

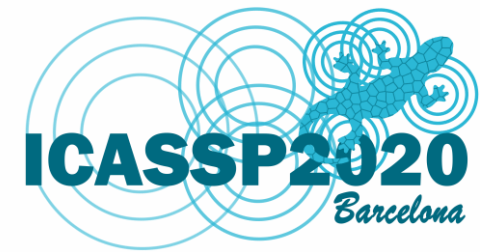


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Image Segmentation Based Privacy-Preserving Human Action Recognition for Anomaly Detection



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1. Motivations

- Anomaly Detection for Surveillance Applications;

2. Privacy-protection Issues

- Previous Work;
- Current Work;

3. Methodology

- Image Segmentation Using Mask-RCNN;
- Action Recognition Algorithm;

4. Results and Discussions

- Detection Results for UCF101 and HMD51;
- Learning Processes for UCF101;

5. Conclusions and Future Work

Motivations

Anomaly Detection for Surveillance Applications



CCTV Automatic Investigation



Outdoor Surveillance



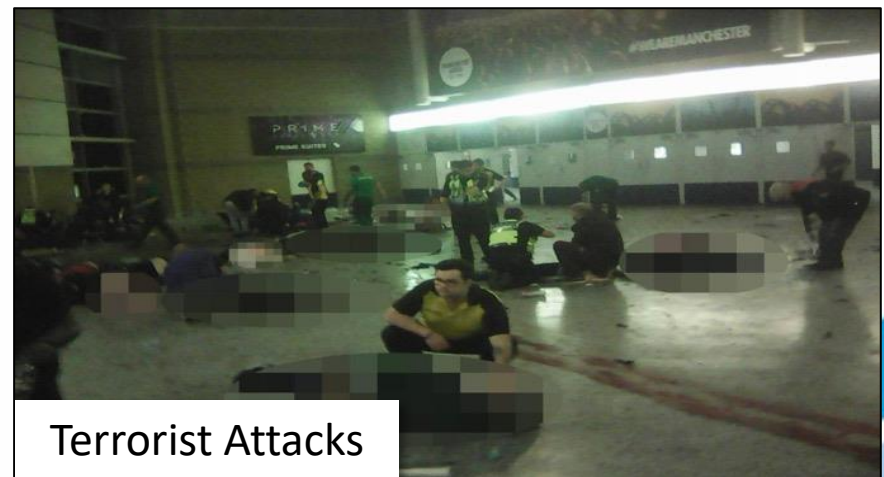
Automated Alarm



