

Multimedia and New Services

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EIC0064

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couse slides and content adapted from
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Multimedia Field of Study

- originally seen as a vertical application area, i.e., a niche application with methods that belong only to itself.
- multimedia is now essentially a **horizontal application area** and forms an important component of the study of:
 - algorithms
 - computer graphics
 - computer networks
 - image processing
 - computer vision
 - databases
 - real-time systems
 - operating systems
 - information retrieval, and so on.



<https://about.netflix.com/>
<https://netflixtechblog.com>

Multimedia Field of Study

- even if still considered as secondary, **multimedia** is becoming an important field of study within the electrical and computing engineering domain.
- technically speaking, what exactly is about the multimedia field of study?

understanding **human perception of audiovisual signals** + the **nature and physical characteristics** of real-world media signals

combined with

knowledge on **media processing and encoding approaches**

methods for managing **trade-offs** between competing resources

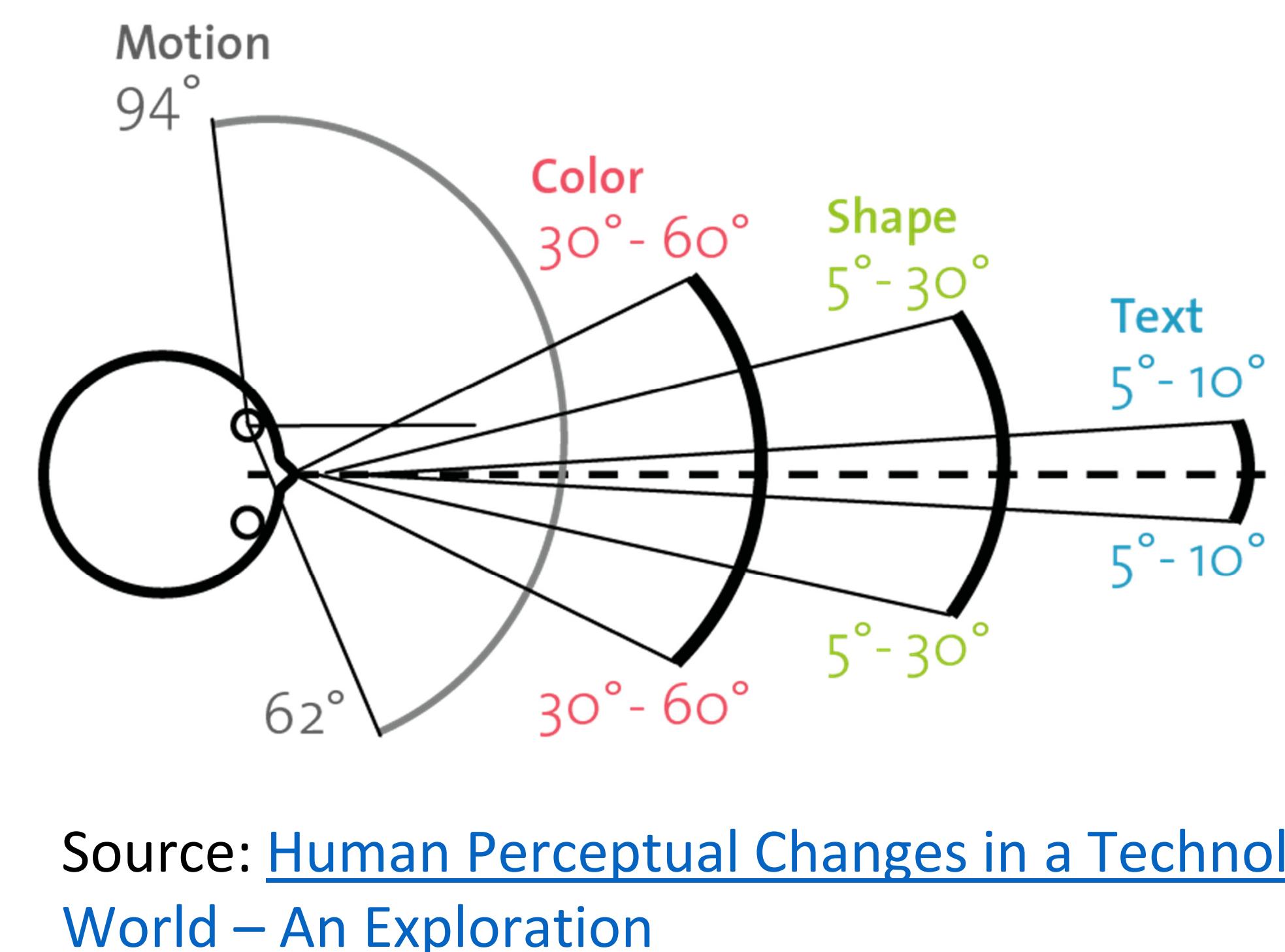
techniques for **evaluating the efficiency of alternatives**

to deliver

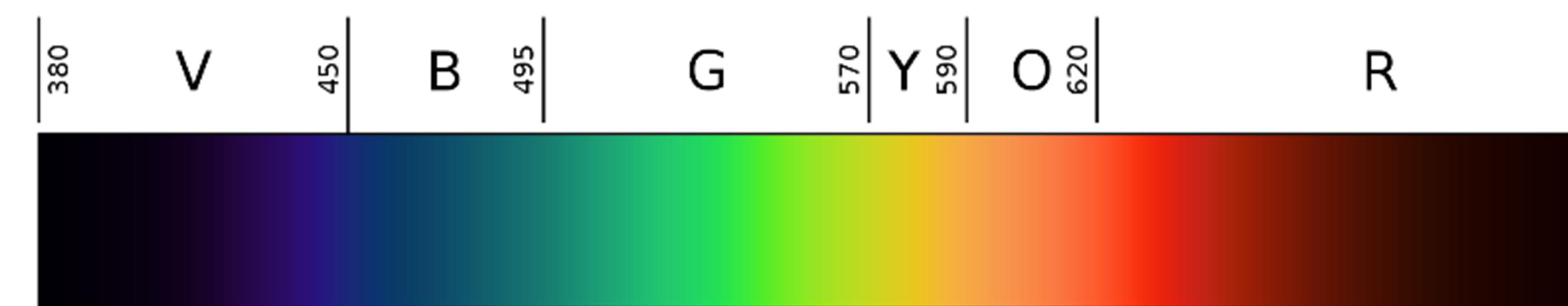
practical solutions for the problem of optimising the use of resources which can be integrated in **real-world multimedia applications and services**

Multimedia Field of Study

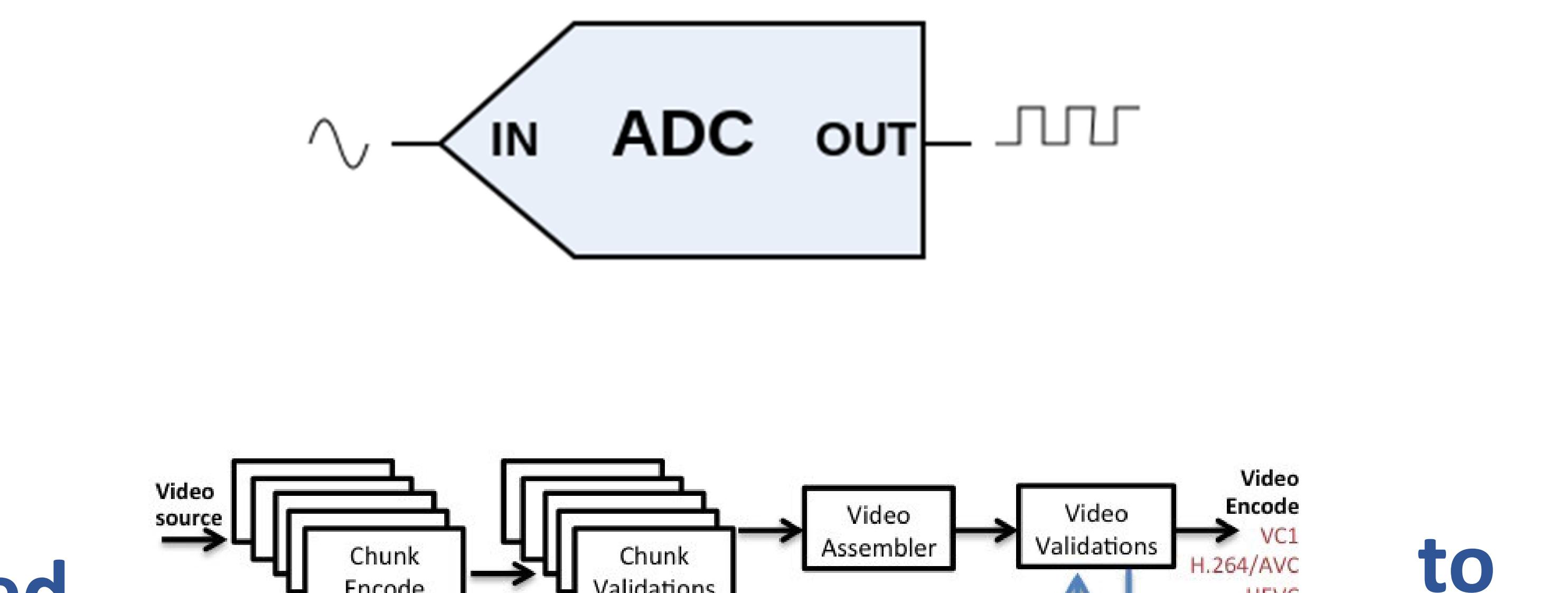
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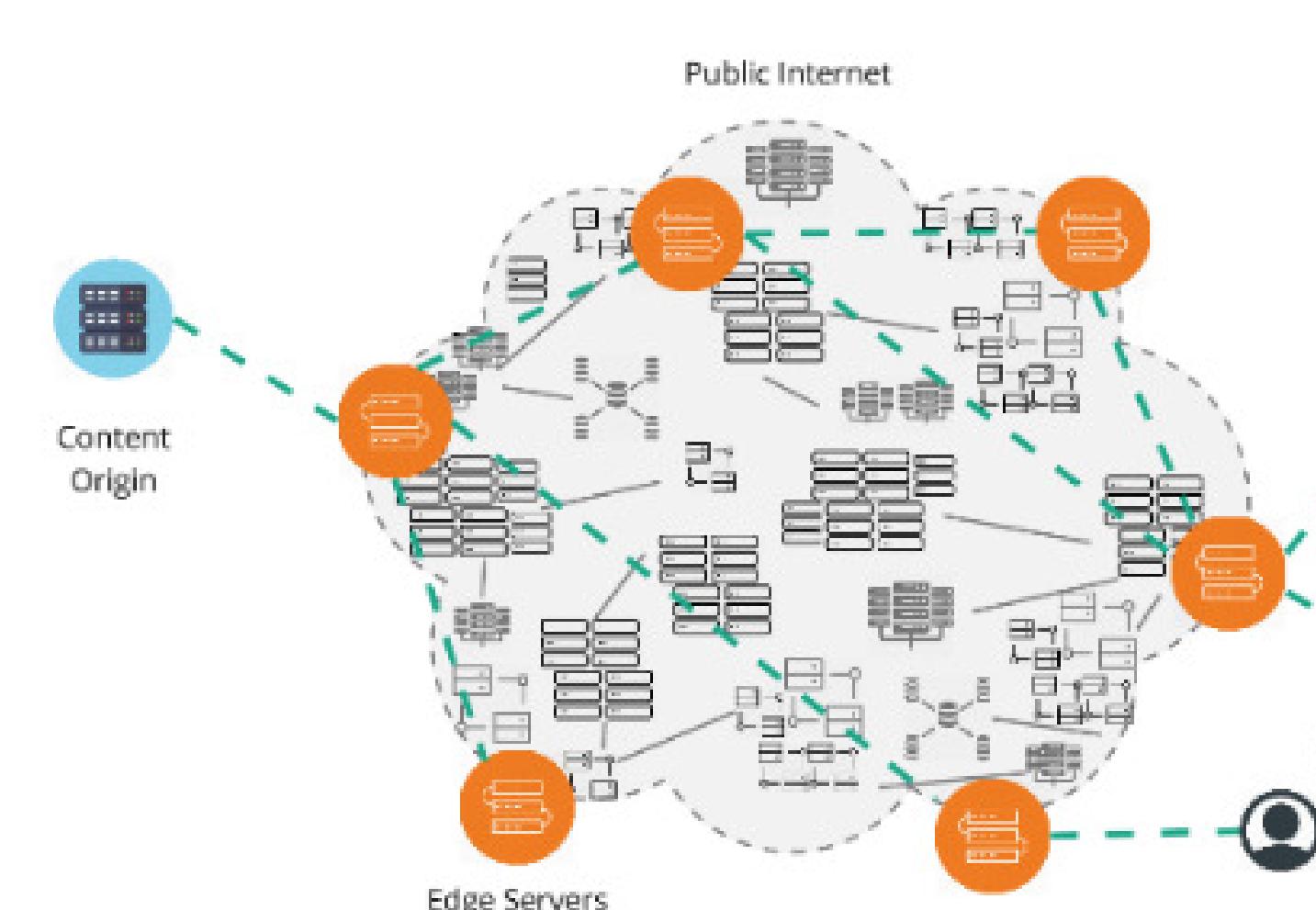
combined
with



Source: [sRGB rendering of the spectrum of visible light](#)



to
deliver



Objective Quality Measurements

- Signal-to-Noise Ratio, ...
- Human Visual Perception, ...

