EVENT-BASED HIGHLY DYNAMIC OBSTACLE AVOIDANCE BASED ON STATE ESTIMATION AND OBJECT DETECTION

Shifan Zhu, Hochul Hwang, Shangqun Yu
University of Massachusetts Amherst

Motivation

Highly dynamic obstacles are challenging for mobile robotic systems to avoid by utilizing traditional frame-based cameras due to motion blur and latency issues. Here, we utilize an event-based neuromorphic camera and develop a pipeline to detect high-speed objects and predict their trajectories to output robot control commands for object avoidance. We believe that our method can improve safety in real-world navigation applications such as guide dog robots.

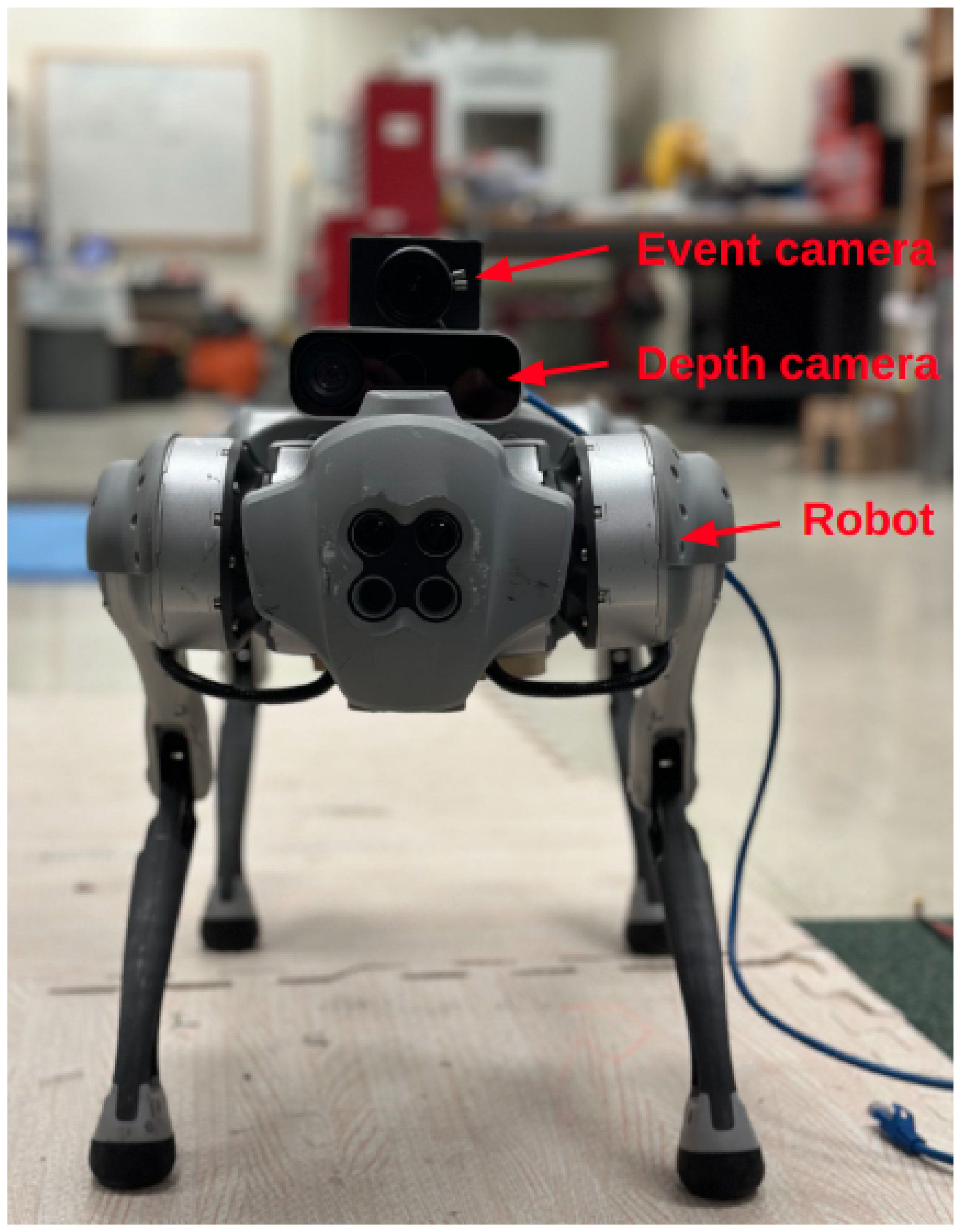

Figure 1: Device setup

Development plan

1. Calibrate intrinsic and extrinsic matrices of the event camera and synchronize the timestamp between the event camera and the depth camera.
2. Implement a feature-based baseline algorithm and neural network-based architecture for dynamic obstacle detection and trajectory prediction.
3. Implement a local path planner that generates robot control commands to avoid obstacles based on obstacle information.

