# Acme Robotics Human Obstacle Detector and Tracker

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## 1. Executive Summary

In response to the evolving industrial landscape and the challenges posed by the COVID-19 pandemic, we propose the adoption of the Collaborative Industrial Robot (CIR). This innovative solution utilizes advanced human detection and tracking methods, enabling safe and efficient collaboration between robots and human workers in industrial settings. Equipped with cutting-edge sensors and real-time tracking capabilities, the CIR ensures workplace safety by maintaining safe distances and preventing potential collisions. By embracing this technology, businesses can address workforce shortages, adhere to social distancing guidelines, and optimize productivity in a professional and forward-thinking manner

## 2. Project Description

In the context of the Collaborative Industrial Robot (CIR), our project focuses on the imperative task of real-time human detection and tracking. Our solution entails a specialized human detection and tracking module, leveraging advanced computer vision algorithms. It abstracts the intricacies of the underlying algorithms and offers three operational modes: training, testing, and real-time execution.

Throughout the project, we will follow Agile Iterative Processs (AIP) to optimize our software development process. In the initial sprint, we implement backlog requirements, monitor bugs, and introduce features, while daily meetings ensure progress and resolve conflicts. Each sprint concludes with an iteration review for code and backlog assessment in preparation for the next sprint. This can be integrated with other modules like Controls and Motion planning/navigation to develop a fully operational robot.

### 2.1 Objectives & Deliverables

- Develop a pipeline for human detection.
- Develop a pipeline for human detection.
- Iteration Review Reports for each sprint.
- A final presentation and demonstration of the module's capabilities to the Acme team.

### 2.2 Assumptions

- Adequate computational resources are available for real-time processing.
- There is a shared understanding and agreement on the desired accuracy and FPS thresholds.
- The hardware and camera setup meet the project's technical requirements.
- Robot configurations are known.
- The training and testing data(Humans) are from the same distribution with similar characteristics.

### 2.3 Methodology

In the context of the Collaborative Industrial Robot (CIR), the approach for this project is created to meet the crucial duties of human identification and tracking. The process starts with the accurate real-time detection and labeling of humans from incoming image streams using Single-Shot Detection models like YOLO and its variations. A Kalman filter-based tracking system is put in place to guarantee the continuous and accurate association of detected humans over succeeding frames, with quality evaluation depending on metrics like Intersection Over Union (IOU). Additionally, parallel testing looks into different tracking algorithms like Medianflow, Goturn, or Lucas Kanade, as well as different detection algorithms like Histogram of Gradient (HoG), in order to ensure consistent and reliable human detection and tracking even in difficult scenarios. In order to ensure the safety and effectiveness of human-robot collaboration in dynamic industrial situations, this technique ensures the system's robustness and effectiveness.

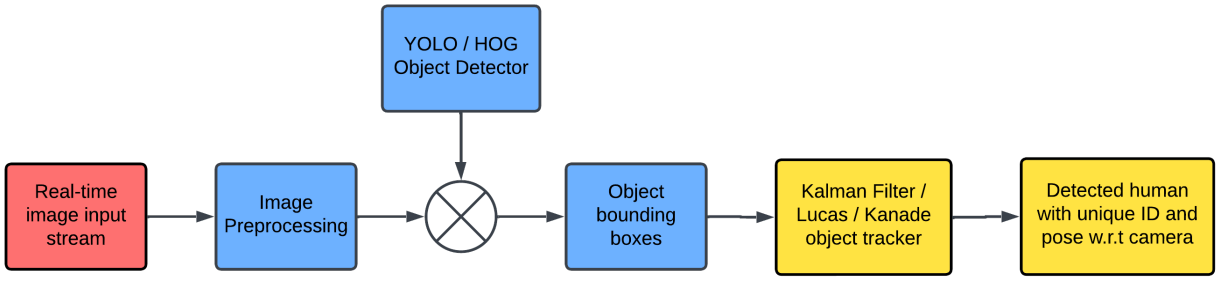


Figure 1: Implementation flow diagram

## 3. Project Timeline

1. **Phase 0**: October 10 2023 - October 17 2023
    - Software development project plan submission.
2. **Phase 1**: October 17 2023 - October 24 2023
    - Develop and test single human detection and tracking pipeline.
3. **Phase 1**: October 24 2023 - October 31 2023
    - Develop and test multiple human detection and tracking pipeline.

## 4. Tools & Software used

1. OpenCV 4.5.0 and higher versions are licensed under the Apache 2 License.
2. C++ version 11 or above.
3. CMake
4. Google Test
5. Doxygen
6. CppCheck
7. Valgrind
8. cpplint
9. CodeCoverage

## 5. Risk Assessment

1. **Technical Risk**: Ensuring the human detection and tracking model consistently meets high accuracy threshold may be challenging. Mitigation involves rigorous testing, frequent model updates, and exploration of alternative algorithms.
2. **Project Risk**: Unforeseen impediments or conflicts during development can slow progress. Daily meetings and proactive issue resolution will maintain project momentum, while adherence to the Agile Iterative Process minimizes such risks.

## 6. References


1. Redmon, Joseph, et al. "You only look once: Unified, real-time object detection." Proceedings of the IEEE conference on computer vision and pattern recognition. 2016.
2. Patel, Hitesh A., and Darshak G. Thakore. "Moving object tracking using kalman filter." International Journal of Computer Science and Mobile Computing 2.4 (2013): 326-332.
3. Vasuhi, S., M. Vijayakumar, and V. Vaidehi. "Real time multiple human tracking using kalman filter." 2015 3rd International Conference on Signal Processing, Communication and Networking (ICSCN). IEEE, 2015.
4. "OpenCV - Open Computer Vision Library." OpenCV, 11 Oct. 2023, opencv.org.