Multimedia and New Services Course

- Title:
 - Multimedia and New Services
- Description:
 - falls under the Multimedia technological field of study and therefore its goals and outcomes can be seen as a subset of the objectives and aspects addressed in this field of study

“A course in Multimedia is rapidly becoming a necessity in Computer Science and Engineering curricula [...]” (Li, 2014)

Multimedia and New Services Course

- Major goals:
 - to provide an **overall technological perspective** of the multimedia field of study
 - to address the major aspects of **generation, processing, encoding, distribution and perception** of multimedia signals
 - to provide the students specific knowledge and skills to **process and encode audio-visual signals**
 - to create knowledge and competences to **design, implement and manage multimedia applications and services** according to different requirements and purposes and under distinct resources availability

Multimedia and New Services Course

- Major competences:
 - ability to **distinguish/classify** real-world visual and auditive signals based on their **physical characteristics**
 - ability to describe the operation, the components and their role and the limitations of the **Human Audio Visual System**
 - enumerate and explain the different types of **redundancy** and **irrelevancy data** associated to media signals
 - identify and characterise currently used **media compression tools and standards**
 - **plan and design** multimedia applications

Multimedia and New Services Course

- Major learning outcomes:
 - describe the fundamental concepts of multimedia systems
 - identify the most relevant physical characteristics of real-world media signals and distinguish signals based on those characteristics
 - understand the nature of the Human Audio Visual System, how vision and hearing occur and the importance of such processes for the definition of representation and compression models of media signals
 - understand practical implementation of commonly used media processing and compression techniques and their role within a multimedia application
 - explain how and why compression algorithms make use of the HAVS limitations and of media signal physical characteristics
 - compare different lossless and lossy media compression techniques
 - identify the different currently used standards for efficient media compression
 - identify requirements of multimedia applications and design corresponding systems

Multimedia and New Services Course

- Syllabus
 - Introduction
 - What is “multimedia information”?; ...
 - On the generation and perception of media signals
 - Characterisation of media signals in the real-world and their digital representation; the Human AudioVisual System; ...
 - Fundaments of media processing
 - filters
 - Audio encoding
 - compression principles, standards and proprietary encoders; evaluation of quality and performance
 - Image and video encoding
 - compression principles, existing tools and standards; evaluation of quality and performance
 - Advanced visual formats
 - 3D and multi-view formats and compression standards; scalability; ultra high definition.
 - Networked multimedia applications
 - challenges and emergent solutions for networked multimedia applications; Quality of Experience and Quality of Service

Teaching methodologies

- **Lectures:**
 - exposing knowledge and examples
 - visualisation of short videos during lectures
 - work group, raising questions, discussing and replying to quizzes
- **Practice:**
 - TP: Work group for experimenting media processing algorithms (Matlab)
 - P: Work group for specifying and developing a multimedia application (Final Project)
- **Grading (C):**
 - assessment activities (TP) + Multimedia Application (P): $C = 0,35TP + 0,65P$
- **Work groups:**
 - 2 elements

Assessment activities

- Example of an assessment activity:

Assignment Name: Image Quantisation

Due Date: May 25th, 2021.

Submission: Submit in Moodle your report file in PDF and all the Matlab files with the code you have developed as a single compressed archive.

Purpose: To enable students to better understand the quantisation process and its role in image compression; to evaluate its effects and the relevant techniques used in the MPEG compression algorithms; to evaluate alternative approaches, namely, vector quantisation.

Why is it important? Because quantisation is one of the most influential aspects of the efficiency of the digitisation and compression processes applied to media and, nowadays, all multimedia applications rely on media compression

Assessment activities

- Access to MATLAB:
 - Matlab is available in the application server apps.fe.up.pt
 - Accessible in campus
 - Accessible outside the campus via VPN: colab.up.pt
- Matlab Resources:
 - A Beginner's Guide to MATLAB ([link](#))
 - MATLAB Resources at MIT ([link](#))
 - Mathworks: Learn to code with MATLAB ([link](#))
 - Mathworks: Examples ([link](#))
 - Tutorialspoint: MATLAB – Overview ([link](#))

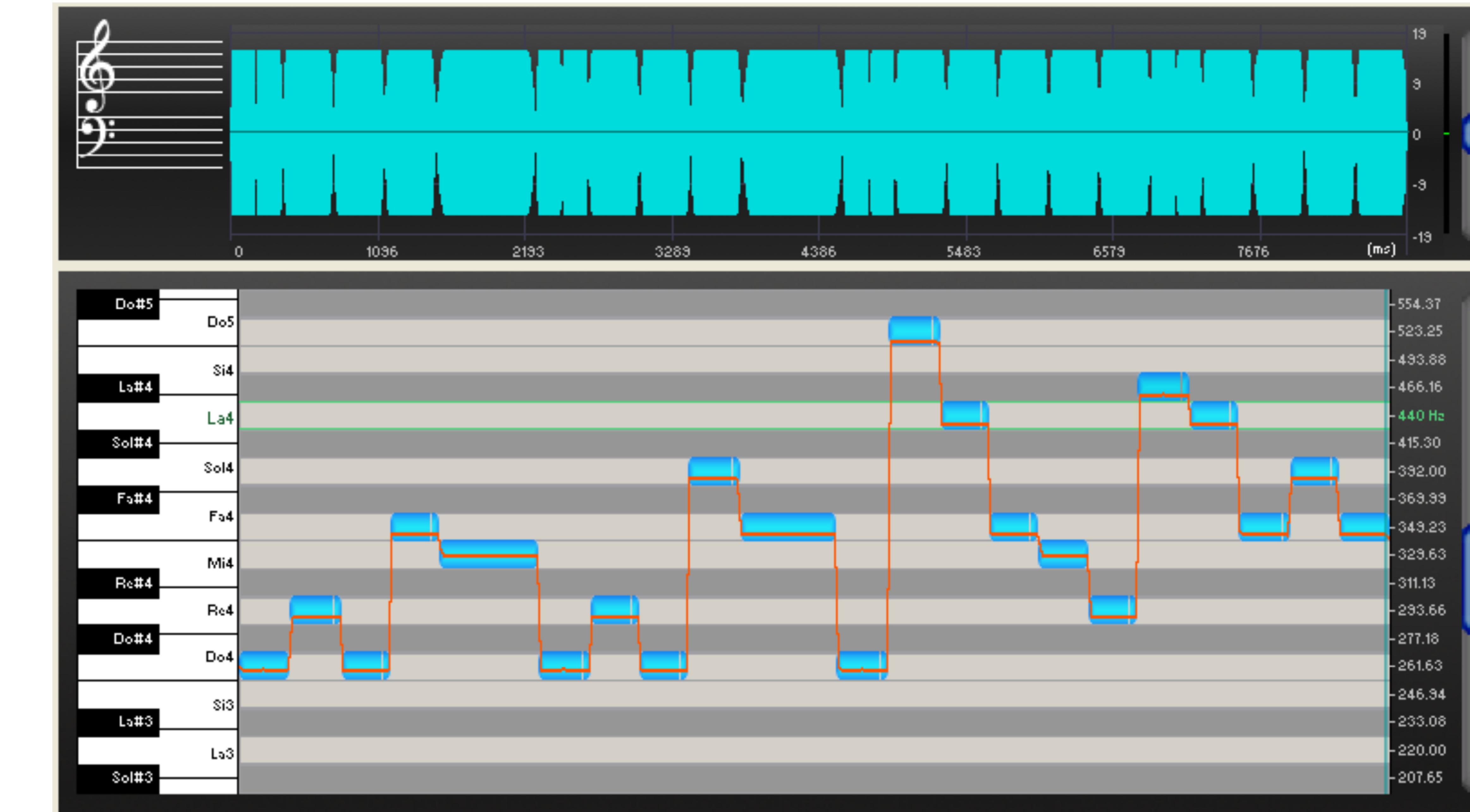
Assessment activities

- Signal Quantization:



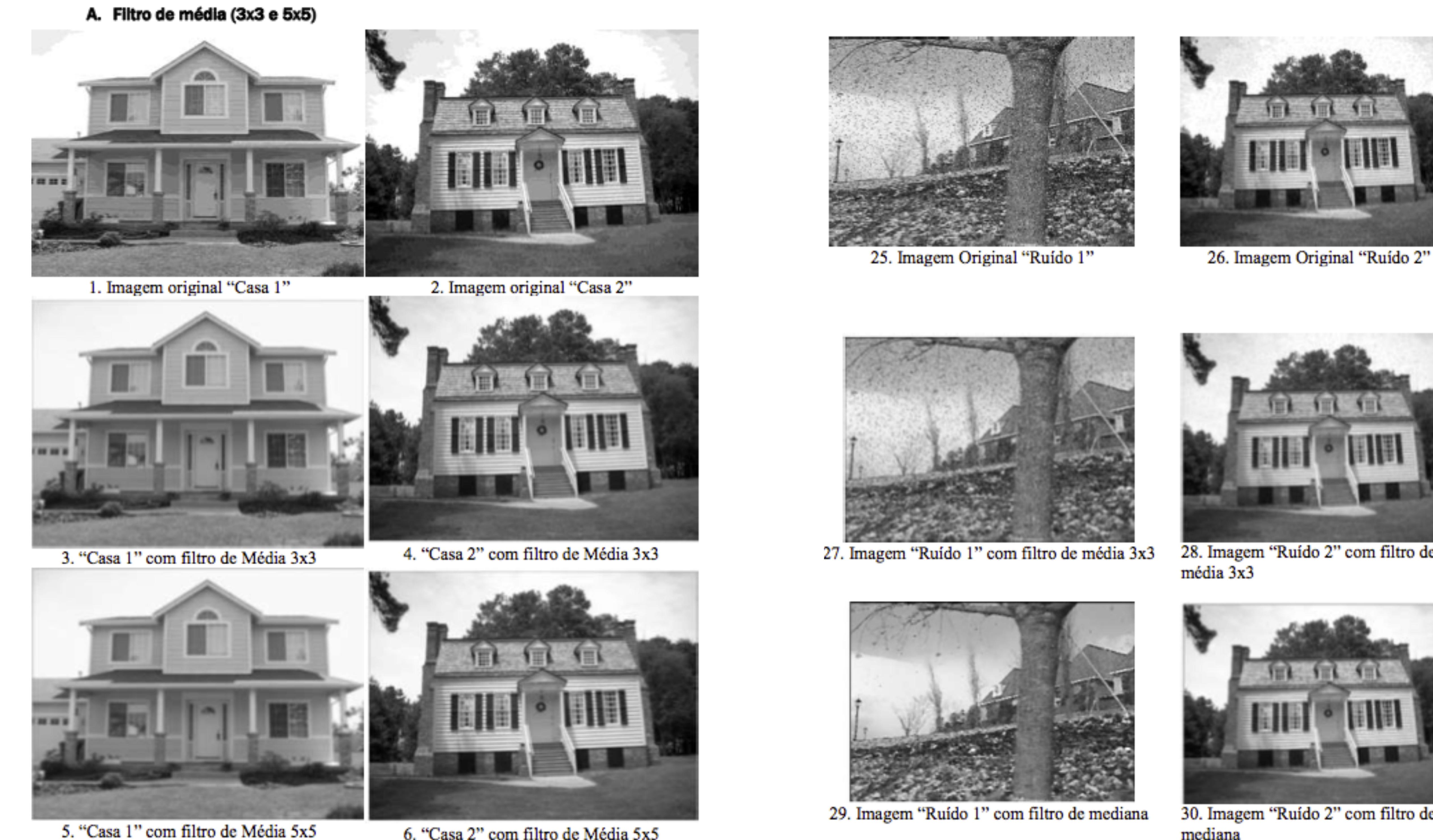
Assessment activities

- Music Synthesis:



Assessment activities

- Image processing:
 - Filters and Noise reduction:

