Surveillance – Enhanced Collision Avoidance

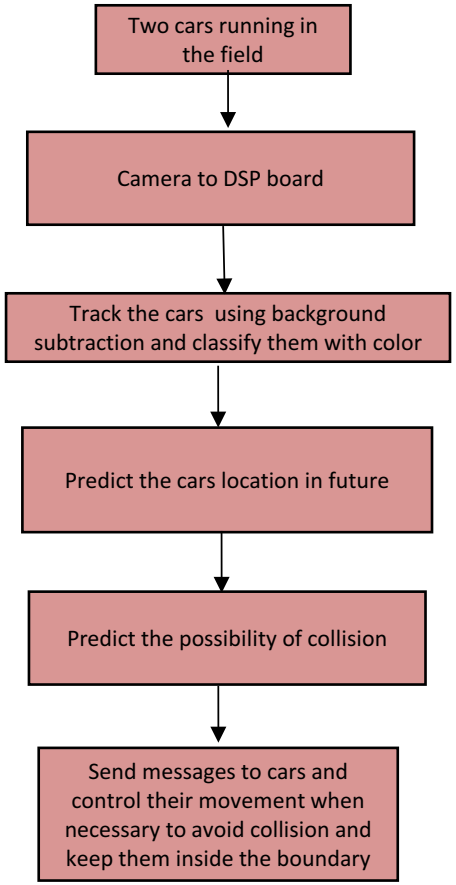
Final Presentation

Rohit Annigeri Akash Joshi Yifei Shen Thaddaeus Voss

USC
School of Engineering
University of Southern California

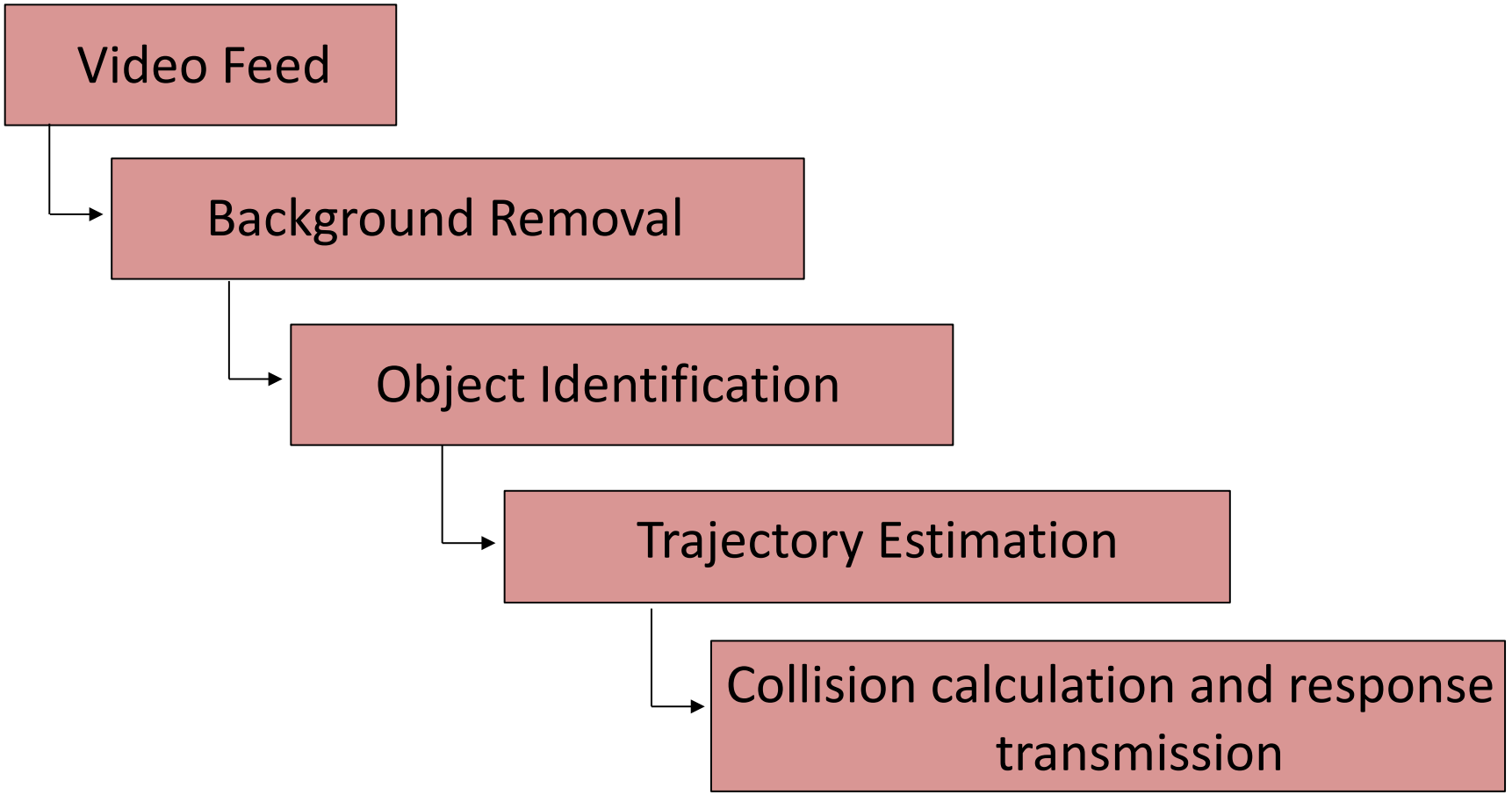
Motivation

System Description



- Final System
- Simulating the collision scenario with two remote control cars and using a simple lab camera as surveillance camera, send instructions to take control the cars when it's necessary to avoid collision.

Algorithms: Flow Chart



Algorithms: Low Level View

- Background Subtraction

  - Estimate background to identify foreground objects. Used Gaussian model to tag background (Initial training)([4])

- Object Identification

  - Offline : Used LDA to classify between foreground and cars.

  - Online : Explore foreground pixels to distinguish between cars. Used Color statistics.