Wide Area Monitoring

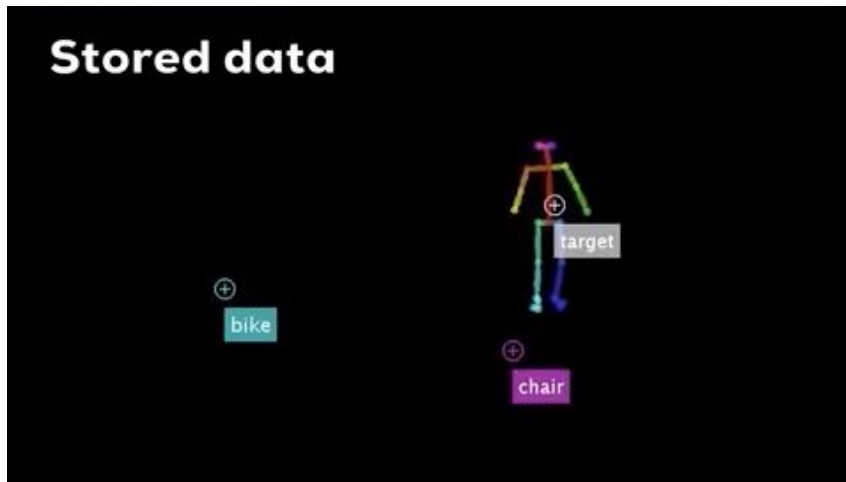
Motivations

Anomaly Detection for Surveillance Applications

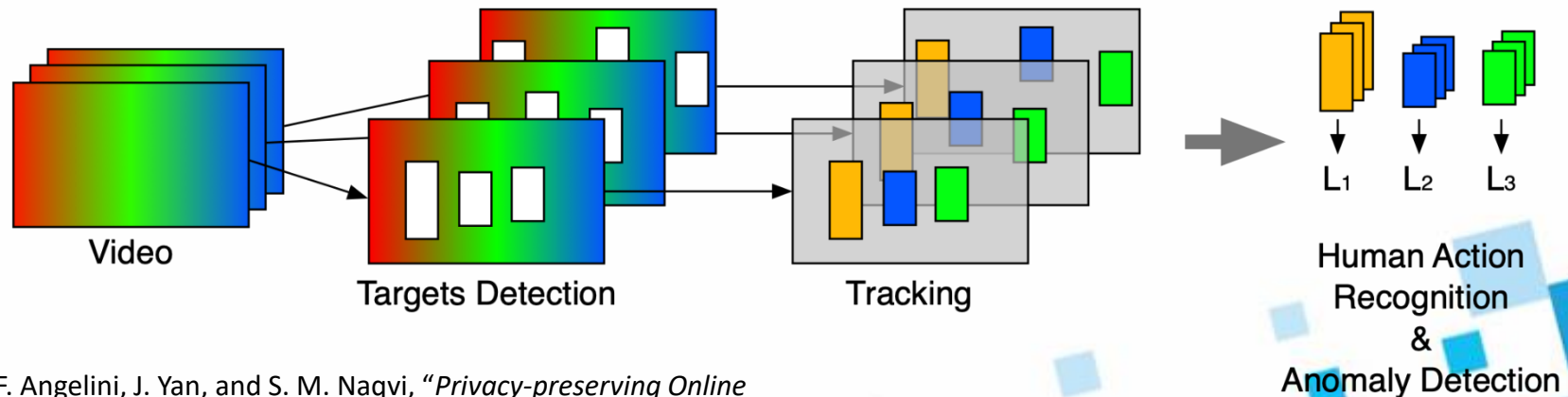


Previous Works

Privacy-preserving Online Human Behaviour Anomaly Detection based on Body Movements and Objects Positions [1]



- Target detections are used for *tracking*. Can we also use them for *Anomaly Detection*?
- Can we define an Anomaly Detection system that **does not require to store any** RGB data?

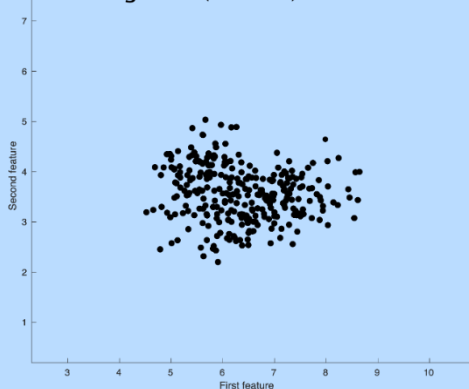


[1] F. Angelini, J. Yan, and S. M. Naqvi, "Privacy-preserving Online Human Behaviour Anomaly Detection Based On Body Movements And Objects Positions", ICASSP 2019.

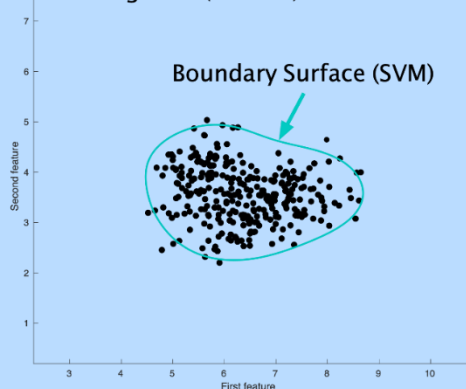
Previous Works

Semi-supervised Anomaly Detection (SVM one-class)