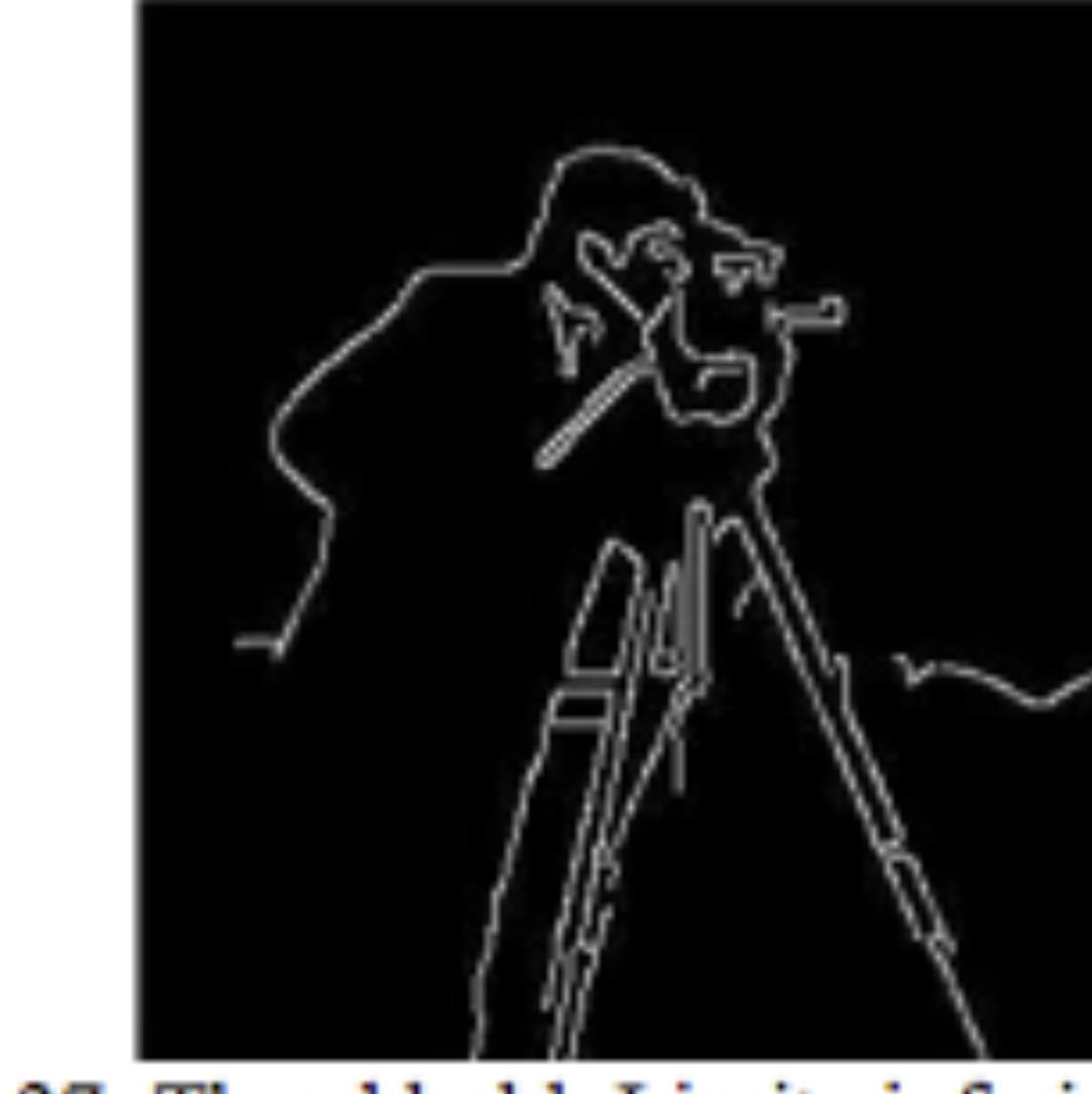


Assessment activities

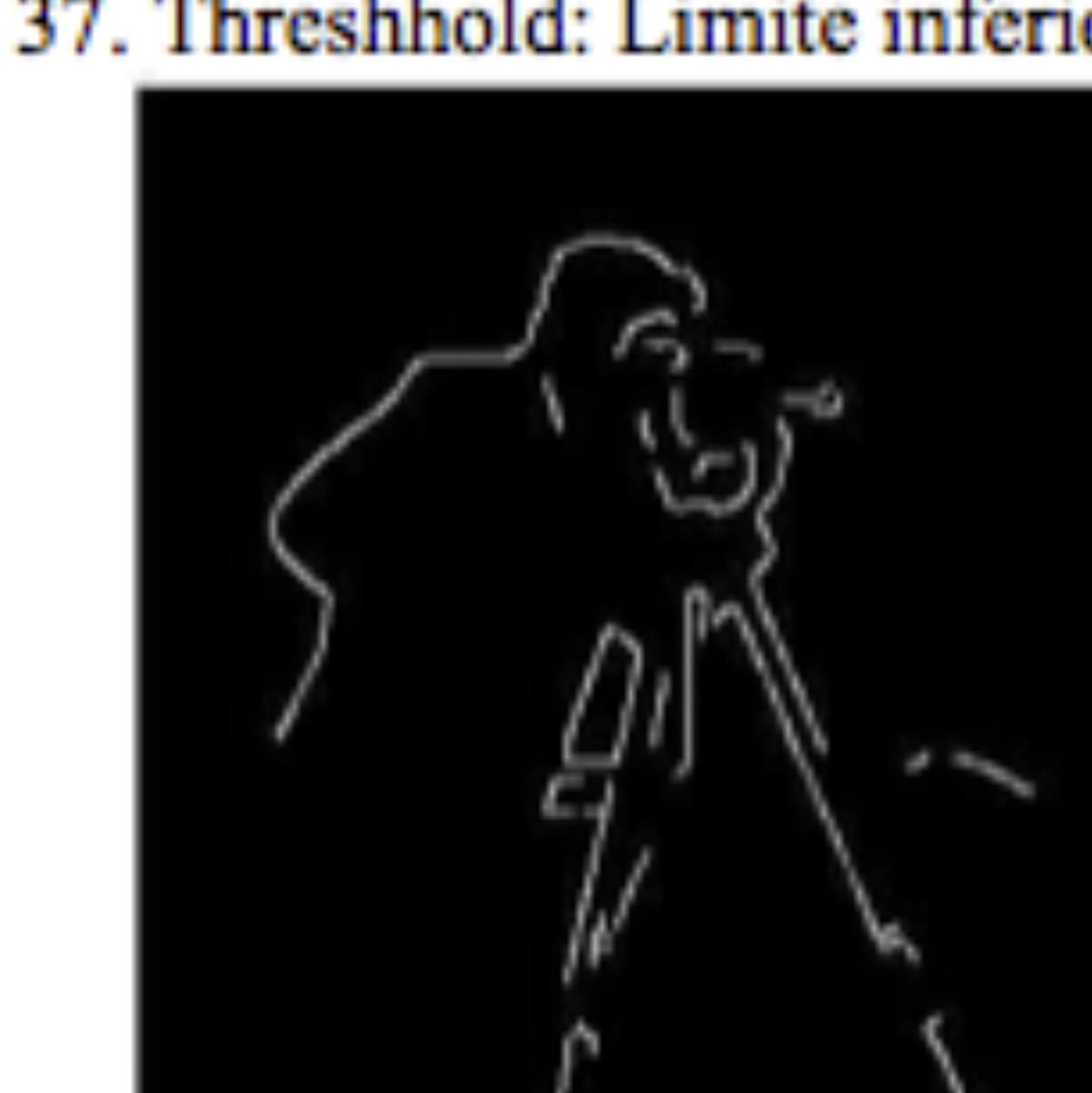
- Image processing:
 - Edge Detection:



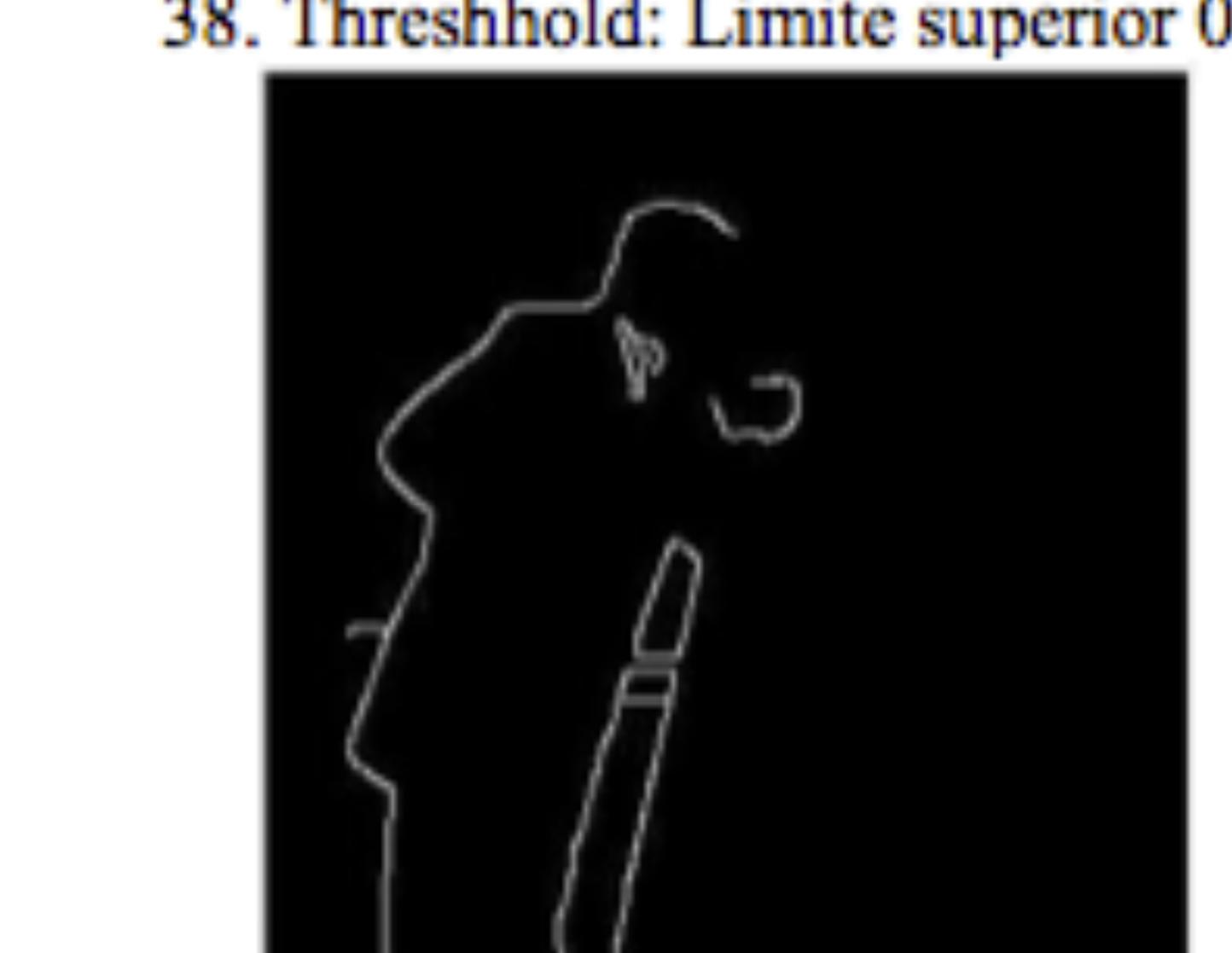
35. Threshold: Limite inferior=0,1



36. Threshold: Limite superior 0,5



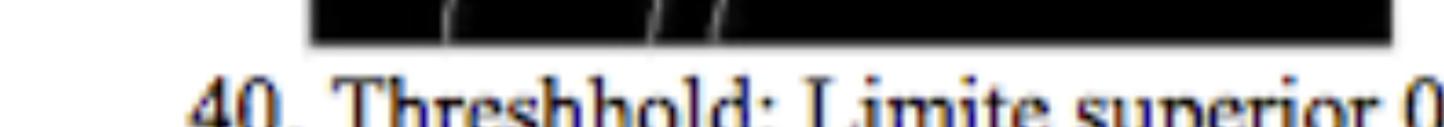
37. Threshold: Limite inferior=0,3



38. Threshold: Limite superior 0,7



39 Threshold: Limite inferior=0,5



40. Threshold: Limite superior 0,9

Assessment activities

- Image processing:
 - Image Segmentation:



