Kalman Filter Driven Video Subsampling for Energy Efficient Computer Vision

SenSIP Algorithms and Devices REU

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MOTIVATION

Current problems in embedded object tracking:

- ❑ Lack of efficient image subsampling techniques
- ❑ Problem with excessive use of high resolution videos for object detection
- ❑ Lack of energy-efficient image sensors

Fig.1. KBCR-S02MU camera for embedded systems [1]

PROJECT AIM

- ❑ Reduce energy expense during image capture while maintaining computer vision task accuracy
- ❑ Use Kalman filtering to effectively subsample by alternating between detection/update and prediction [3]

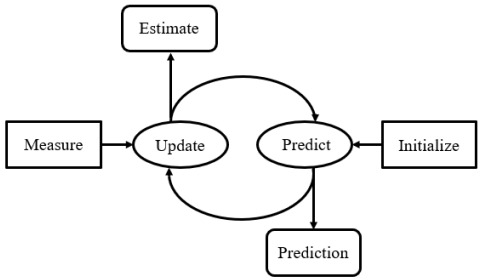

Fig.2. Kalman Filter block diagram

METHOD

Kalman Filter Equations [6]

State Prediction: $x_{pred} = Ax_{n-1}$

Covariance Prediction: $P_{pred} = AP_{n-1}A^T + Q$

Innovation: $y = z_n - Hx_{pred}$

Innovation Covariance: $S = HP_{pred}H^T + R$

Kalman Gain: $K = P_{pred}H^T S^{-1}$

State Update: $x_n = x_{pred} + Ky$

Covariance Update: $P_n = (I - KH)P_{pred}$

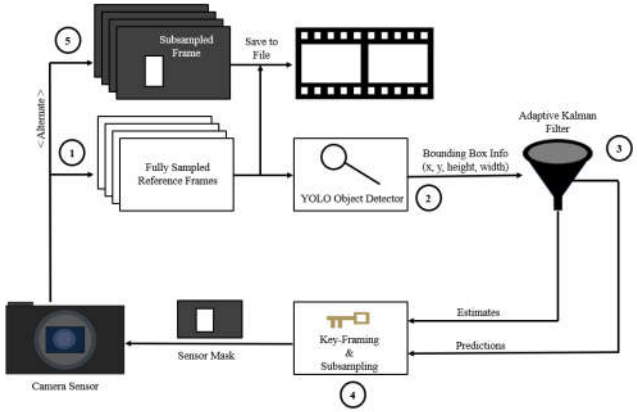

Fig.3. Algorithm for efficient video subsampling

Fig.4. Example of bounding box being used to subsample an image. [2]

RESULTS

- ❑ Mean intersection over union (IOU) and mean deactivated pixel ratio for varying update intervals from 28 videos:

	Continuous	Alternating	5 Predictions	10 Predictions
Mean IOU	0.12	0.118	0.112	0.108
Ratio	0	0.327	0.55	0.599

Table.1. Results from tests run on single object videos from tb100 data set [2]. Energy savings % is the % of pixels disabled.

FUTURE WORK

- ❑ Adjust tracking using adaptive Kalman filter
- ❑ Implement multi-object tracking
- ❑ Increase single target tracking accuracy

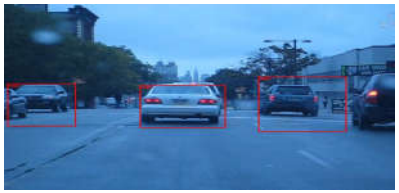

Fig.5. Mutli-object detection example [6]

REFERENCES

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[2]http://cvlab.hanyang.ac.kr/tracker_benchmark/datasets.html

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[6] http://greg.czerniak.info/guides/kalman1/

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