Surveillance – Enhanced Collision Avoidance

Project Proposal

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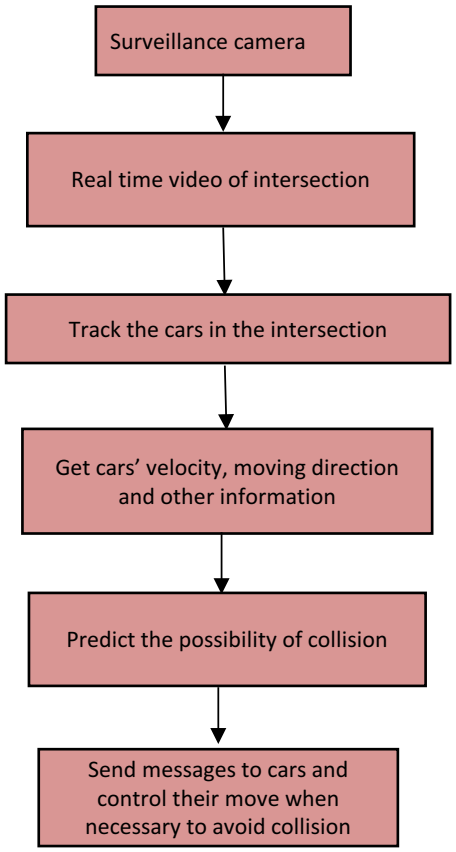
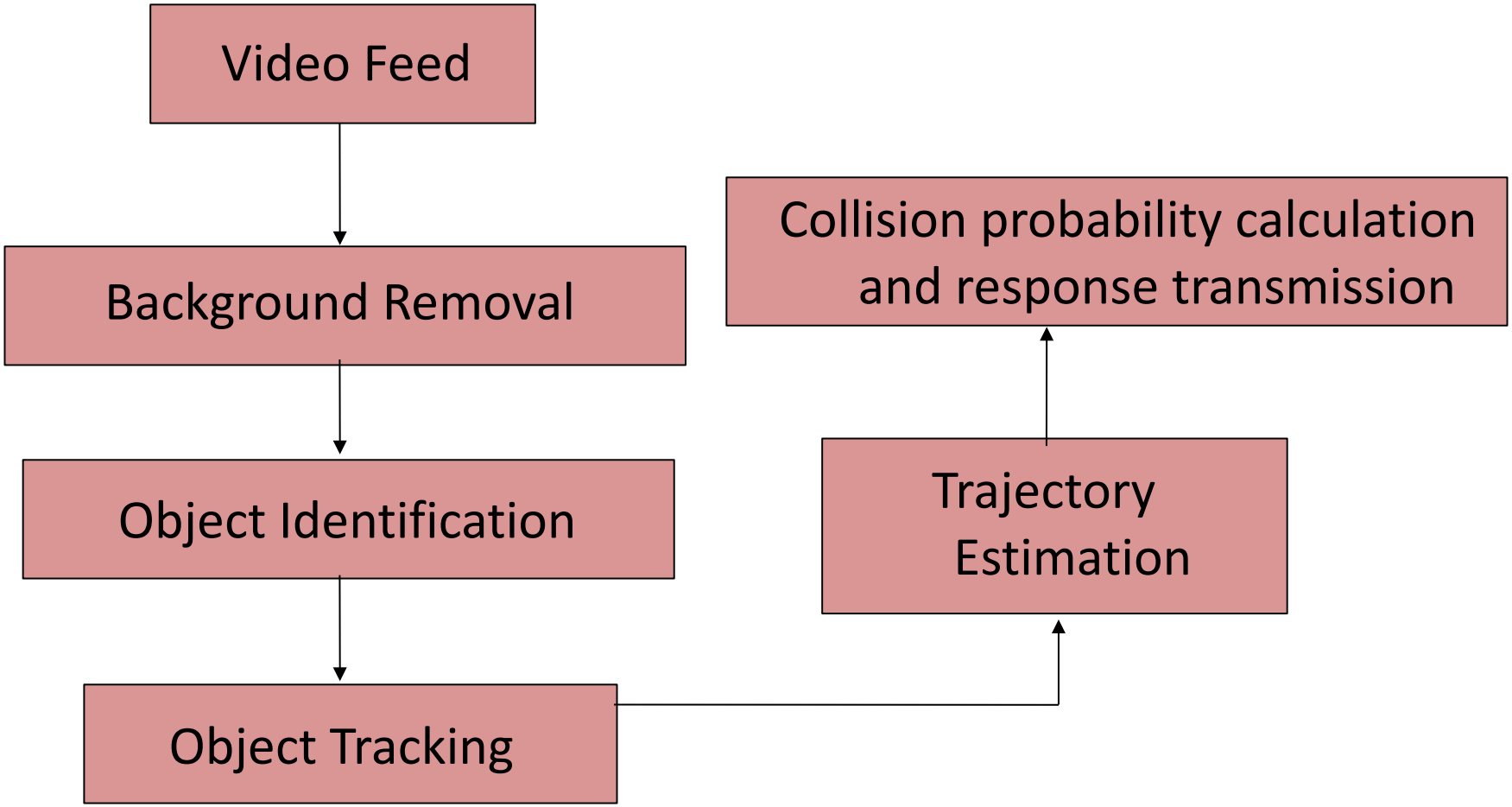
Motivation