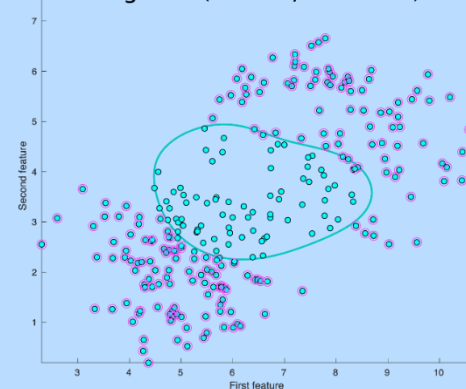
Training Data (Normal)



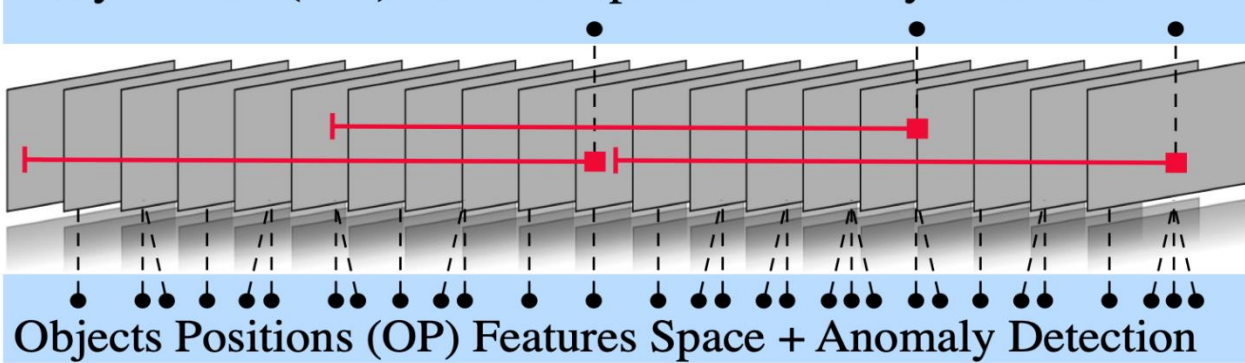
Training Data (Normal)



Testing Data (Normal/Abnormal)



Body Motion (BM) Features Space + Anomaly Detection



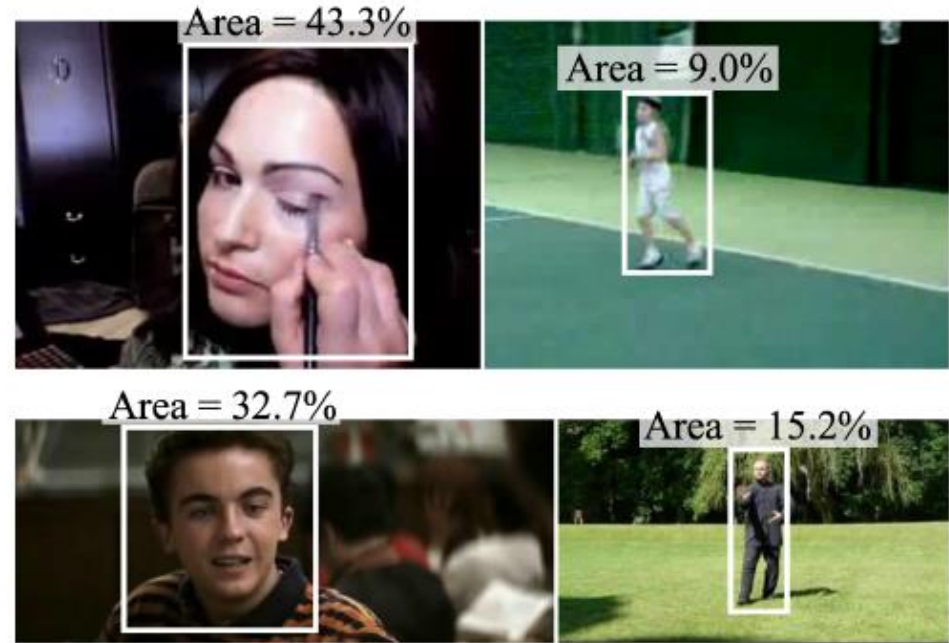
BM based output

Logic OR Level

OP based output

Joint BM-OP output

- Target data: human body.
- Contextual data: the background and visible objects.

