2020「中技社科技獎學金」
2020 CTCI Foundation Science and Technology Scholarship
境外生生活助學金
Living Grant for International Graduate Students

Deep Spatial-Temporal Network For Flame Detection

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Abstract

Every year, fire accidents cause substantial economic losses and casualties. Being able to detect a fire at the early stage is the only way to avoid notable disasters. Deep Neural Networks (DNN) have become a popular foundation for state-of-the-art safety system. In the present work, we proposed a two-stage cascaded architecture. In the first we introduced the Spatio-Temporal network, which efficiently and effectively combines both shape and motion flicker based. Besides, to minimize false-positive due to some object similar to flame, in second original image and heatmap of candidate region are fused for improving abilities of to distinguish whether it is a fire or not.

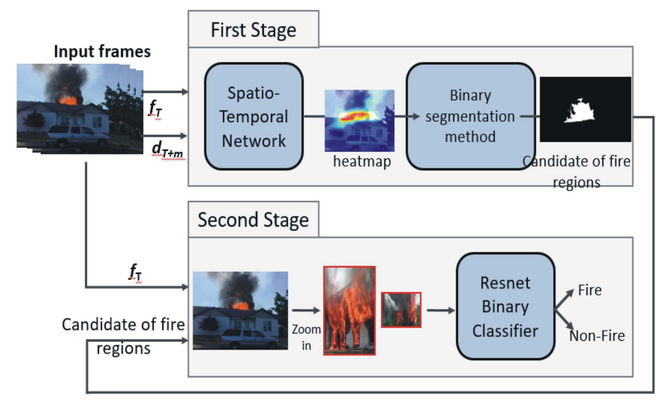
Motivation

- Vision-based fire detection systems have fast response.
- Monitor larger areas and higher probability of successes than conventional sensor base

Datasets

We evaluated our method on Taiwan-tech dataset, BoWfire Dataset .The performance is measured in terms of accuracy and F1-Measure score. **Networks are trained** on Nvidia GTX 1080Ti with 11 GB memory processor using Pytorch Library and Ubuntu 64-bit operating system with 64 Gigabyte RAM installed on an Intel(R) i7-7700K CPU @4.20GHz.

Methods



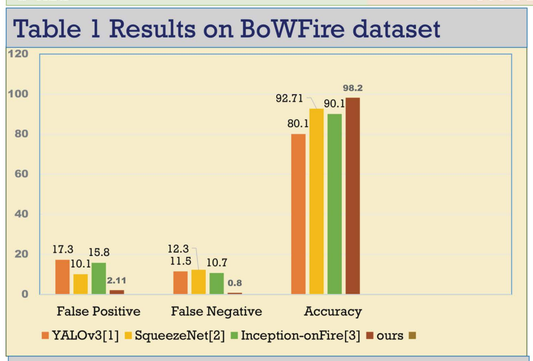
The overview of our approach. First stage, sending frames f_{t+l}, l = [−T,T] into spatiotemporal Net to get heatmap of fire and use it find fire region. Second stage, zoom in the region proposal of frame at time at time and used fire binary classifier to classify whether it is fire or not.

Experimental Results

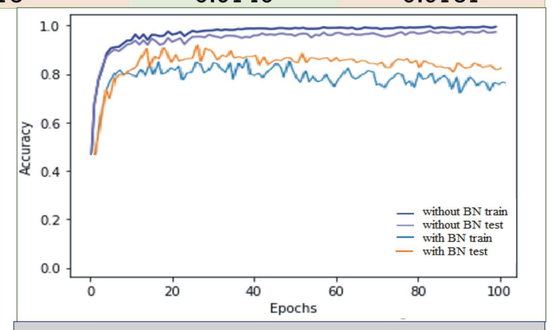
The experimental results obtained from datasets, used to compare with other state-of-the-art methods such as YOLOv3[1], sqeezenet [2] , InceptionV1-OnFire [3] please as shown in table below.

