Project

Project title

VigilHeat - Analyzing Surveillance Camera Heatmaps for Improved Security

Introduction to VigilHeat

VigilHeat is a state-of-the-art project that harnesses computer vision and human-object interaction models to analyze surveillance camera footage, providing businesses with valuable insights. By delivering actionable data about how people interact with products and spaces, VigilHeat empowers businesses to optimize their spaces, improve products, and enhance security.

For example, a retail store can leverage VigilHeat to analyze customer behavior and interactions with different products to determine which items are generating the most interest or attention. This information can be used to optimize product displays and enhance the overall layout to increase sales and improve customer experience.

In a similar manner, VigilHeat can be used to enhance security in condominium complexes. By analyzing footage from surveillance cameras, VigilHeat can detect and alert security personnel to any suspicious activities such as car theft or unauthorized entry. This can help prevent crimes and provide peace of mind to the residents.

Moreover, VigilHeat can also be used in manufacturing facilities. By analyzing footage from surveillance cameras, VigilHeat can detect worker interactions with equipment, identify potential safety hazards, and inefficiencies in the manufacturing process. This data can be used to optimize workflows, improve employee safety, and increase productivity.

VigilHeat can also be leveraged in transportation hubs such as airports and train stations. By analyzing footage from surveillance cameras, VigilHeat can identify patterns in passenger behavior, such as areas of congestion or traffic flow. This information can be used to optimize passenger experience, enhance security measures, and improve overall operations.

Additionally, VigilHeat can be used in forest fire prevention by analyzing footage from surveillance cameras installed in high-risk forest areas. This can help detect potential sources of fire such as campfires or cigarette butts, and help prevent forest fires before they start.

Investing in VigilHeat is an investment in the future of security camera analysis. With its advanced technology, proven results, and potential for scalability, VigilHeat is a solid investment opportunity that will provide long-term benefits for businesses, condominium management companies, and forest management authorities. VigilHeat unlocks the potential of surveillance camera footage, providing valuable insights that can help businesses thrive, increase safety, and enhance security.

Target Users

The target users of VigilHeat are commercial stores, condominium management companies, forest management authorities, manufacturing facilities, and transportation hubs such as airports and train stations. These businesses and organizations can benefit from VigilHeat's ability to analyze surveillance camera footage and provide valuable insights that can help optimize operations, improve customer experience, increase safety, and enhance security measures.

Technologies involved

VigilHeat's solution is powered by the latest advancements in computer vision and machine learning, making it a state-of-the-art technology. The HOI models used in VigilHeat are based on deep neural networks that can detect and recognize objects and humans in real-time with high accuracy. These models are trained on massive datasets, making them extremely robust and capable of handling complex and diverse scenarios.

To ensure high-performance and real-time processing, VigilHeat's solution is deployed on high-end computing systems with GPUs and parallel processing capabilities. This enables the system to process multiple streams of surveillance camera footage simultaneously and provide instantaneous insights.

In addition to HOI models, VigilHeat also employs other advanced computer vision techniques such as object detection and tracking, semantic segmentation, and image recognition. These techniques enable the system to provide a comprehensive analysis of surveillance camera footage, detecting and recognizing not just objects and humans but also their specific interactions and behaviors.

Moreover, VigilHeat's solution is highly scalable and can be integrated with existing security systems, making it easy to deploy and use. The system can also utilize IP cameras for image capture, providing businesses with greater flexibility and ease of use.

Overall, VigilHeat's solution is a cutting-edge technology that utilizes the latest advancements in computer vision and machine learning to provide valuable insights and actionable data to businesses and organizations.

Potential Risks and Solutions

While VigilHeat's solution offers numerous benefits, there are also potential risks associated with its implementation. Below are some of the potential risks and solutions to address them.

- Privacy Concerns: The use of surveillance cameras can raise privacy concerns among customers or passers-by. This can potentially harm a business's reputation and lead to legal issues.

Solution: To mitigate privacy concerns, businesses can implement the use of clear signage indicating the presence of surveillance cameras. Additionally, businesses can limit the use of surveillance cameras to areas that are essential for security and not in public spaces. Finally, businesses can ensure that surveillance footage is securely stored and accessed only by authorized personnel.