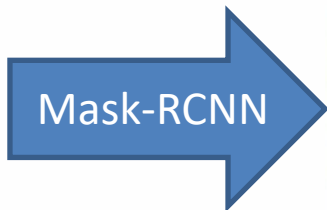


- Can contextual information and a limited amount of target data to perform effective privacy-preserving HAR?

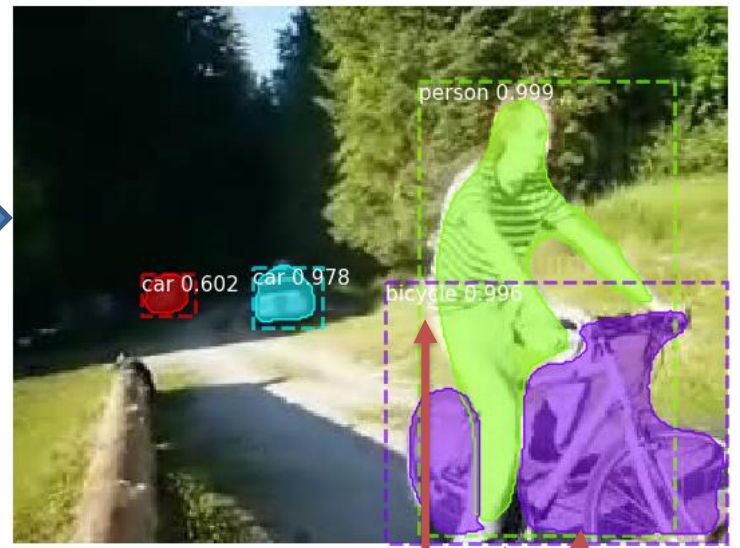
Image Segmentation Using Mask-RCNN

Mask-RCNN is implemented to provide three outputs for each candidate target:

