Mapping pedestrian flow from surveillance cameras for sustainable spatial planning

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Abstract:

As we can read in the V. Mayer-Schönberger and K. Cukier book (2013), humanity is faced with the problem of an excess of collected data, which it cannot process to obtain valuable information from it. The answer to this is using artificial intelligence algorithms to analyze and extract information from data in a process called Data Mining.

In this presentation, the author wants to introduce a methodology developed as part of an author's master's thesis (Czernic, 2024) for automatically extracting video surveillance data on a university campus using deep neural networks, such as YOLO, which allows the detection and tracking of pedestrians in the footage. However, simply tracking pedestrians in camera footage does not allow this information to be directly linked to the global reference system. For this purpose, computer vision techniques (Li&Yoon, 2023) were used to convert the camera coordinates to a global coordinate system based on camera calibration and measurement of reference points. During the experimental phase, it was possible to obtain transformation results with an accuracy of the determined position of up to 1m at a distance of 20-30m from the camera.
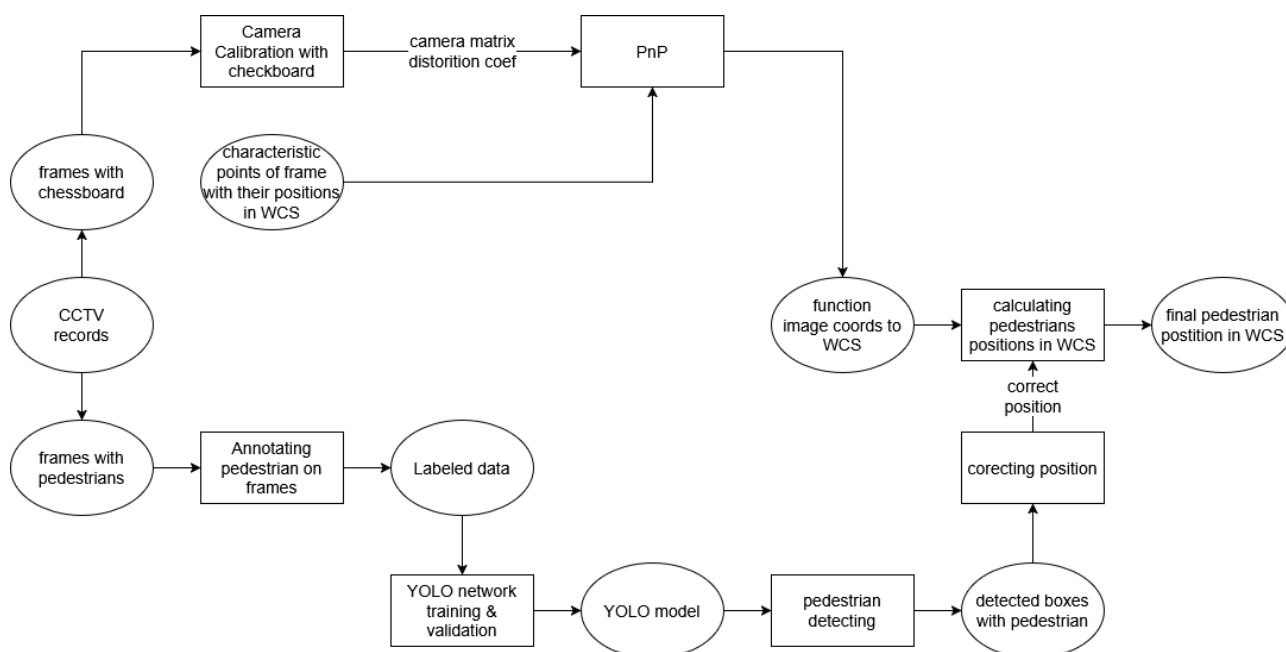
Figure 1 Developed workflow diagram

With such a solution developed, it is possible to perform analyses of the flow of pedestrian routes in the area of view of the surveillance camera and map these flows in a spatial reference system. Having such data allows to perform spatial analyses, the results of which can be used for sustainable environmental planning so that it is human-friendly.

The research will also present a case study on the example of several surveillance cameras located on the main campus of Warsaw University of Technology, which will present quantitative and qualitative results and the accuracy obtained, and demonstrate that a mAP50 of approximately 90% was achieved.
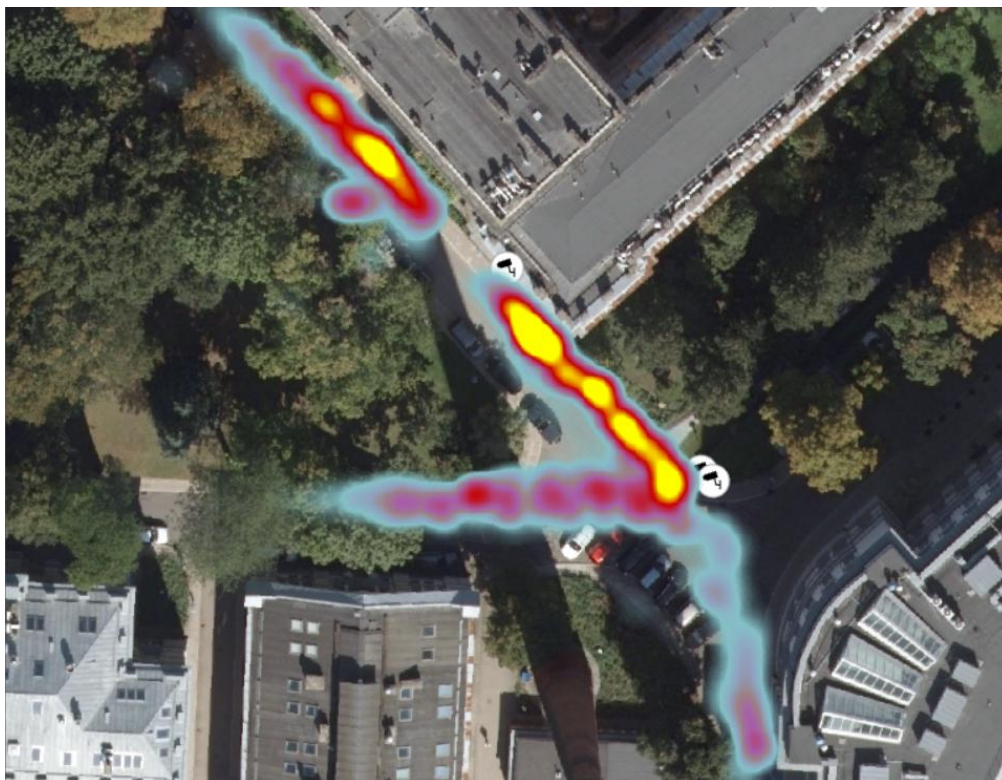
Figure 2 Example of heatmap based on extracted pedestrian data from three cameras (Czernic, 2024)

The undoubted advantage of the proposed methodology is that it is based on existing infrastructure, making it a low-cost and easy-to-implement solution. In addition, aspects of security, ethics, and legal standards will be addressed in the scope of the article.

References

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