- False Positives or Negatives: The use of HOI models can result in false positives or negatives regarding the detected actions, potentially leading to incorrect conclusions and decision-making.

Solution: To address false positives or negatives, businesses can utilize data validation and verification techniques to confirm the accuracy of the data. Additionally, VigilHeat's solution can be designed to learn and adapt from its mistakes over time, improving the accuracy of its predictions.

- Performance Issues: VigilHeat's solution requires the processing of large volumes of surveillance footage, which can lead to performance issues such as delays or lag.

Solution: To address performance issues, businesses can invest in high-performance computing systems that are optimized for real-time processing of surveillance camera footage. Additionally, VigilHeat's solution can be designed to prioritize and analyze footage based on its importance, reducing the workload and optimizing performance.

In conclusion, by addressing potential risks and implementing effective solutions, businesses can confidently implement VigilHeat's cutting-edge solution to enhance security, improve operations, and optimize customer experience.

Demo implementation

1. Data collection: Collect surveillance camera footage that will be used to train and test the HOI models. There are several datasets available for human-object interaction detection, such as DJ-RN, UCF-Crime, and HICO-DET.
2. Data pre-processing: Clean and prepare the surveillance camera footage for analysis by the HOI models. This may involve tasks such as image resizing, normalization, and augmentation.
3. Model selection and training: Choose a deep learning framework such as TensorFlow or PyTorch, select an appropriate HOI model architecture, and train the model using the pre-processed data. This may require access to high-performance computing systems and can be a time-consuming process.
4. Model evaluation: Evaluate the performance of the HOI model using metrics such as accuracy, precision, and recall. This is important to ensure that the model is accurately detecting human-object interactions in the surveillance camera footage.

5. Software development: Develop software that can process surveillance camera footage in real-time, analyze the data using the HOI models, and provide actionable insights to businesses and organizations. This may involve integrating the HOI model into existing security systems, utilizing IP cameras for image capture, and implementing privacy and security measures.
6. Testing and refinement: Test the software on a smaller scale, such as in a test facility or warehouse, and gather feedback from businesses and organizations to identify areas for improvement. Refine the solution based on this feedback to ensure that it meets the unique needs of its target users.
7. Deployment: Deploy the solution in real-world scenarios and continue to gather feedback and refine the solution over time to ensure that it is effective and meets the evolving needs of its target users.

MVP Objectives

In the context of Advanced Software Technology development, our aim is to create a Minimum Viable Product (MVP) that focuses on the initial phases of the final product. The MVP will primarily involve the detection and monitoring of individuals, enabling us to generate a heatmap of high-traffic areas and analyze the duration of people's stays.

Given the potential challenge of securing access to a GPU, we will strive for near real-time performance by leveraging CPU-centric technologies. Depending on the progress made during the current semester, the second phase of the MVP may involve analyzing Human-Object Interaction in terms of basic actions, with a particular emphasis on store applications such as picking up, holding, and releasing objects.

It is important to note that the additional features mentioned are part of the long-term objectives for the product and will not be considered for the final development within the scope of this course.

Group information

- Sebastian Arriagada (hso14z, **team leader**)

Software Engineer with expertise in Machine Learning, specifically in image classification and object tracking utilizing CPU resources. Proficient in monitoring industrial manufacturing facilities and mining applications for enhanced operational efficiency.

- Abdulkhaligov Rashad (vs7vsr)

- Mei Jiaojiao (v6fisc)

Master's studies in Computer Science (Artificial Intelligence), with thesis paper being accepted by TDK. Bachelor's studies in Electronic Engineering, with two papers in signal processing, prizes in mathematical modeling competitions, two exchange semester programs, a degree in Chinese Law, eight months experience in patents drafting and analysis.

- Muliter Mark (uupw2m)

Machine Learning Engineer Trainee with experience developing object detection and anomaly detection systems for industrial projects. Computer Scientist BSc with a thesis paper about code optimization using ML.

- Ákos Rúzsa (fr2wt6)

R&D Software Engineer with extensive experience in ML, audio, image and video codecs and code optimization for performance-critical systems. In parallel to his work, he's also studying at ELTE's Computer Science MSc on the specialization of Artificial Intelligence.