photos will get the event tag assigned. This algorithm assumes that the user is involved in the preparation of the folder structure with splitting the folders by common event and assigning a predefined event tag to the set of photos. As soon as the event tags are assigned to the photos, it will be possible to search those photos by event.

Conclusion

This paper focuses on describing several IR Multimedia Systems and provides their comparison in terms of functionality. Moreover, it provides the definition of the user needs, identifies and prioritizes the issues in private IR multimedia systems to be addressed. The following issues have been addressed as the most important from the end-point user's perspective:

- Not existing metadata;
- Linking a photo to an author person entity;
- Linking the set of photos to the predefined type of event.

For each issue we have provided the approaches, algorithms and relevant tools to use. We have also described human involvement into the process, if a totally automated process is not possible.

Glossary

Table 3. Terms and definitions used

Term	Definition
Apple Photo	is a photo management and editing application developed by Apple.
Aperture	is a hole or an opening through which light travels. More specifically, the aperture and focal length of an optical system determine the cone angle of a bundle of rays that come to a focus in the image plane.
Apache Tika	is a toolkit for extracting content and metadata from various types of documents, such as Word, Excel, and PDF or even multimedia files like JPEG and MP4. All text-based and multimedia files can be parsed using a common interface, making Tika a powerful and versatile library for content analysis.
Camera maker	is a brand name of device manufacturer.
Camera model	is unique (shall be unique) name of device model inside of one device manufacturer.
CBIR	Content-based image retrieval, also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR), is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases (see this survey for a recent scientific overview of the CBIR field).
curl	A command line tool and library for transferring data with URL syntax, supporting HTTP, HTTPS, FTP, FTPS.
digiKam	digiKam is an advanced open-source digital photo management application that runs on Linux, Windows, and MacOS. The application provides a comprehensive set of tools for importing, managing, editing, and sharing photos and raw files.
Dictionary	A dictionary is a general-purpose data structure for storing a group of objects. A dictionary has a set of keys and each key has a single associated value. When presented with a key, the dictionary will return the associated value.
DOM	The Document Object Model (DOM) is a cross-platform and language-independent interface that treats an XML or HTML document as a tree structure wherein each node is an object representing a part of the document.
Exif	Exchangeable image file format (officially Exif, according to JEIDA/JEITA/CIPA specifications) is a standard that specifies the formats for images, sound, and ancillary tags used by digital cameras (including smartphones), scanners and other systems handling image and sound files recorded by digital cameras.
exiftool	ExifTool is a free and open-source software program for reading, writing, and manipulating image, audio, video, and PDF metadata

Facial recognition	A facial recognition system is a technology capable of identifying or verifying a person from a digital image or a video frame from a video source.
Google	Google LLC is an American multinational technology company that specializes in Internet-related services and products, which include online advertising technologies, a search engine, cloud computing, software, and hardware.
Google Maps	Google Maps is a web mapping service developed by Google. It offers satellite imagery, aerial photography, street maps, 360° interactive panoramic views of streets (Street View), real-time traffic conditions, and route planning for traveling by foot, car, bicycle and air (in beta), or public transportation.
Google Photo	Google Photos is a photo sharing and storage service developed by Google. The service automatically analyzes photos, identifying various visual features and subjects. Users can search for anything in photos, with the service returning results from three major categories: People, Places, and Things.
GPS	The Global Positioning System (GPS), originally NAVSTAR GPS, is a satellite-based radio navigation system owned by the United States government and operated by the United States Space Force.
HTML	Hypertext Markup Language (HTML) is the standard markup language for documents designed to be displayed in a web browser.
IR Multimedia Systems	multimedia information retrieval means the process of searching for and finding multimedia documents; the corresponding research field is concerned with building multimedia search engines.
images.google.com	Google Images is a search service owned by Google that allows users to search the World Wide Web for image content.
IPTC	The International Press Telecommunications Council (IPTC), based in London, United Kingdom, is a consortium of the world's major news agencies, other news providers and news industry vendors and acts as the global standards body of the news media.
JSON	JSON (JavaScript Object Notation) is a lightweight data-interchange format.
jhead	Tool to work with metadata of Exif jpeg files.
multimedia data	Multimedia in principle means data of more than one medium. It usually refers to data representing multiple types of medium to capture information and experiences related to objects and events. Commonly used forms of data are numbers, alphanumeric, text, images, audio, and video. In common usage, people refer a data set as multimedia only when time-dependent data such as audio and video are involved.
Multimedia IR	Multimedia Information Retrieval (MIR) is an organic system made up of Text Retrieval (TR); Visual Retrieval (VR); Video Retrieval (VDR); and Audio Retrieval (AR) systems. So that each type of digital document may be analyzed and searched by the elements of language appropriate to its nature, search criteria must be extended.
metadata	Metadata is "data that provides information about other data". In other

