CM3065 Intelligent Signal Processing

Project Idea Title 1: Camera Surveillance System

What problem is this project solving?
Developing a home security camera system for indoor surveillance.

What is the background and context to the question above in 150 words or less?
Home security camera systems have exploded in popularity over the past few years. Nowadays, it is possible to install a professional security camera system at home at an affordable price.

However, some users do not want video and photos from inside their houses being shared with a third party, and they prefer to build their own surveillance camera systems using low-cost micro-computers and cameras, and developing their own applications.

List some recommended sources for students to begin their research

- S. Brutzer, B. Höferlin and G. Heidemann, "Evaluation of background subtraction techniques for video surveillance," CVPR 2011, 2011, pp. 1937-1944, doi: 10.1109/CVPR.2011.5995508. URL: https://ieeexplore.ieee.org/abstract/document/5995508

  Abstract (excerpt): Background subtraction is one of the key techniques for automatic video analysis, especially in the domain of video surveillance. Although its importance, evaluations of recent background subtraction methods with respect to the challenges of video surveillance suffer from various shortcomings.

- Y. Jusman, L. Hinggis, R. O. Wiyagi, N. A. M. Isa and F. Mujaahid, "Comparison of Background Subtraction and Frame Differencing Methods for Indoor Moving Object Detection," 2020 1st International Conference on Information Technology, Advanced Mechanical and Electrical Engineering (ICITAMEE), 2020, pp. 214-219, doi: 10.1109/ICITAMEE50454.2020.9398484. URL: https://ieeexplore.ieee.org/document/9398484

  Abstract (excerpt): This study analyzes the method of moving object detection using video images by comparing two methods, namely background subtraction and frame differencing.

- N. Srivastav, S. L. Agrwal, S. K. Gupta, S. R. Srivastava, B. Chacko and H. Sharma, "Hybrid object detection using improved three frame differencing and background subtraction," 2017 7th International Conference on Cloud Computing, Data Science & Engineering - Confluence, 2017, pp. 613-617, doi: 10.1109/CONFLUENCE.2017.7943225. URL: https://ieeexplore.ieee.org/document/7943225

  Abstract (excerpt): Object Detection and Tracking in video has applied in robotics, video-surveillance; human-computer interaction etc. and different approach of object detection e.g. Background subtraction, frame differencing. [...] Two frame differencing is very easy but

there is problem of holes. […] In this paper, the proposed technique is able to reduce the holes problem in dynamic background updating video.

- Shaikh S., Saeed K., Chaki N. (2014) Moving Object Detection Using Background Subtraction. In: Moving Object Detection Using Background Subtraction. SpringerBriefs in Computer Science. Springer, Cham.
URL: https://link.springer.com/chapter/10.1007/978-3-319-07386-6_3

Abstract: Background subtraction is a widely used approach for detecting moving objects from videos captured with static a camera. This chapter introduces the basic concept behind this approach using a simple frame differencing method. A survey on existing literature on this topic is also reported in this chapter.

What would the final product look like?
(e.g. presentation, usability, functionality, results)?

The final product will be a fully functional indoor home security camera system which will allow us to detect intruders in a room. (*)

The core of the system will be a movement detection application that will have the following characteristics:

- Captures and stores video once any kind of motion takes place in the room.
- Sends an 'alarm' message to the phone of a supervisor (an email, for example) describing the problem detected.
- Uploads the video to a web dashboard, along with meta data describing what is going on (for example, the application can detect if the intruder appears to the right or left of the frame, guess if the intruder is an animal or a person – 'small' vs 'big' intruder – etc.).

The system also includes a web dashboard that should let a supervisor see the generated videos, read the video meta data, review the clips, remove the clips, etc.

The video clips uploaded to the web dashboard will have a maximum length of 20 seconds.

(*) We can suppose that there is any pet in the room, so any animal in the room (cat, dog, bird, etc.) can be considered as an 'intruder'.

What would a prototype look like?
What would it show?
What does it need to prove?
*What **IS** important to make clear?*
*What is **NOT** important at this stage?*

Prototype needs to focus on the movement detection application for detecting intruders and on the triggering of the alarm.

The development of the web dashboard, as well as the video storing and uploading, are not important at this stage.

What kinds of techniques/processes are relevant to this project?

- Iterative development
- Frequent testing
- Computer vision: movement detection
- Frame differencing and background subtraction techniques
- Audio and video file formats. Compressing audio and video.
- Python, OpenCV and ffmpeg is strongly recommended.

What would the output of these techniques/processes look like?

- A series of incrementally improving prototypes – showing how you have tested and incorporated the results from these tests.

How will this project be evaluated and assessed by the student (i.e. during iteration of the project)?

What criteria are important?

Student will simulate different intruders attacks at different times during the day. Student will check if the movement detection application is functioning properly (i.e. if the alarm triggers when an intruder enters into the room) for any intruder and behaviour, and under any room lighting conditions.

Student will also check that the alarm message is immediately received by a supervisor, who should be able to verify the authenticity of the warning message viewing the video clips uploaded to the system web dashboard.

For this brief, what would a minimum pass (e.g. 3rd) student project look like?

- The movement detection application captures and stores video when it detects motion in the room. The application sends a warning to the phone of a supervisor, who can verify this warning examining the video clips uploaded to the web dashboard. The whole process is performed without major issues.
- The web dashboard is functional, although it has a poor user interface design.
- Written report lacks research, detail of process, issues encountered in production, and/or does not reference correctly.

For this brief, what would a good (e.g. 2:2 – 2:1) student project look like?

- The movement detection application is based on a simple but effective method for moving object detection.
- The automatic analysis of the clips generates useful and mostly correct information about the problem detected. This information is both sent in the alarm message and saved as meta data within the video file.
- The movement detection application is able to automatically adapt the application algorithm to different rooms and lighting conditions.

- The web dashboard has a user-friendly design.
- The surveillance system generates video clips in a correct format – in terms of balance between quality and size, and browser compatibility – although it could be improved.
- The report is well written and it describes the methods, algorithms and processes implemented, as well as details the issues encountered in production.

For this brief, what would an **outstanding** (e.g. 1st) student project look like?
- The movement detection application is based on a sophisticated and very effective method for moving object detection.
- The automatic analysis of the clips generates mostly correct and detailed information about the problem detected. This information is both sent in the alarm message and saved as meta data within the video file.
- The movement detection application includes a sophisticated method to adapt the application algorithm to different rooms and lighting conditions.
- The web dashboard is highly-polished in terms of design and usability.
- The surveillance system generates video clips in an optimal format in terms of balance between quality and size, and browser compatibility.
- The report is flawlessly written. Excellent spelling and grammar. Appropriate academic tone is taken throughout. The report describes the methods, algorithms and processes implemented, as well as details the issues encountered in production.