Input



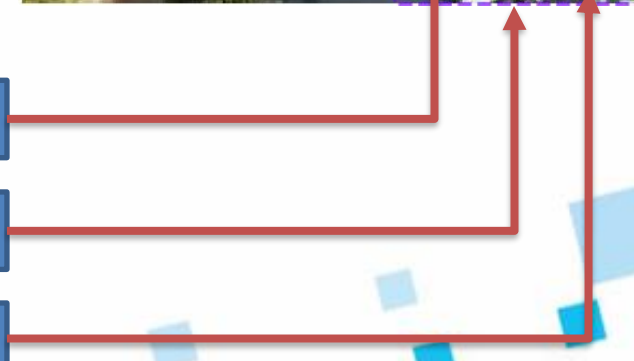
Output



① Class label c

② Bounding box b

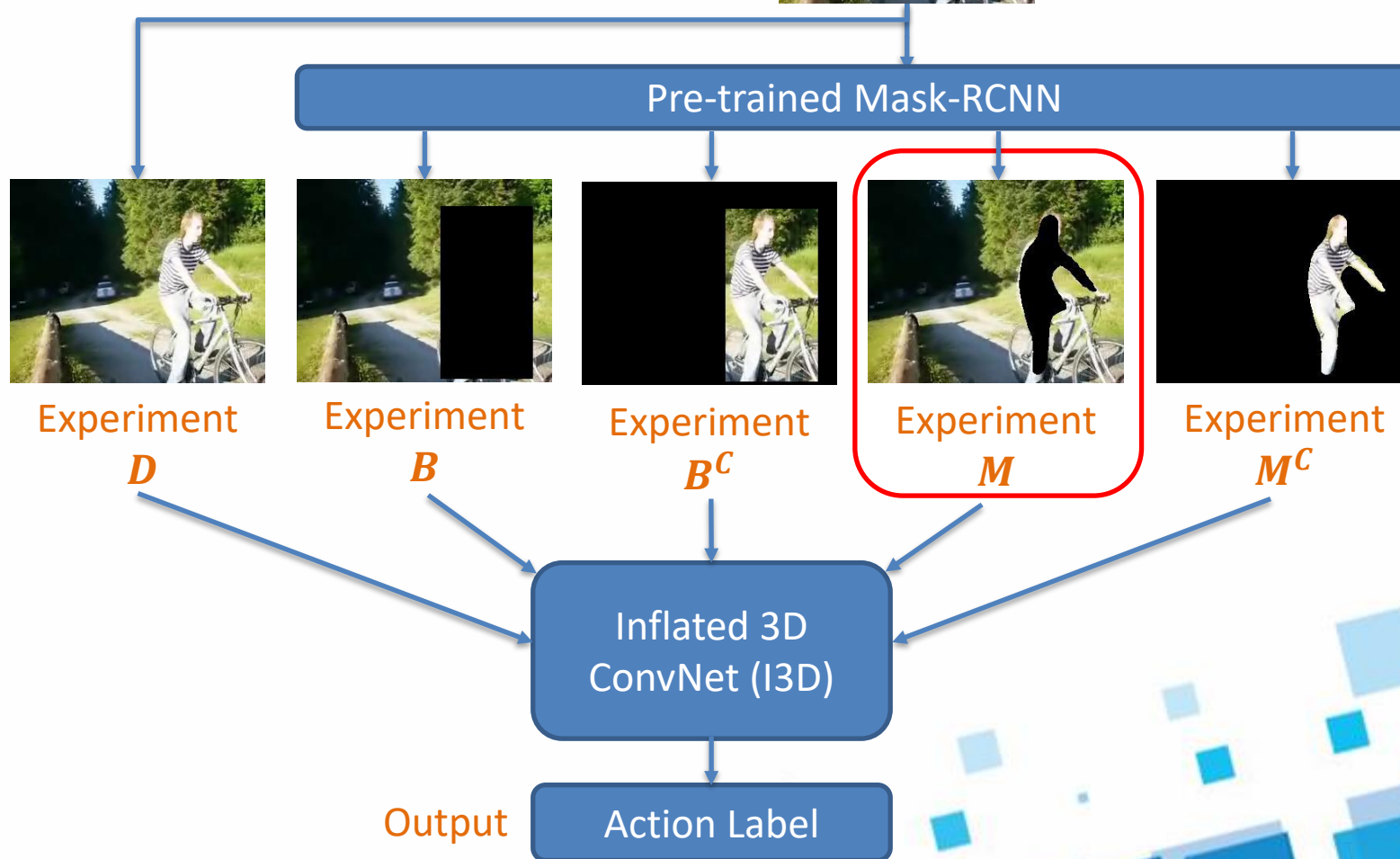
③ Segmentation mask $S_c(p)$



Methodology

Action Recognition Algorithm

Input



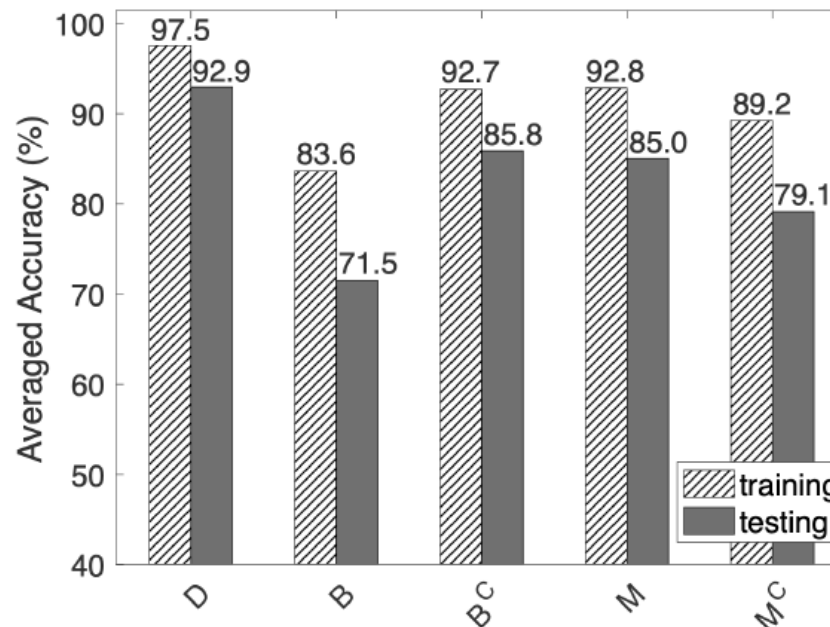
Output

Action Label

Recognition Results for UCF101

UCF101

Experiment		D	B	B^C	M	M^C
Split 1	Train	97.6	83.6	92.5	92.6	89.0
	Test	92.7	71.4	85.8	84.2	78.5
Split 2	Train	97.5	83.6	92.7	93.1	89.2
	Test	93.5	71.9	86.2	86.7	80.8