Algorithms: Low Level View (contd)

- Trajectory Estimation/ Retrieval:

- Offline: Kalman filter based path estimation [5][7]
- Online: Predicted position based on car speed and ability to make decisive turn.

- Collision Prediction and Response Transmission:

- Thresholding on distance after which collision is not preventable.
- Making appropriate action to avoid collision. Transmission to cars.

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

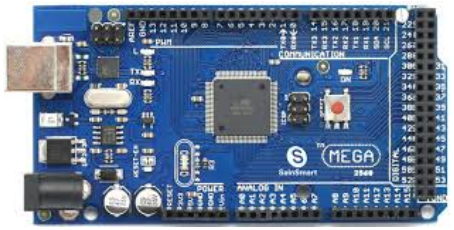
  - Foreground object detection (background removal)
  - Turning decision calculation
  - Transmission rate from DSP to car.

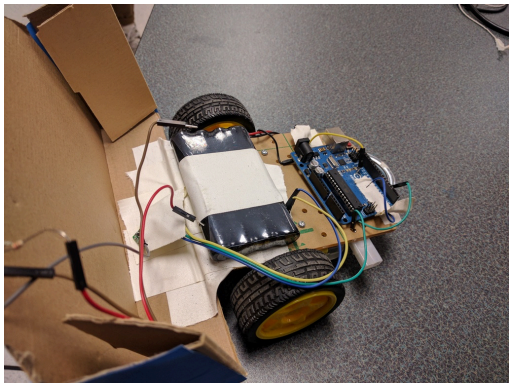
Challenges

- Accurate background estimation, changing background [4]
- Speeding up overall execution.
- Distinguishing between the cars.
- Turn Decision calculation and response transmission.