Dynamic obstacle avoidance framework

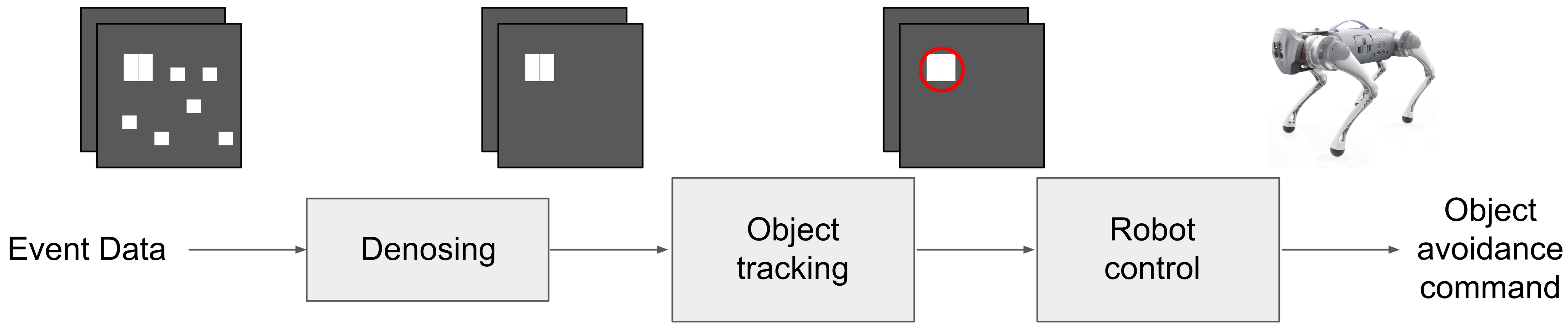

Figure 2: device setup

1. **Event data accumulation** We use a Dynamic Vision Sensor (DVS) event camera to record events for 2 millisecond and store it as a time surface image.
2. **Remove background noise** We use a Median blur filter to denoise the background noise.
3. **Dynamic obstacle detection** We utilize a thresholded time surface to filter the active dynamic objects. Then, we compute the average of the events to detect the dynamic obstacle. The dynamic obstacle is depicted as the red circle in the Fig. 3 Directions are counted between adjacent frames showing yellow lines.
4. **Robot control** Based on the obstacle predictions made by the detection algorithm, an obstacle avoidance action is selected and provided to the high-level controller.

Results and Discussion

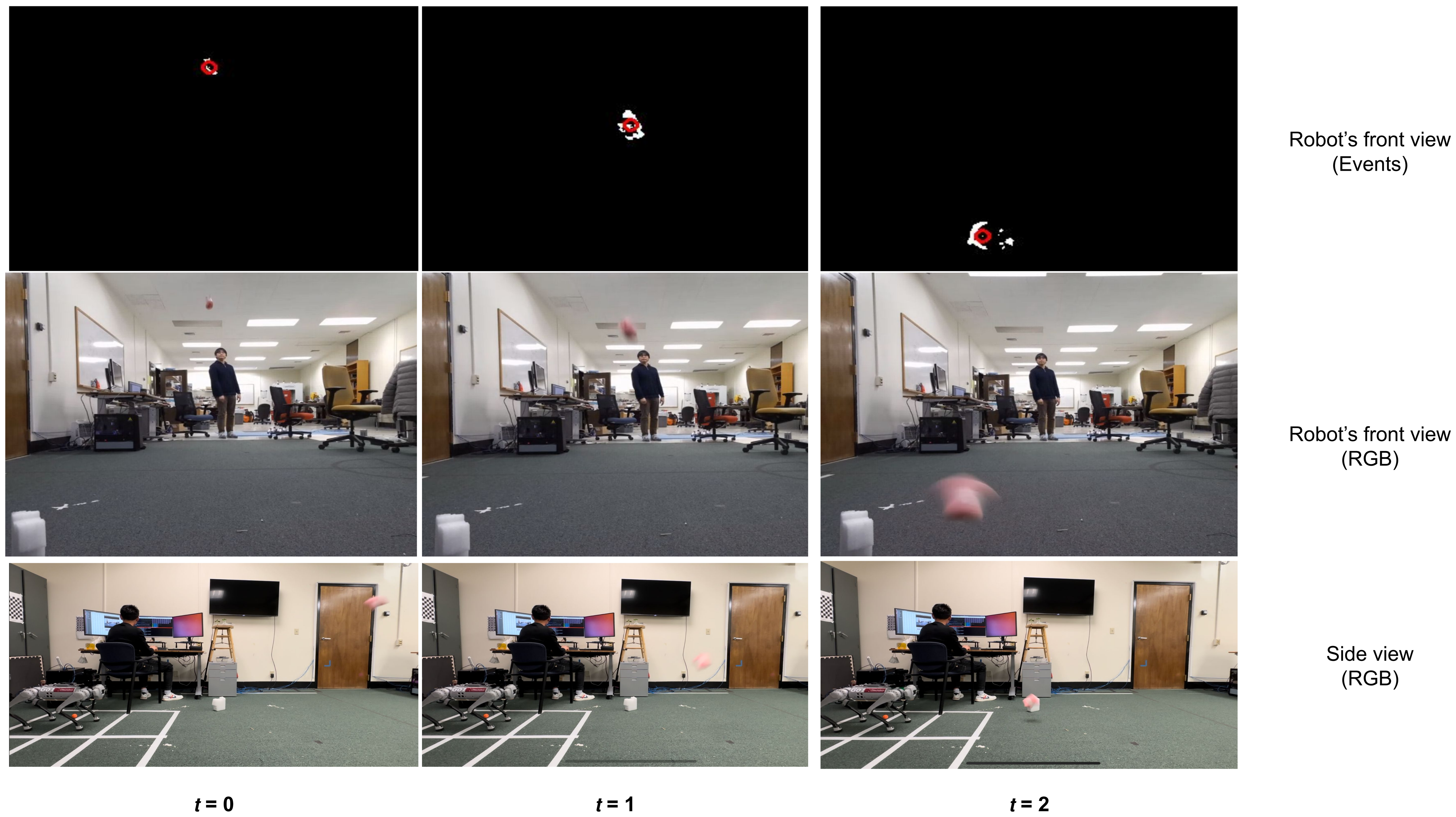

Figure 3: Dynamic obstacle detection output of an event-based detection algorithm

Preliminary results of the feature-based obstacle detection algorithm are shown sequentially in Fig. 3. The red circle depicted in the first row indicates the prediction of the obstacle position. We can observe in the figure that traditional frame-based methods (RGB) may suffer from motion blur and latency.