1. Imagem original "Aviao"



2. Imagem original "Zebras"



3. "Aviao" segmentado com Threshold obtido por método de Otsu



5. "Aviao" segmentado com Threshold de 20 em 255



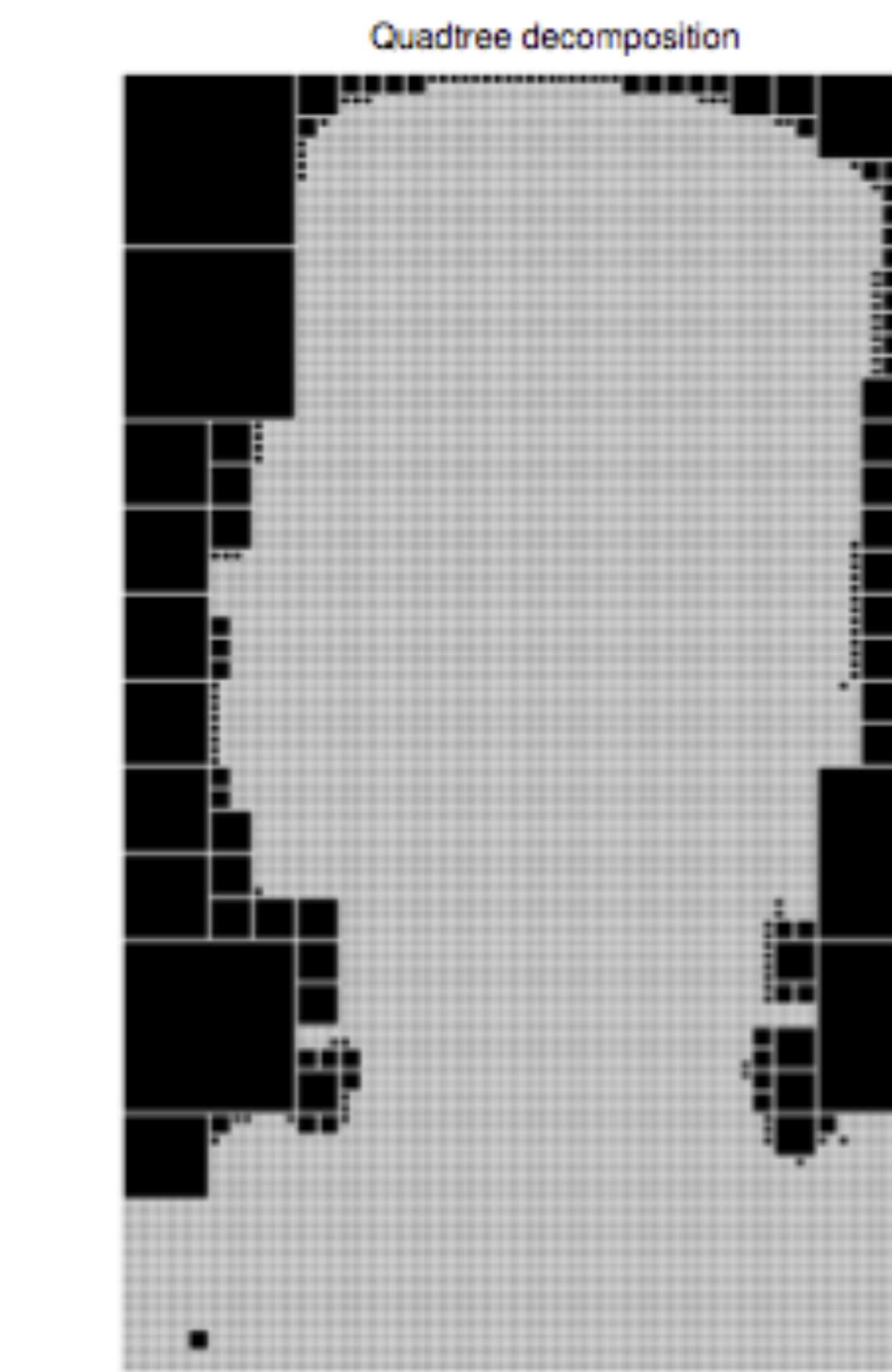
4. "Zebras" segmentado com Threshold obtido por método de Otsu



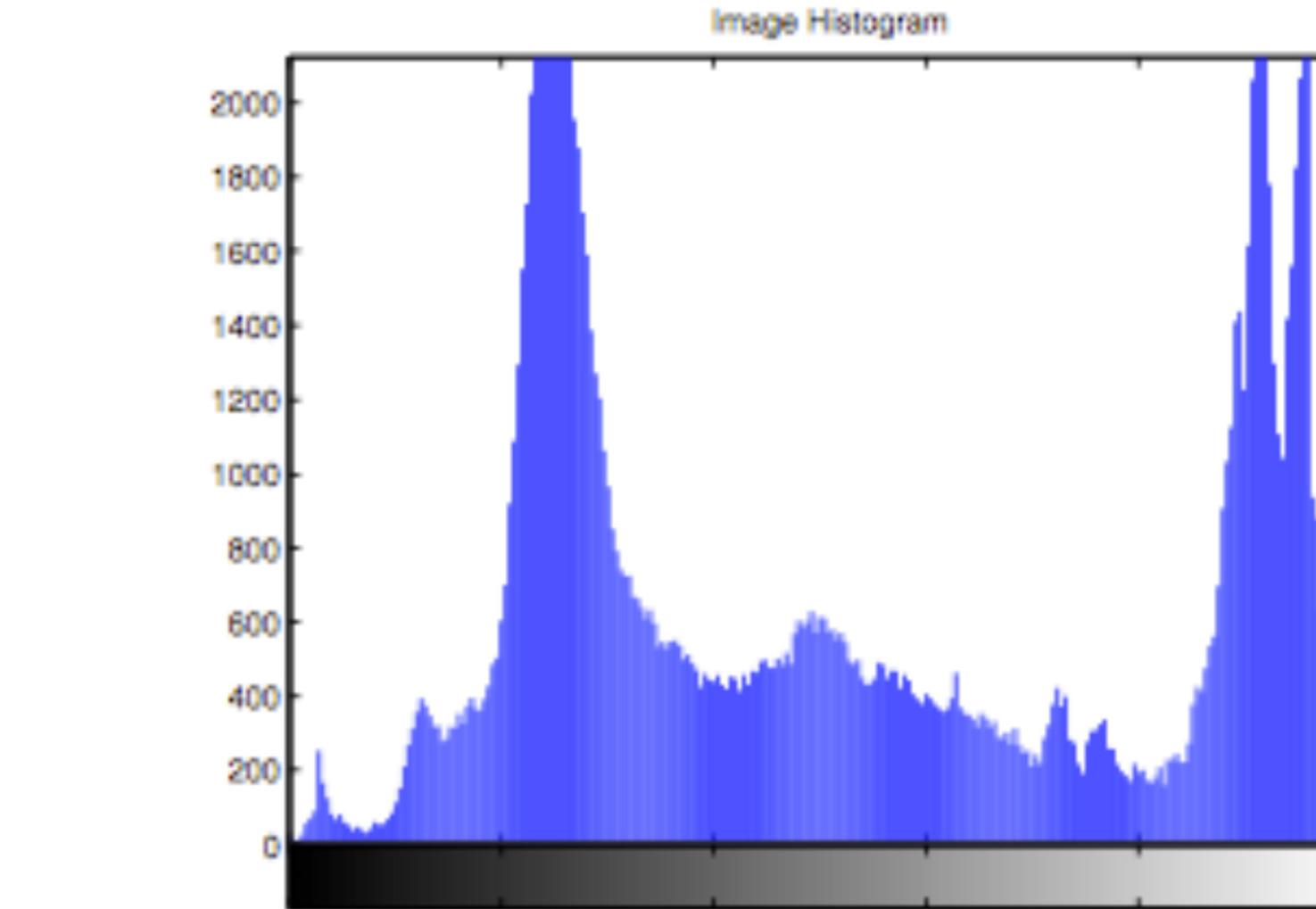
6. "Zebras" segmentado com Threshold de 100 em 255



(a) Original Image



(c) Image block segmentation



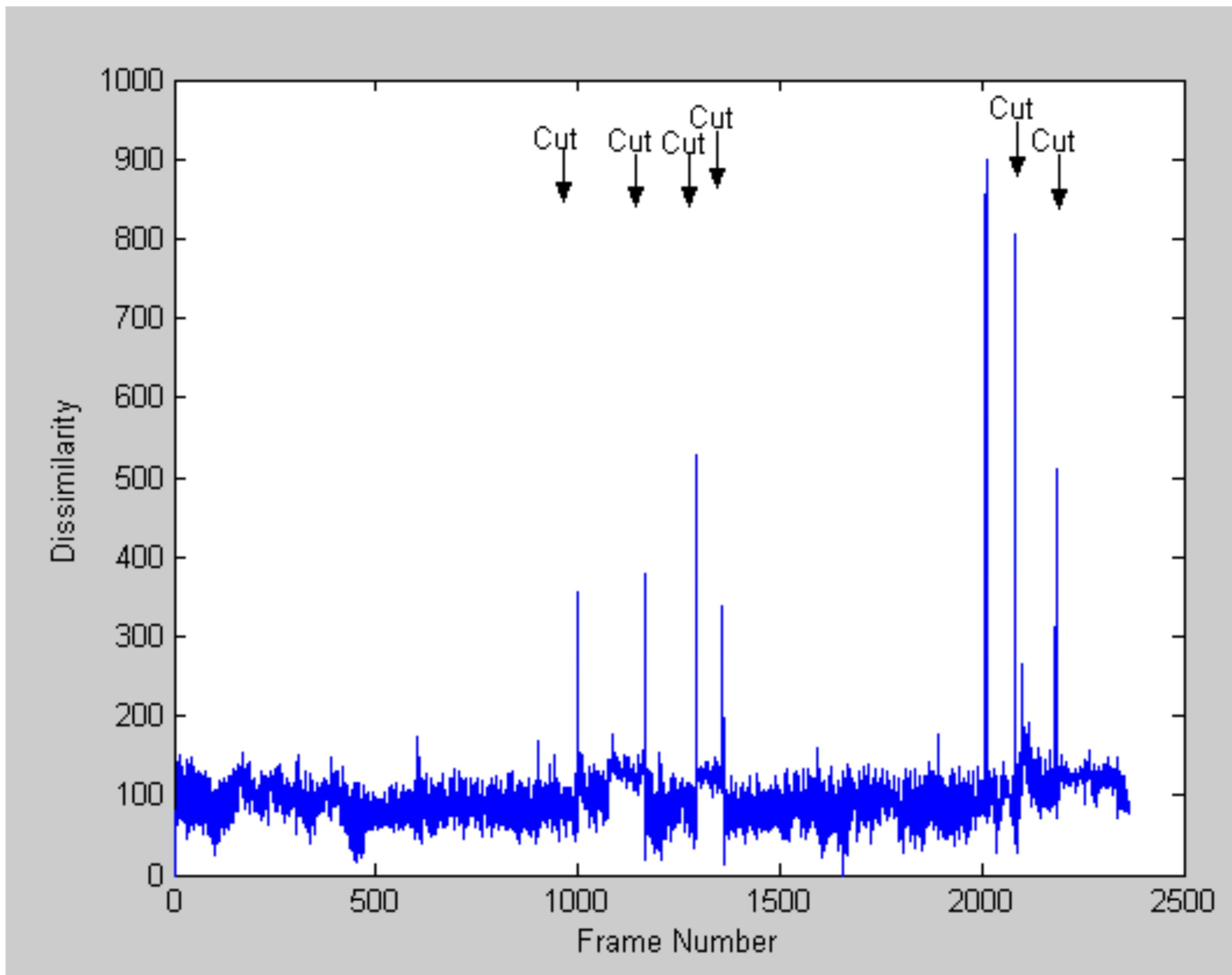
(b) Original image histogram



(d) Output image

Assessment activities

- Video processing:
 - Temporal Segmentation (cut detection):



Assessment activities

- **Important Dates:**

- 28/02/2021 - First Lab Assignment
 - Lab 1: Sampling and Quantisation of media signals
- 14/03/2021 - Second Lab Assignment
 - Lab 2: Principles of Visual Processing in Matlab
- 28/03/2021 - Third Lab Assignment
 - Lab 3: Image Processing in Matlab

Development Multimedia Application

- Objectives:
 - intends to offer the opportunity to the student to jointly apply creativity with technological knowledge for building a multimedia application.
 - students should adopt a formal methodology for conceiving their application, starting with the identification of the problem their application should solve or message/information it should transmit to the user, going through a phase of identification of user requirements, use cases, to a full formal functional specification of their application.
 - constructing an early mock-up or prototype of the application is also envisaged.
 - at the end of the semester, students should have a **working version of their application**.
- Project presentation
 - Each group must **present their application** during the last class of the semester.

Development Multimedia Application

- **Minimum requirements** (up to 14 values):

The application must fully comply with the definition of multimedia:

- digital format
- more than one type of media
 - at least one of them must be continuous
 - some kind of interaction/coordination must exist between at least two of such media
 - temporal or spatial
- must offer some form of interactivity to the user
 - the user should be able to (partially) control the way information is presented

Note: groups of three students should include some form of animations, even if basic, as minimum requirements.