Modeling Tasks

- Build two autonomously driven RC cars to model the collision system
  - Cars: Hobbyist Motors + Wheels
  - Receivers: Arduino Uno (x2)
  - Transmitter: Arduino ATmega2560
- One-way communication to both of the cars simultaneously from the DSP board through the transmitter

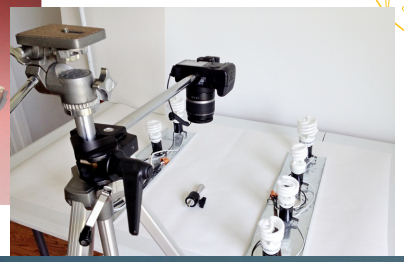




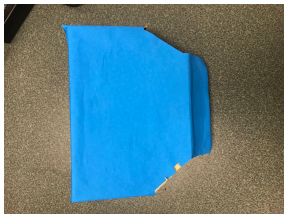
Final Schedule

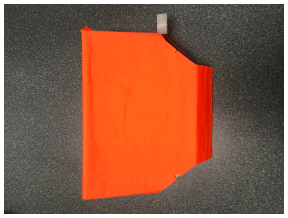
	Milestone	Associated Tasks	Completion Date
Milestone 1	Detect objects in a scene, identify each of the objects, and predict future location	• Isolate moving objects from background (R, Y) • Detect objects in the scene (R, T) • Identify objects (R, T) • Predict future location (Y, R)	March 13
Milestone 2	Successfully run intersection simulation using remote-controlled cars	• Obtain two remote-controlled cars (A) • Develop code to control two cars using relevant hardware (A) • Perform tests controlling cars at different speeds, in collision and non-collision scenarios (R, Y, T, A)	April 7
Milestone 3	Derive percentage likelihood of a crash using car metrics and apply these warnings to intersection simulation	• Transmit successfully over GPIO to remote-controlled cars (A, R) • Develop algorithm to keep cars within the intersection (R, T, Y) • Develop and implement algorithms to avoid a collision (Y, R, T, A)	April 19

Final Test Setup



- Equipment
  - TI TMS320C6416 Fixed-Point DSP Board
  - Overhead Video Camera
  - Remote-Controlled Cars (2) and RF Transmission Board





- 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 overlaid onto live feed
  - Test scenarios for vehicle-vehicle non-collision, near-collision, and collision instances run, with vehicles being corrected by the DSP if a collision is imminent

References

[1] https://www.bloomberg.com/news/articles/2016-09-12/google-car-project-loses-leaders-and-advantage-as-rivals-gain
[2] http://inhabitat.com/lexus-unveils-autonomous-advanced-active-safety-research-vehicle-at-ces-2013/
[3] https://www.newyorkpersonalinjuryattorneysblog.com/2013/08/new_york_accident_prevention_p_1.html
[4] J. Gallego, M. Pardàs, and G. Haro, "Enhanced foreground segmentation and tracking combining Bayesian background, shadow and foreground modeling," Pattern Recognition Letters, vol. 33, no. 12, pp. 1558–1568, Sep. 2012.
[5]. [Online]. Available: http://www.cc.gatech.edu/~ksubrama/files/FPGA_Report.pdf. Accessed: Feb. 13, 2017.
[6]. [Online]. Available: http://www.kev-smith.com/papers/smith-thesis.pdf. Accessed: Feb. 13, 2017.
[7]. S. Kang; J. Paik; A. Koschan; B. Abidi & M. A. Abidi (2003). "Real-time video tracking using PTZ cameras". Proc. SPIE. 5132: 103–111. CiteSeerX 10.1.1.101.4242Freely accessible. doi:10.1117/12.514945.
[8] https://www.youtube.com/watch?v=eMl5u-iENr4
[9] https://www.youtube.com/watch?v=nsHYg3ENgk4
[10]http://snakeclamp.com/blog/wp-content/uploads/2015/06/DSLR-overhead-2-reduced.jpg
[11] http://www.ti.com/diagrams/med_tmdsdsk6416_6416_kit_72.jpg
[12] https://i.ytimg.com/vi/7Vrk0xX7cUQ/hqdefault.jpg
[13] https://www.isr.umd.edu/~austin/enes489p/projects2011a/CollisionAvoidance-FinalReport.pdf

Questions?