Split 3	Train	97.4	83.6	92.8	92.7	89.5
	Test	92.6	71.4	85.5	84.1	78.1

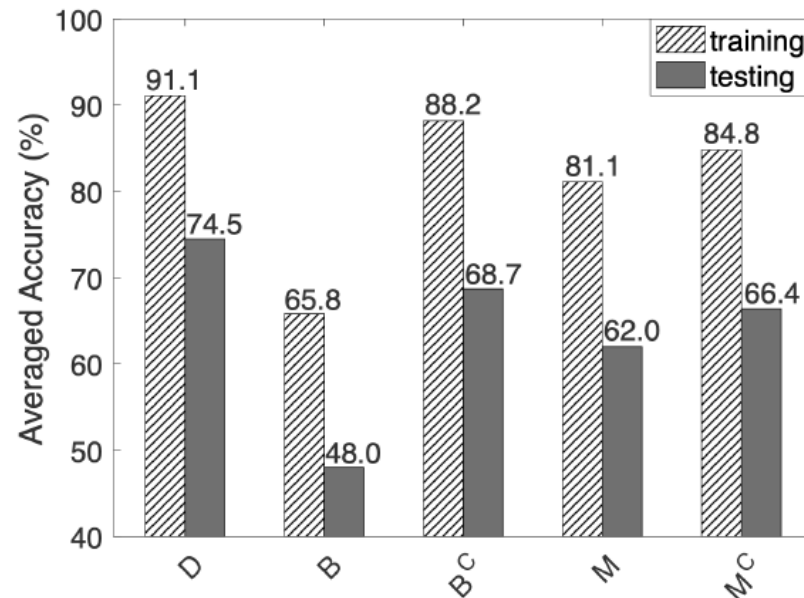


false negative rate for UCF101: 1.5%

Recognition Results for HMDB51

HMDB51

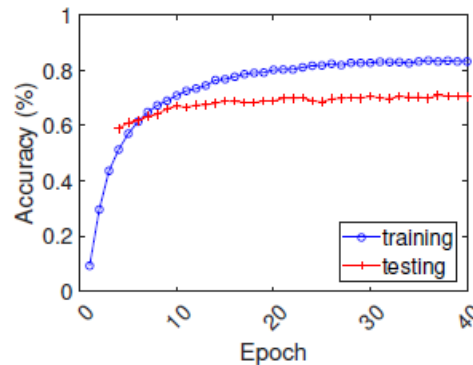
Experiment		D	B	B^C	M	M^C
Split 1	Train	90.9	65.7	87.8	80.2	84.7
	Test	75.2	50.0	70.4	64.3	66.7
Split 2	Train	91.2	66.5	88.9	81.9	85.9
	Test	72.9	46.3	68.0	60.6	64.6
Split 3	Train	91.1	65.1	88.0	81.2	83.7
	Test	75.5	47.8	68.0	61.1	83.7