Development Multimedia Application

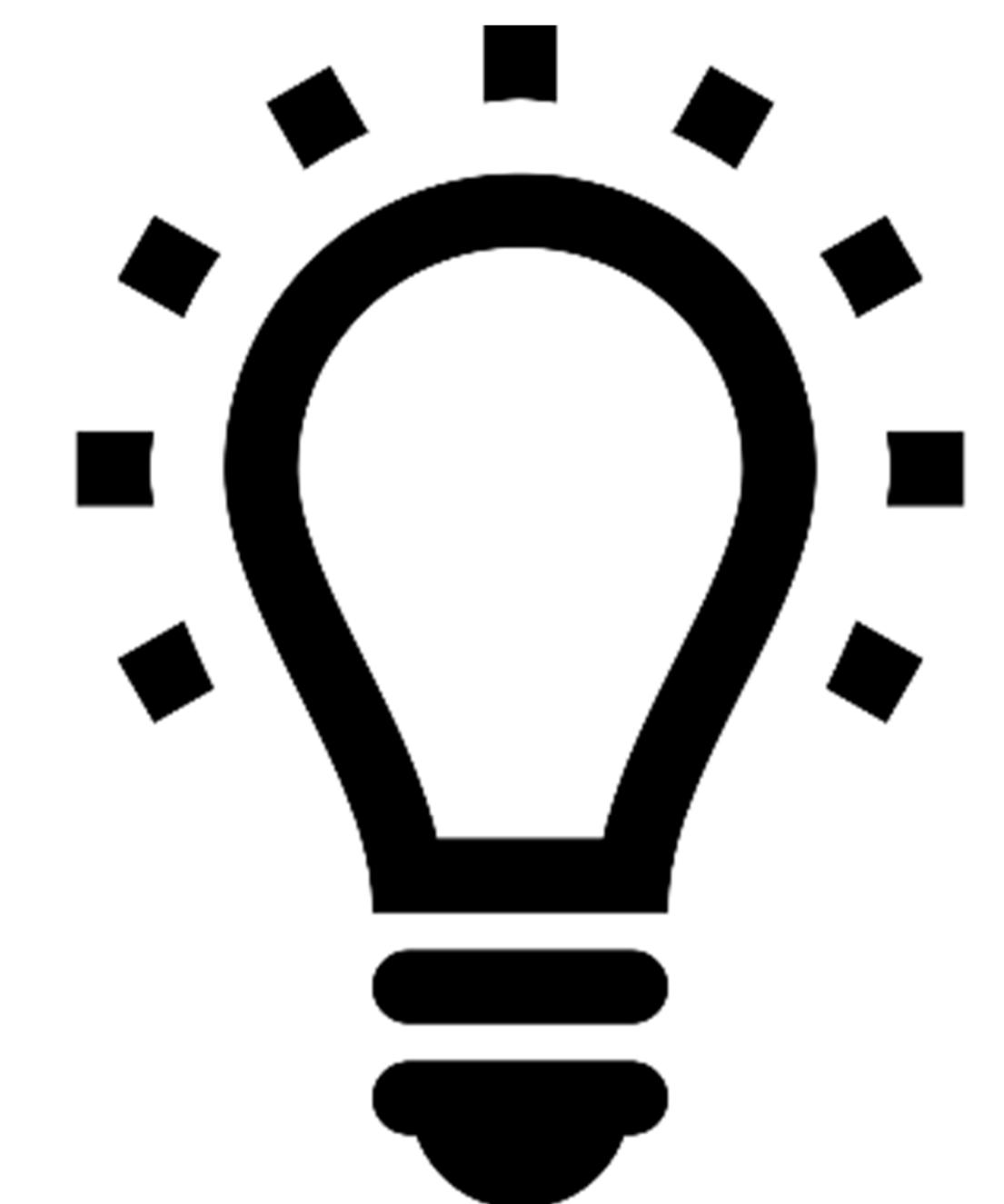
- Additional requirements (up to more 3 values):
The application must fully comply with the definition of multimedia, plus
 - incorporate animations
 - editing video and audio
- Bonus:
 - Functional Specification
 - Presentation of an early mock-up
 - four weeks before the end of the semester (by May 5th).

Development Multimedia Application

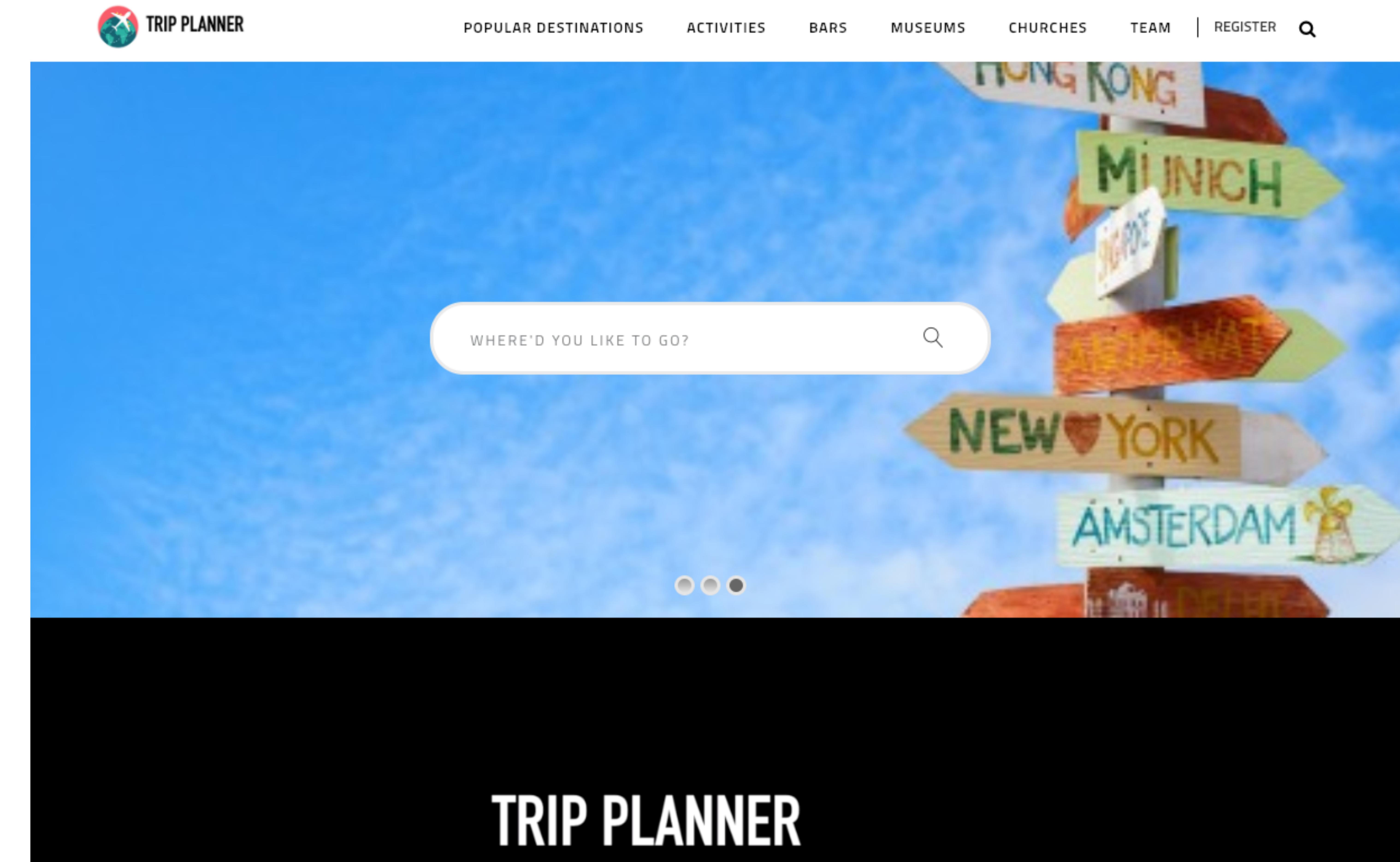
- General methodology to apply
 - Identify a problem to solve or a challenge to overcome
 - many times this goes by speaking with friends, users, making questionnaires
 - think of ideas, even the most unrealistic ones, that may help solving the problem
 - do not try to think whether they are feasible/practical or not; give space to your imagination (“think in the shower”) and write down your ideas until you have a sufficiently large pool of ideas
 - go through that pool of ideas and select the ONE
 - elaborate a list of (formal) requirements and functionality
 - what should the application offer to their users? what actions should it perform? what are the expected results?
 - ex., the application should allow the user to register, build a profile and visualize and change personal data
 - identify use cases and elaborate a narrative description of them
 - draw a sketch/diagram of the user interface and user interactions
 - draw a block diagram illustrating the different components identifying interactions
 - build a mock-up/prototype

Development Multimedia Application

- Homework:
 - start with idea or ideas
 - do brainstorming with your colleagues
 - research needs
 - refine your idea
 - define the target audience, target area
 - multimedia types (hypermedia, audio, picture, video, etc)
 - web, mobile, service, etc
 - ...



