Analysis of unstructured high density crowded scenes for video surveillance and crowd monitoring

Invention: Automated system for detection of organized movements in human crowds

Computer vision algorithms can extract information from videos of crowded scenes and automatically track groups of individuals undergoing organized motion which might represent anomalous behavior. Computational tools and applied mathematics are indispensable for automated image analysis of human crowds, where information about changes in pixel intensity is translated into particle tracks used to detect rapid changes in crowd dynamics. We propose to use the existing infrastructure of video cameras for collecting images and to develop an **innovative software system** for parsing of significant events by analyzing image sequences taken inside and outside of sports stadiums. Our specific aims will be:

1. To design and implement software for **automated human detection** and use our existing image analysis algorithms for **human tracking in crowded scenes**.
2. To develop novel computer vision algorithms for **classification of motion patterns** and **anomalous motion identification in video surveillance**.

We will aim at developing a system which can reliably analyze the behavior of up 200, 000 people and vehicles located inside and in the surroundings of a large stadium. Our goal is to create a fully **automated real-time accident aversion system**.

Rationale:

Video cameras monitoring the activity of people around football venues are commonplace in cities worldwide. At sports games, where crowds of tens of thousands gather, such monitoring is important for safety and security purposes. It is also challenging to automate. Human operators are generally employed for the task, but even the most vigilant individuals may fail to see important information that could ultimately **signal the onset of a potentially dangerous situation**, such as the **overcrowding** of a sector of the audience. Our research efforts are focused on the development of a system that provide the security personnel **on-the-fly** with automatedly generated alert signal regarding **rapid motion of groups of individuals** or events of interest in crowded scenes. More specifically, the system will offer crowd density estimation and prediction of overcrowding in front of the gates and parking lots around the sports arenas, as well as within the stadium. Additionally, our system will be able to detect when small groups of fans are about to confront each other and predict the place of clash by calculating the speed and direction of motion of the opposing groups.

Significance:

We will apply computer vision methods to capture organized movement of groups of spectators in crowded scenes. Tracking in unstructured crowded scenes has recently gained attention in computer vision for the surveillance of human or vehicle motion in vulnerable public areas such as stadia, airports, train stations or roads. Our approach offers a high speed solution allowing real-time tracking. Thus, it could be used to **predict on the fly anomalous behaviors or congestions associated with a security alert** at the outside or within a sports stadium, an airport terminal or with the arrival of a new train in a highly frequented station. This project will generate novel technology which can be used to analyze video of conflict situations at different types of sports stadia, e.g. for association football (Fig. 1), American football (Fig. 2), and baseball. Furthermore, we can envisage additional applications such as using the technology to detect dangerous behaviors at airports (Fig. 3), train station (Fig. 4), political rallies (Fig. 5), mass demonstrations, music festivals and large chain stores (Fig. 6), and busy resorts (Fig.8), among a number of other **important security applications**. We will develop software applications for various platforms and devices, such as CCTV camera systems, smartphones (iOS/Android) as well as smart glasses (Vive/HoloLens). Our technology can be made available as turn-key software or through a web interface where additional modules with algorithms to analyze images of specific types of motion from live online cameras or other imaging methods can be added.

Fig. 1. Fans at an association football stadium

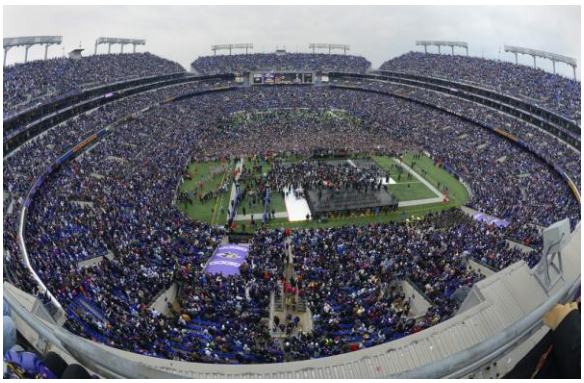
Fig. 2. Fans at an American football stadium

Fig. 3. Passengers at an airport terminal


Fig. 4. Passengers at a train station

Fig. 5. Spectators at a political rally

Fig. 6. Customers at an Apple store


Fig. 7. Spectators at a music festival


Fig. 8. Tourists at a summer resort beach