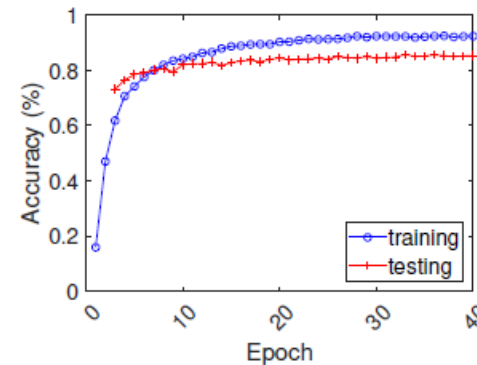
false negative rate for HMDB51: 5.4%

Learning Process for UCF101

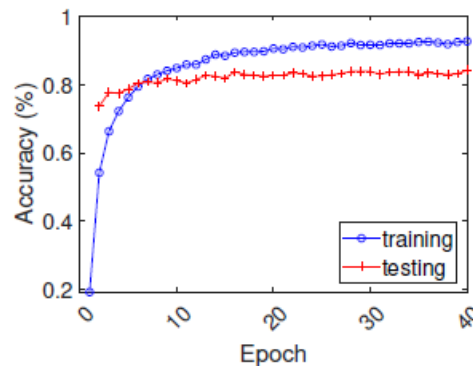
Example of training/testing curves obtained from UCF101 Split1.



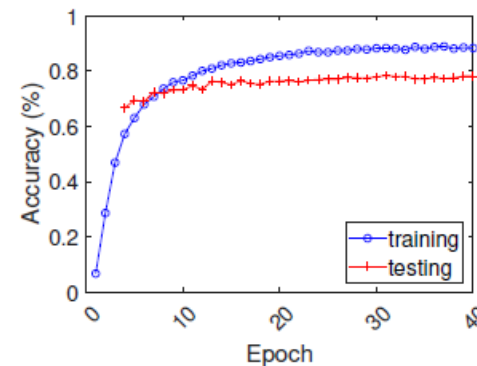
(a) Experiment B .



(b) Experiment B^C .



(c) Experiment M .

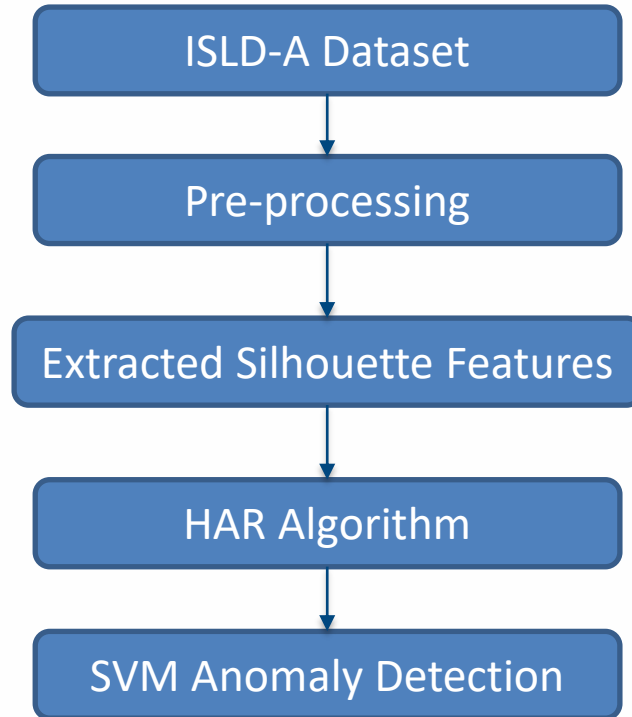


(d) Experiment M^C .



- Only contextual information is provided, the network can still classify most of actions.
- When the target data is removed, the detection accuracy is still high enough.
- Pre-processed data can preserve sensitive data and keep human action recognition performance.

Future Work



Human and Object Target



Multi Human Targets



Privacy-preserving Anomaly Detection

On

ISLD-A DATASET

Intelligent Sensing Lab,
Newcastle University, UK



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Thank You