Development Multimedia Application



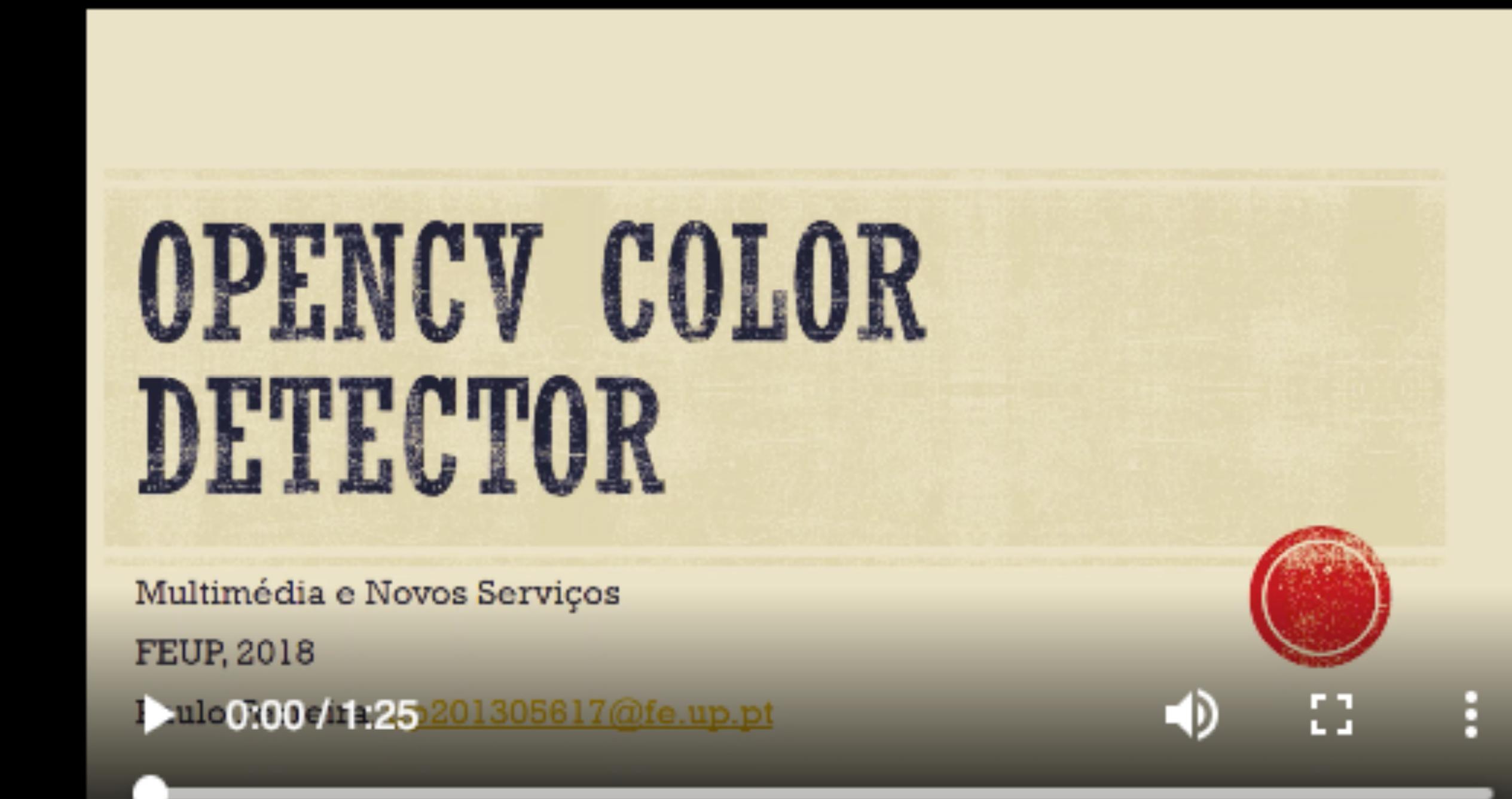
Development Multimedia Application

COLOR BLINDNESS ABOUT SYMPTOMS EXAMPLES CAUSES QUIZ MANAGEMENT APP DOWNLOAD

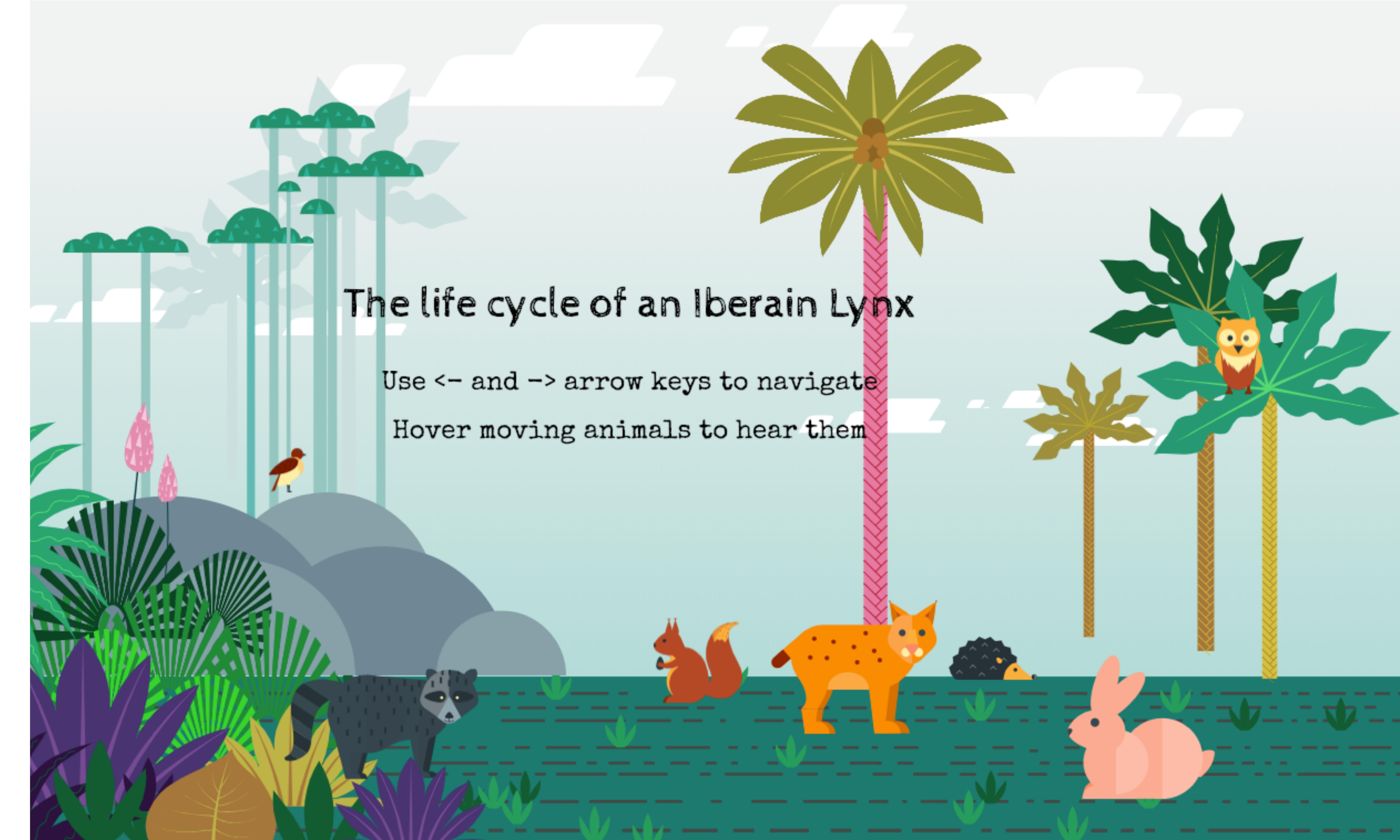
APP

In order to improve this application, a program capable of detecting colors in a video file, image file or the computer webcam stream, was developed. This program was written in the Python programming language with the help of the computer vision library, OpenCV.

The following video shows how to use this program.



Development Multimedia Application

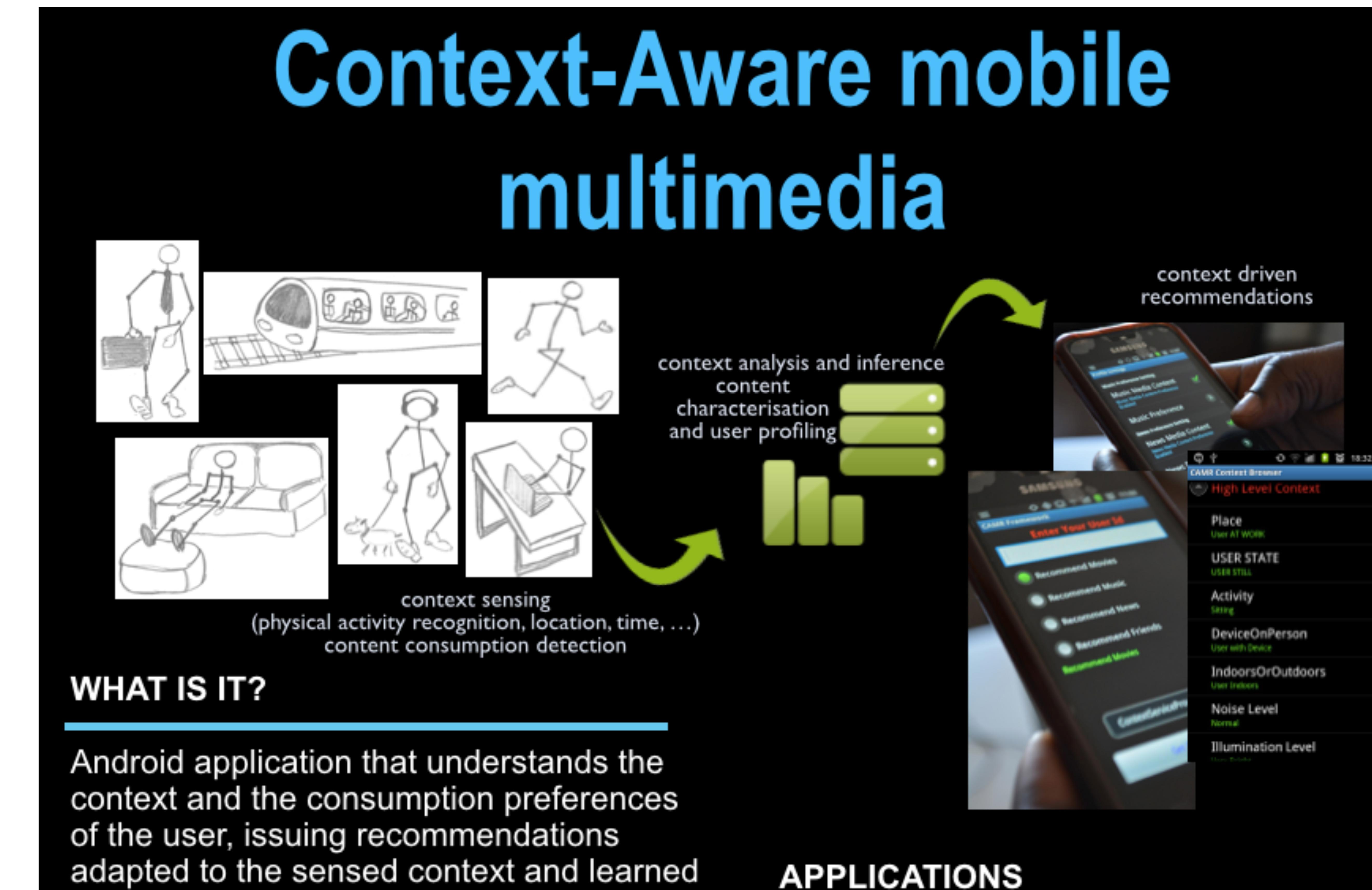


Multimedia Technological Areas

- R&D projects:
 - automated (or semi-automated) music generation
 - automated (or semi-automated) video analysis:
 - annotation, captioning, classification
 - television environments
 - mobile environments
 - surveillance and human behavioral analysis
 - object tracking, face recognition, etc
 - personalized content visualization 3D e 360°