System Description



- Final System
  - Integrated with the traffic monitors that already exist on the intersections and provide additional information for autonomous and non-autonomous vehicles
- Prototype
  - (1) Analysis system applied to live CCTV or prerecorded videos
  - (2) Simulation scenario in lab using a simple camera as a surveillance camera and remote-controlled cars to simulate the real cars

Algorithms: Flow Chart



Algorithms: Low Level View

- Background Removal

  - Estimate background to identify foreground objects (eg. Frame difference, mean filtering, Gaussian averaging. [4])

- Morphological post-processing
- Object Identification

  - Connected component labeling, blob detection (interest point detection), color statistics

Algorithms: Low Level View (contd)

- Object Tracking:

  - Feature based, optical flow based, mean shift, kalman filter [5][7]

- Trajectory Estimation/ Retrieval:

  - Compute projective transform between image coordinates and world coordinates from which position, velocity are calculated [6][7]

- Collision Prediction

  - Predict paths of objects and quantify as probability

Complexity Analysis

- Two Part System

  (1) Control center, with a real time video feed, DSP and a RF transmitter

  (2) Local environment, consisting of an intersection and independent cars with RF receivers

- Bottlenecks

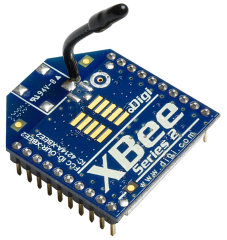
  - Total response time between video capture to response transmission maybe high depending on velocity of car

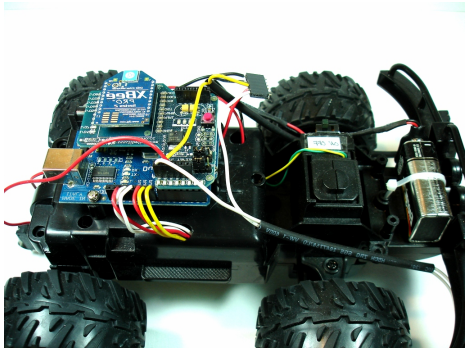
Challenges

- Accurate background estimation, changing background [4]
- Real time feature detection and grouping features for objects
- Handling fast and very slow moving objects
- Perspective transformation and estimating trajectories
- Quantifying results as probability and setting it as an appropriate threshold

Modeling Tasks

- Develop two autonomously driven RC Cars to model the collision system
- Have predefined collision path algorithms in place for generating different collision scenarios
- Use a communication device like a Xbee to dynamically transmit data from the two cars to the TMS Board
- Receive data from the TMS Board and take preventive measures to avoid collision





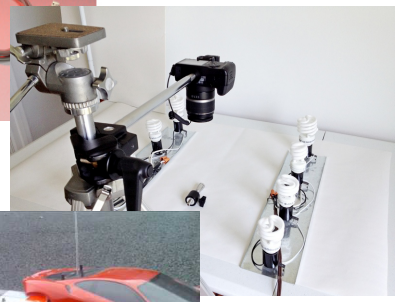
Training Data

- Real surveillance videos which including collision and non-collision scenarios as testing data [8,9]
- Also use MATLAB to simulate the intersection traffic
- Simulated crossing with remote controlled cars and camera

Rough Schedule

	Milestone	Associated Tasks	Completion Date
Milestone 1	Calculate speed, direction vector, and displacement of objects in a sample intersection surveillance video	• Pre-process input video • Isolate moving objects from background • Apply Kalman filtering to calculate metrics • Overlay data on the input video / MATLAB simulation • Test algorithms on live feed data	March 13
Milestone 2	Successfully run intersection simulation using remote-controlled cars	• Obtain two remote-controlled cars • Develop code to control two cars using relevant hardware • Perform tests controlling cars at different speeds, in collision and non-collision scenarios	April 1
Milestone 3	Derive percentage likelihood of a crash using car and human movement data from video feed and apply these warnings to intersection simulation	• Process mobile object metrics in real-time • Develop a set of equations to predict percentage likelihood of a crash using vectors and movement data • Continually test these algorithms on test vectors, sample intersection surveillance data, and the running simulation • Overlay these warnings live onto the video feed and evaluate human responses to warnings	April 15

Final Test Setup



- Equipment
  - TI TMS320C6416 Fixed-Point DSP Board
  - Overhead Video Camera
  - Remote-Controlled Cars (2) and RF Transmission Board
  - Physical Mini-Intersection for Simulation
- Simulation
  - Remote-controlled cars running on a mock intersection, with camera capturing live video of the entire intersection from directly above, fed into the DSP
  - Movement data of cars and simulated pedestrians overlaid onto live feed
  - Test scenarios for vehicle-vehicle and pedestrian-vehicle non-collision, near-collision, and collision instances run, with vehicles being corrected by the DSP if a collision is imminent

References

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Questions?