Method	Recall	Precision	F-Measure
YOLOv3 [1]	0.9813	0.9173	0.9415
sqeezenet [2]	0.9579	0.9582	0.9580
InceptionV1-OnFire [3]	0.8139	0.9010	0.8646
Ours	0.9775	0.9740	0.9757

Table 1 Results on BoWFire dataset

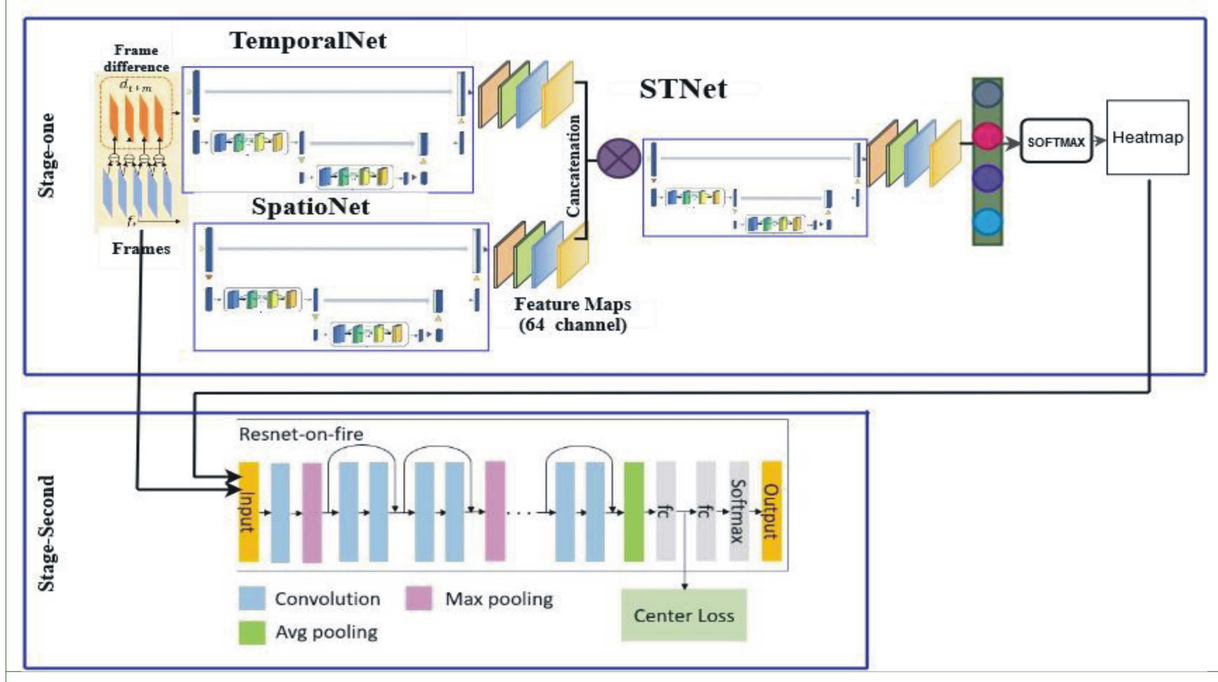


Comparison on Taiwan Tech dataset



Learning process of network with and without batch normalization

Network Architecture



- Structure of model consists of SpatioNet, TemporalNet, STNet, convolutional (Conv), pooling, fully connected (fc) layer & softmax with center loss.
- SpatioNet, TemporalNet and STNet, all the three components have a similar architecture that is composed of 1x1 conv and DenseU-Net.
- DenseNet has the cell of DenseBlock which consists of Conv(1×1) - ReLU−Conv(3×3)−ReLU

Conclusion

In this study, we proposed a novel two-stage architecture for early fire detection. Even though both SpatioNet and TemporalNet play a vital role to produce an enhancement on performance, the TemporalNet provide more contributions than SpatioNet when they are combined. By introducing the center loss to our network, the proposed network is able to learn more discriminative features.

References

1. Redmon, J, et al. "Yolov3: An incremental improvement." arXiv preprint arXiv:1804.02767 (2018).
2. Dunnings, A,. et al. "Experimentally defined convolutional neural network architecture variants for non-temporal real-time fire detection." 2018 25th IEEE (ICIP).
3. Muhammad, K, et al. "Efficient deep CNN-based fire detection and localization in video surveillance applications." IEEE Transactions on Systems, Man, and Cybernetics: System 49.7 (2018): 1419-1434.