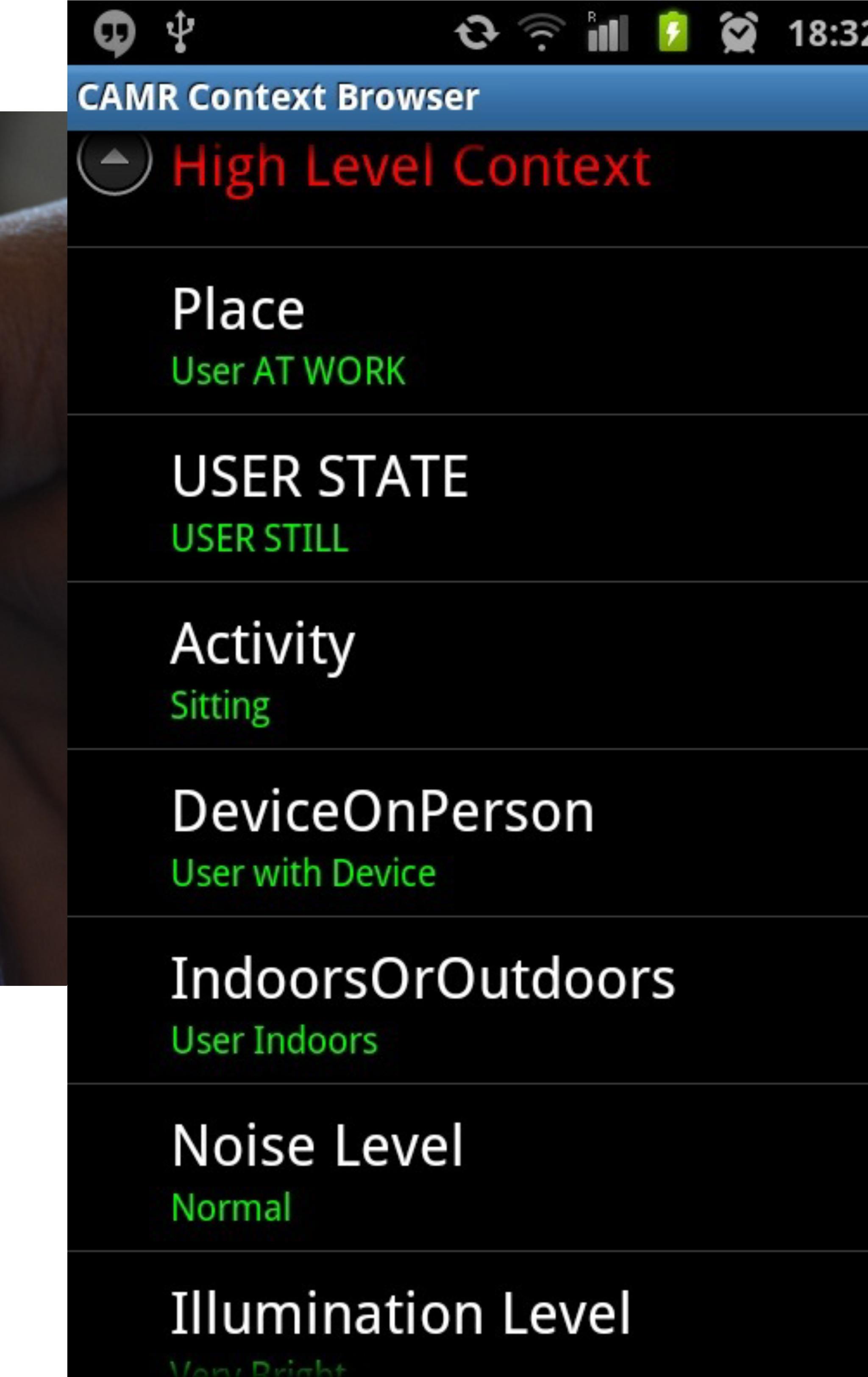
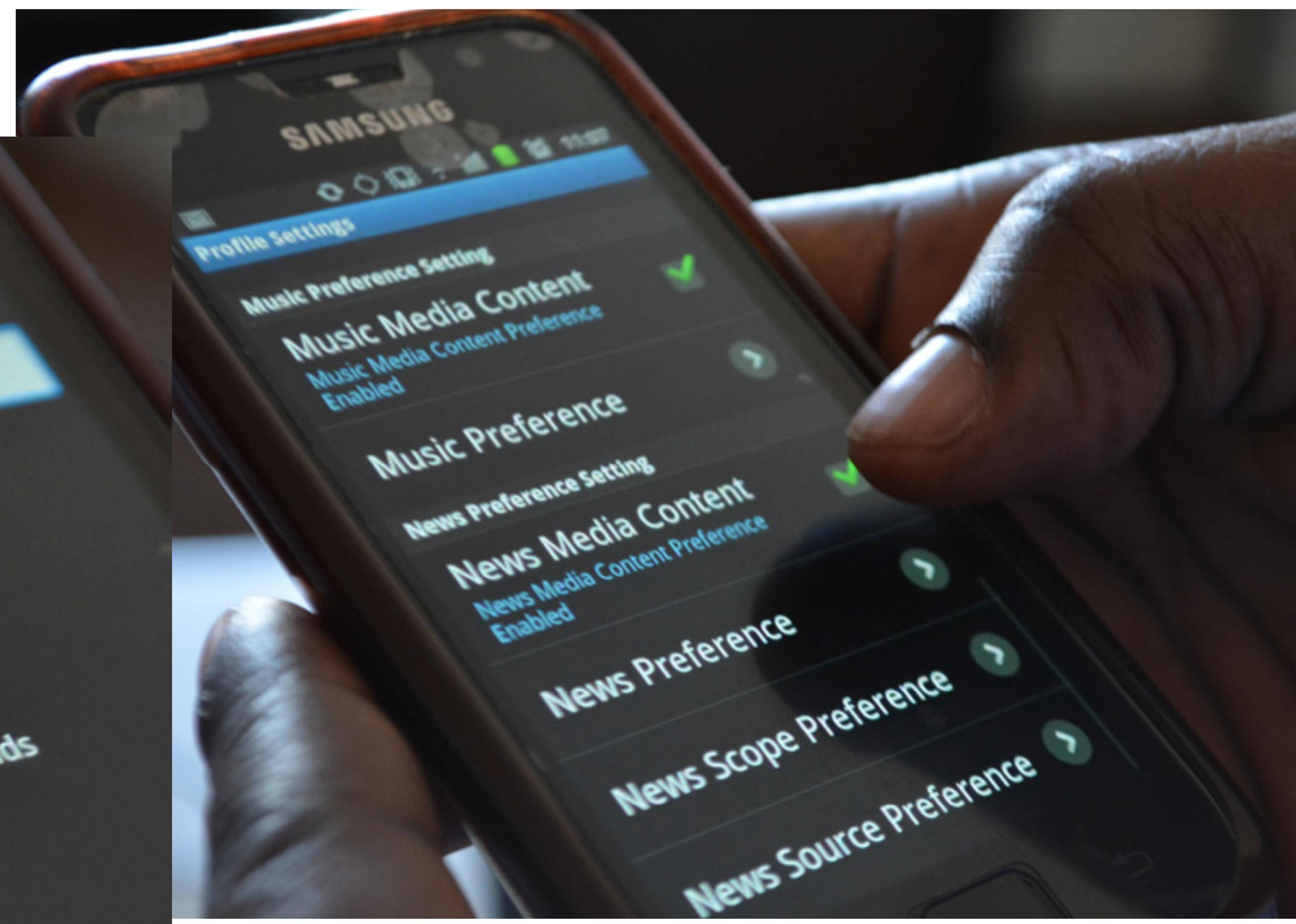
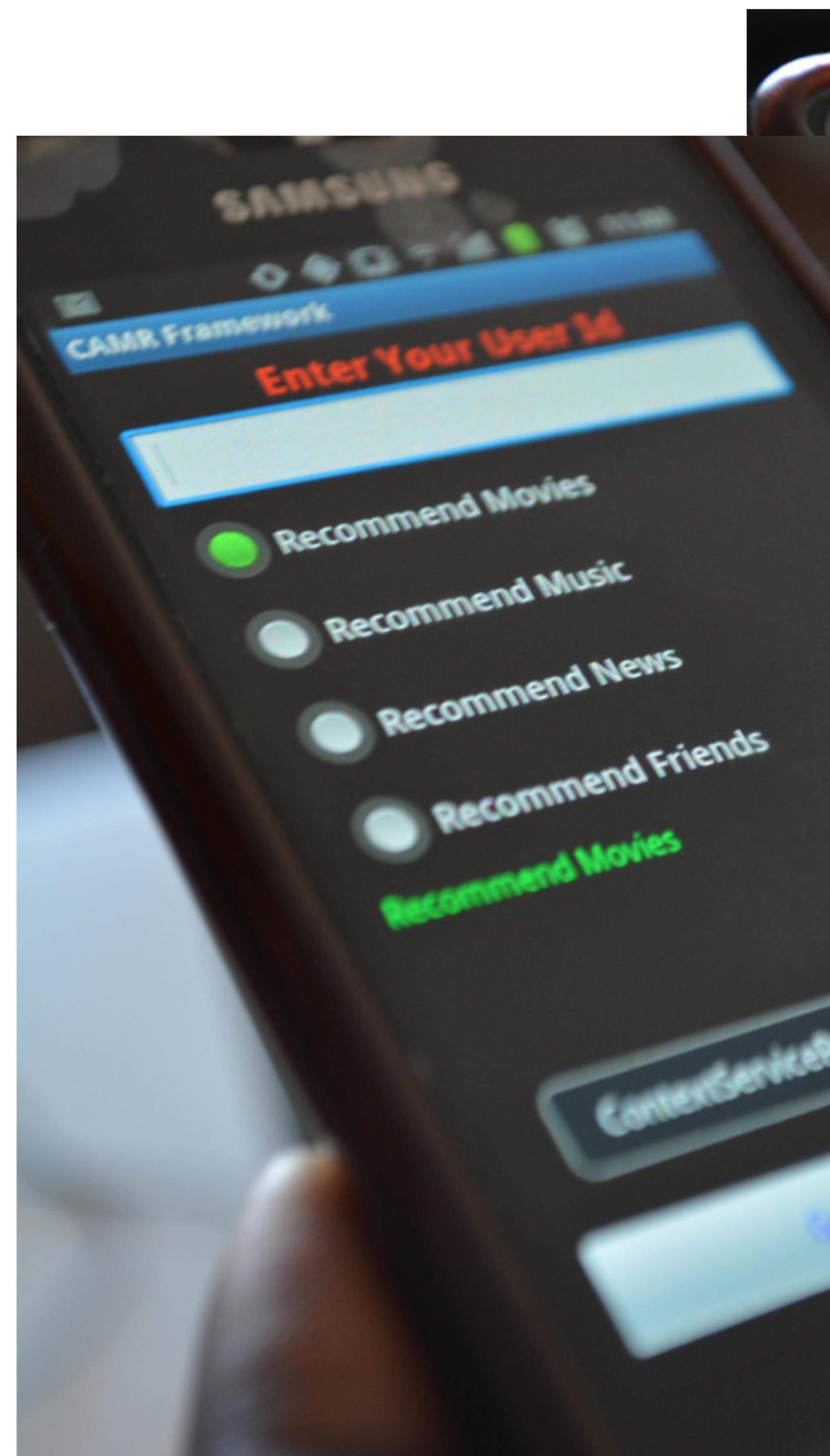
Multimedia Technological Areas