	words, it is "data about data." Many distinct types of metadata exist, including descriptive metadata, structural metadata, administrative metadata, reference metadata and statistical metadata.
Mylio	Mylio has a suite of tools to help you locate and consolidate your images across a variety of locations, including external hard drives, online services.
mrisa.mage	MRISA (Meta Reverse Image Search API) is a RESTful API which takes an image URL, does a reverse Google image search, and returns a JSON array with the search results.
OpenStreet maps	OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. The geodata underlying the map is considered the primary output of the project.
Private Multimedia IR systems	Multimedia IR systems for not corporate users.
serpapi.com	API to get search engine results with ease.
Synology Moments	It gathers all your photos and videos in one private place and organize them in an entirely new way. Synology Moments is the brand-new photo solution for personal and home use, offering a modern browsing experience with the image recognition technique.
Tagging	In information systems, a tag is a keyword or term assigned to a piece of information (such as an Internet bookmark, digital image, database record, or computer file). This kind of metadata helps describe an item and allows it to be found again by browsing or searching.
XMP	The Extensible Metadata Platform (XMP) is an ISO standard, originally created by Adobe Systems Inc., for the creation, processing and interchange of standardized and custom metadata for digital documents and data sets.

References

1. CHAPTER 8 Multimedia Information Retrieval - e-PG Pathshala. – 2020. – [Web] – Online access: http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/library_and_information_science/information_storage_and_retrieval/09._multimedia_information_retrieval/et/4292_et_8.pdf
2. Unified concept-based multimedia information retrieval technique/[Kambau, Ridwan, Hasibuan, Zainal], 10.1109/EECSI.2017.8239086 – 2012. – Book
3. How Many Photos Will Be Taken in 2020? - INSPIRATION/TECH TODAY. - January 10, 2020. – [Web] – Online access: https://focus.mylio.com/tech-today/how-many-photos-will-be-taken-in-2020
4. Content Based Multimedia Information Retrieval To Support Digital Libraries/[Mohammad Nabil Almunawar], - 2012.07.18 – Magazine
5. Multimedia Retrieval/[Jimmy Lin , University of Maryland, Dr. Ramesh R. Sarukkai, Yahoo! Search] – [Slides] - Online access: http://www.ccs.neu.edu/home/jaa/CSG339.06F/Lectures/multimedia.pdf
6. Multimedia Information Retrieval/[Stefan Rüger, The Open University], - 2009. – [Book] - Online access: https://www.morganclaypool.com/doi/abs/10.2200/S00244ED1V01Y200912ICR010
7. Content Analysis with Apache Tika [Nguyen Nam Thai]. - August 14, 2019. - [Web] – Online access: https://www.baeldung.com/apache-tika
8. Top 25 Photo Organizing Software and Apps of 2020[Boaz Eapen]. - Nov 06, 2019. - [Web] – Online access: https://www.pixpa.com/blog/photo-organiser
9. Image organizer. – [Web] – Online access: https://en.wikipedia.org/wiki/Image_organizer

10. Tag your media [Adobe]. – [Web] – Online access: https://helpx.adobe.com/elements-organizer/using/tag-media.html
11. Tagging Photos[digital-photo-secrets]. - [Web] – Online access: https://www.digital-photo-secrets.com/tip/63/tagging-photos/
12. The digiKam Handbook [The digiKam developers team]. - [Web] – Online access: https://docs.kde.org/trunk5/en/extragear-graphics/digikam/index.html