- R&D projects:
 - Context-Aware mobile multimedia



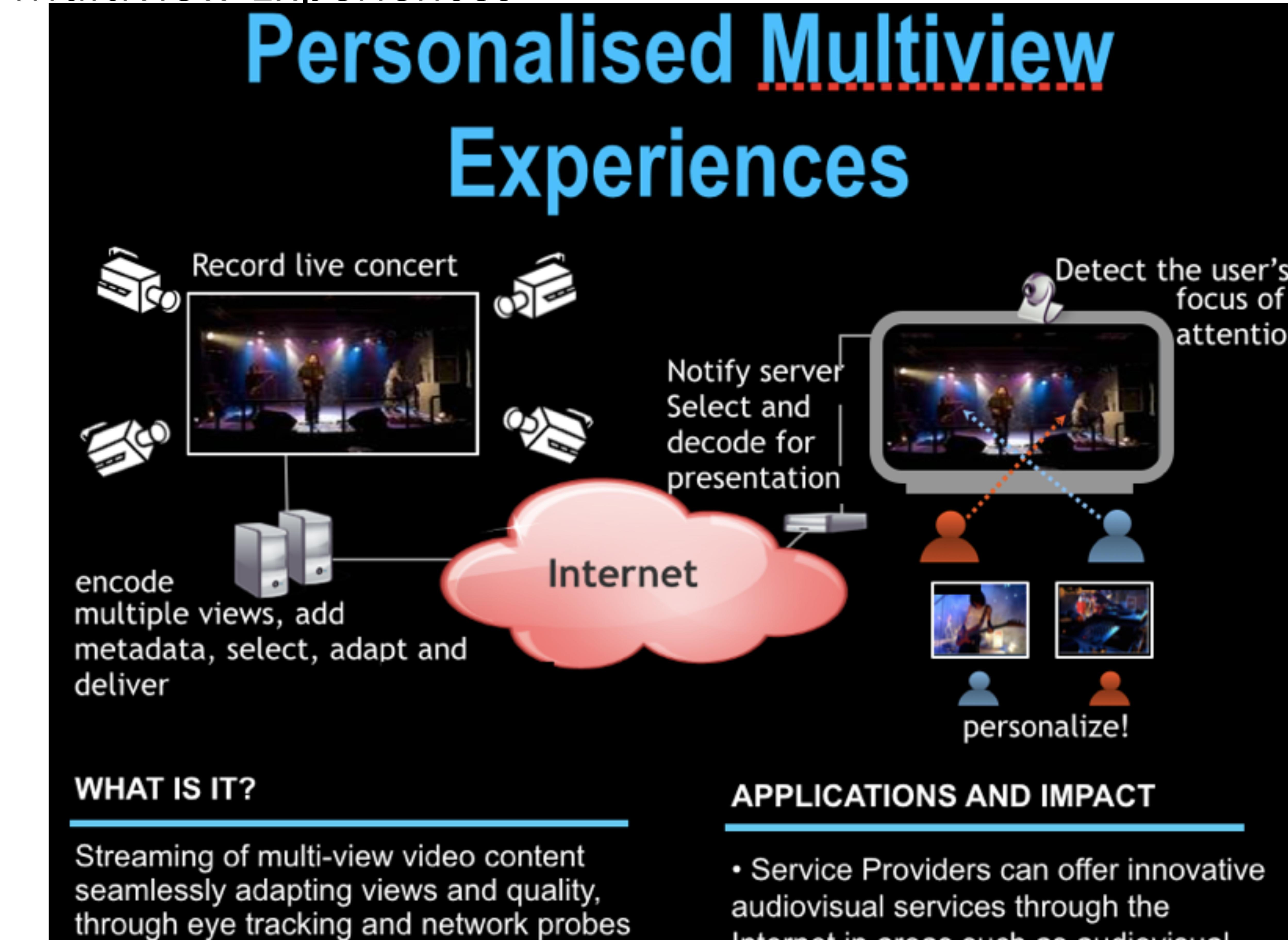
Multimedia Technological Areas

- R&D projects:
 - Context-Aware mobile multimedia



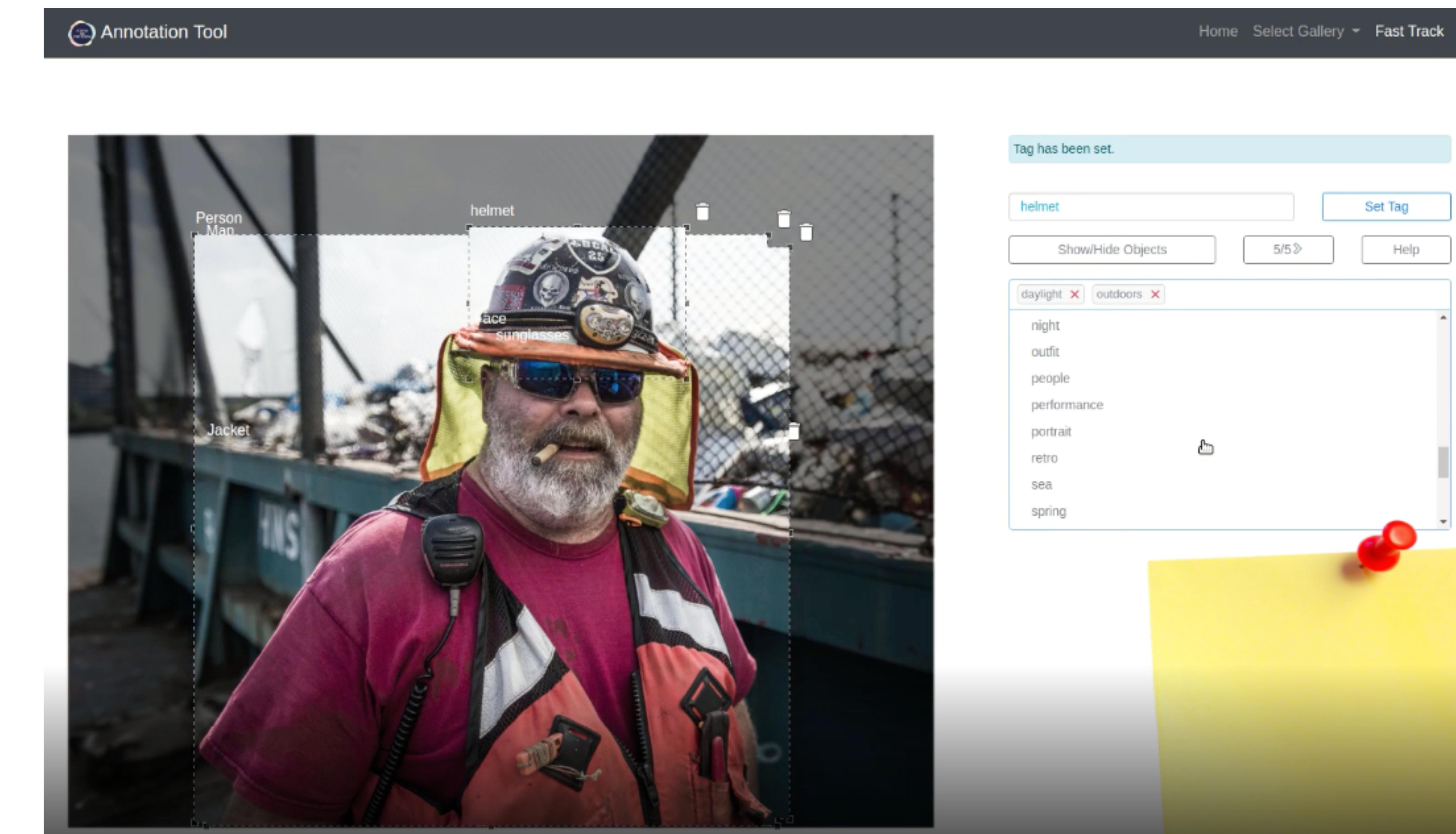
Multimedia Technological Areas

- R&D projects:
 - Personalised Multiview Experiences



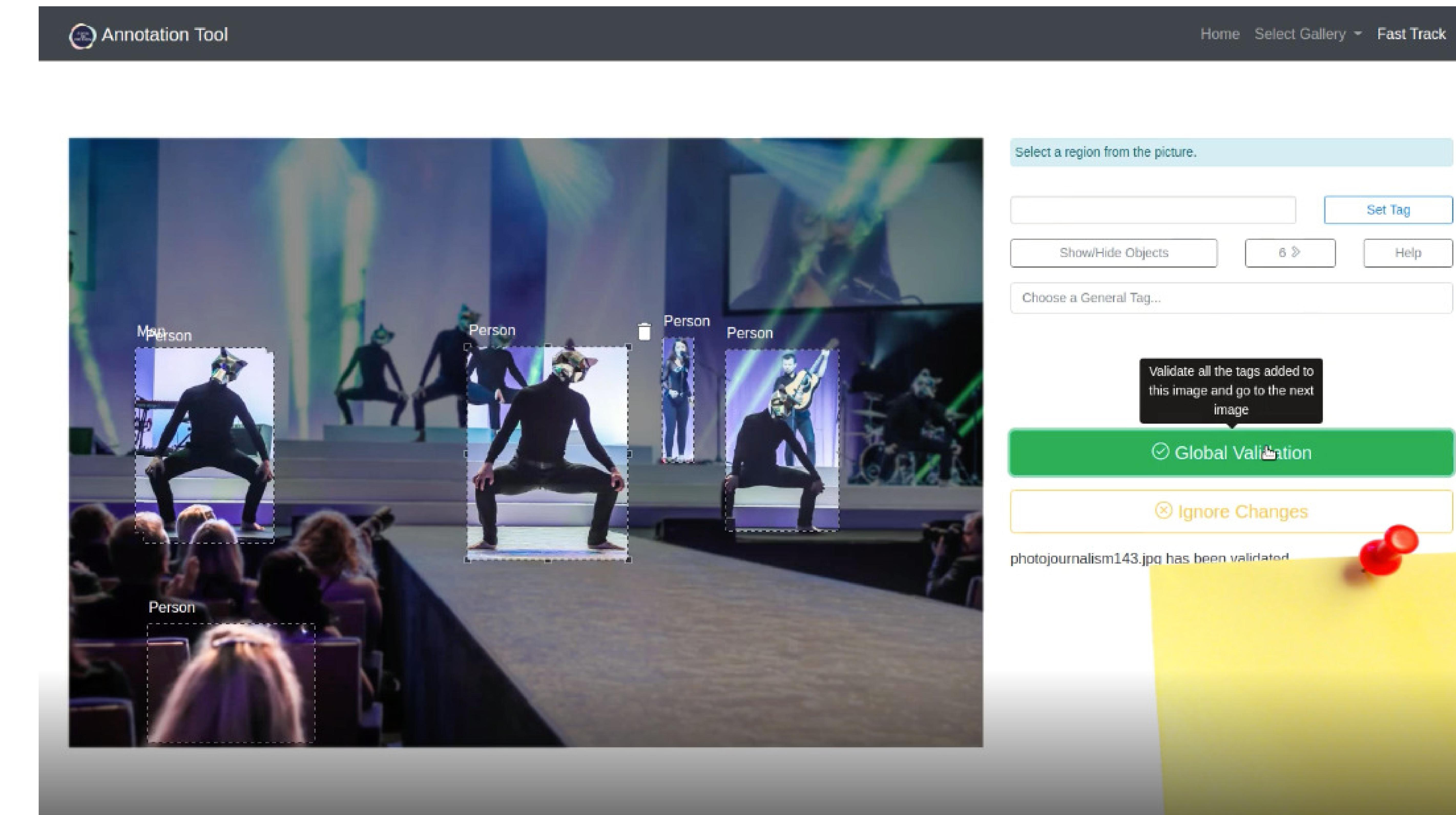
Multimedia Technological Areas

- R&D projects:
 - Video Annotation Tool



Multimedia Technological Areas

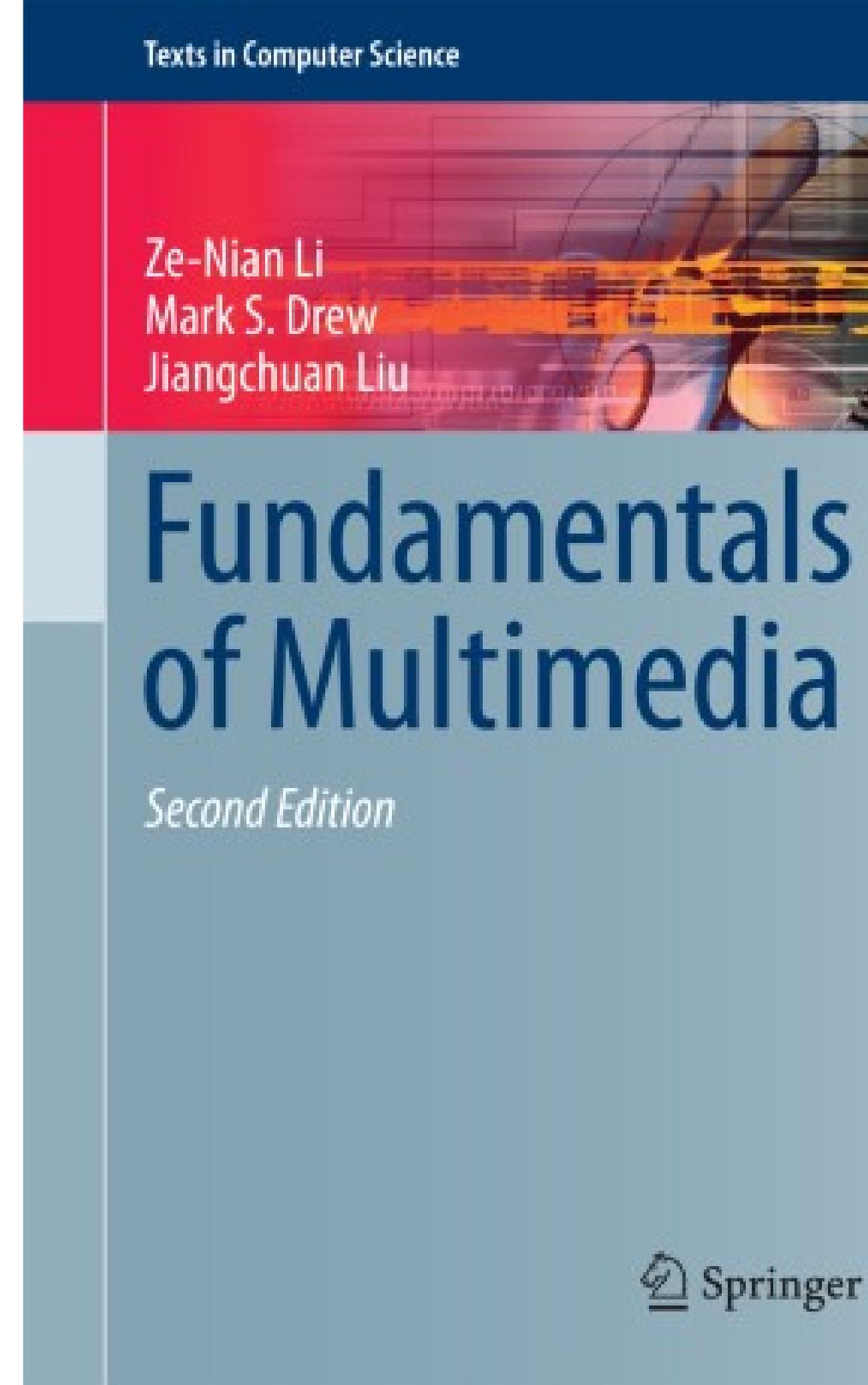
- R&D projects:
 - Video Annotation Tool



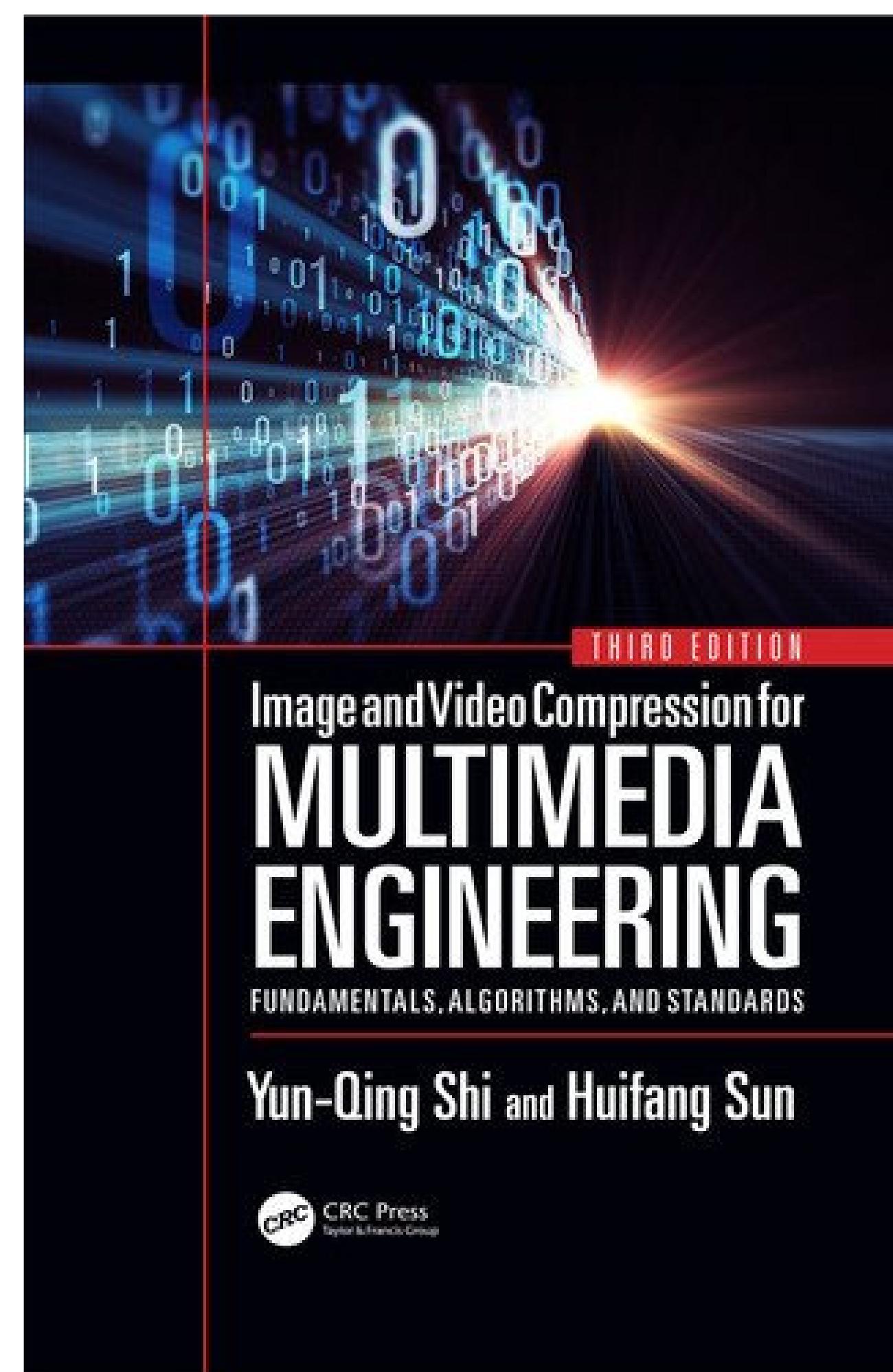
Development Multimedia Application

- Important Dates:
 - 10/04/2021 – Multimedia Project Proposal
 - 28/04/2021 – Preliminary Project Demonstration
 - 26/05/2021 – Final Project Presentation
 - 30/05/2021 – Final Project Report Submission

Bibliography



Li, Z.-N., Drew, M. S., & Liu, J. (2014). *Fundamentals of Multimedia* (2nd ed.). Springer Publishing Company, Incorporated.



Shi, Y. Q., & Sun, H. (2019). *Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards* (3rd ed.). CRC Press, Inc.