Forest Fire Detection Review Report

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Main task

A brief review of DL methods and their applications on the UAV-based imagery to solve classification, object detection, and semantic segmentation problems.

- Environment Mapping
- Urban Mapping
- Agriculture Mapping

Highlights:

- UAVs offer flexibility in data collection, they present the dynamic data with the embedded RBG camera, multispectral, hyperspectral, thermal and LiDAR sensors.
- The sensor on the UAVs can generate different altitude and point-of-view data, which contains more features like patterns and textures etc.
- This survey is particularly related to UAV-imagery, while some of the others focus on the DL in remote sensing but not UAV-based imagery.

DNN:

- Models Types;
- Validation metrics: ROC curve, F-score, IoU and other metrics.

- **classification**
  labeling the image or the patch according to their classes.
- **object detection**
  draw a boundary box around the object and labeling them.
- **semantic and instance segmentation**
  draw the region or structures around the boundary of object, i.e., distinguish the object at the pixel level.
  - The semantic segmentation can not distinguish multiple objects of the same category.
  - detect objects in pixel-level mask and labeling each mask into a class label.
- **regression**
  In comparison to classification, regression tasks using DL is not often used

Scene-Wise Classification, Object Detection, and Segmentation

- **One-stage detectors:**
  regression-based methods, directly make classification and detect the location of the objects. They tend to have lower accuracy.
- **Two-stage detectors:**
  region proposal-based methods, usually 2 steps:
  - generate the candidate boundary box(region)
  - classify the regions into object classes, refine the boundary. The widely used algorithm is the strategy proposed with **Faster-RCNN** and also other methods.

- real-time implementation on the UAVs
- The accuracy decreases due to the noise from the hyperspectral or high-dimensional data.
- The difference between the training and testing images.
- domain adoption and transfer learning
- attention based mechanisms —— transformer
- Multi tasks learning

There are 3 levels of the smoke and early fire detection system according to this review.

- System(platform)
- Sensors(types)
- Methods(traditional + deep learning based)

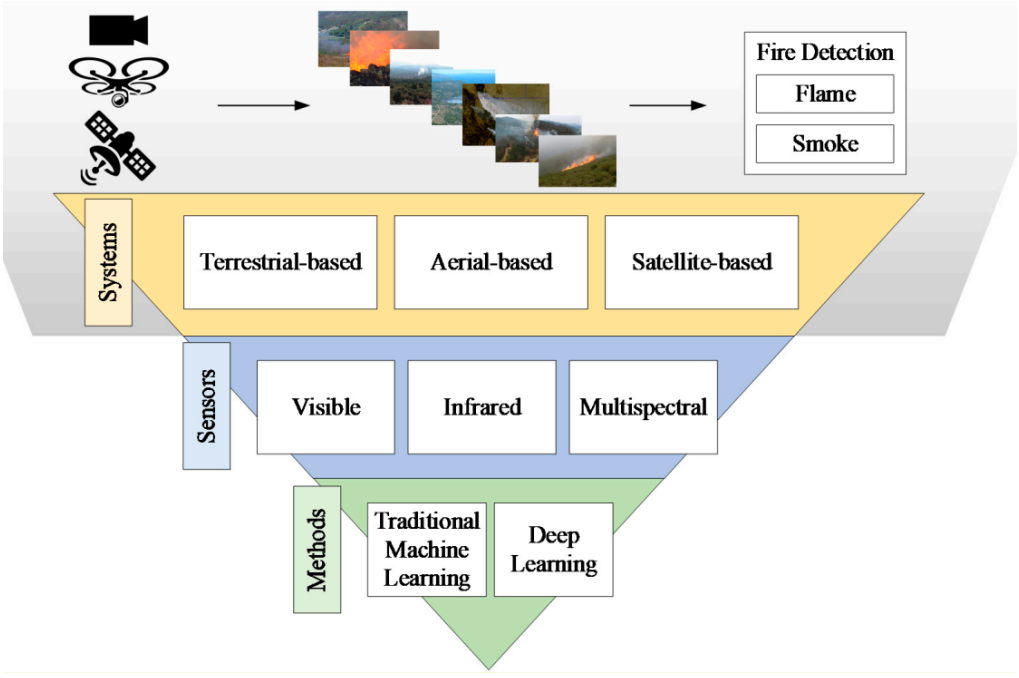


Figure: the 3 levels of the detection systems

A Review on Early Forest Fire Detection Systems Using Optical Remote Sensing —— UAV based detection

UAVs can provide border and more accurate perception, get through a dangerous and inaccessible zones.

Traditional

- noise reducing + color space + threshold = fire segmentation
- color space + Kalman filter = smoke detection
- color + motion features = fire and smoke segmentation(The flame has turbulent features → optical flow)
- (ROS + SLAM + DJIF550 = navigation) + (color, movement, temporal variation of fire intensity) = Simulation implementation

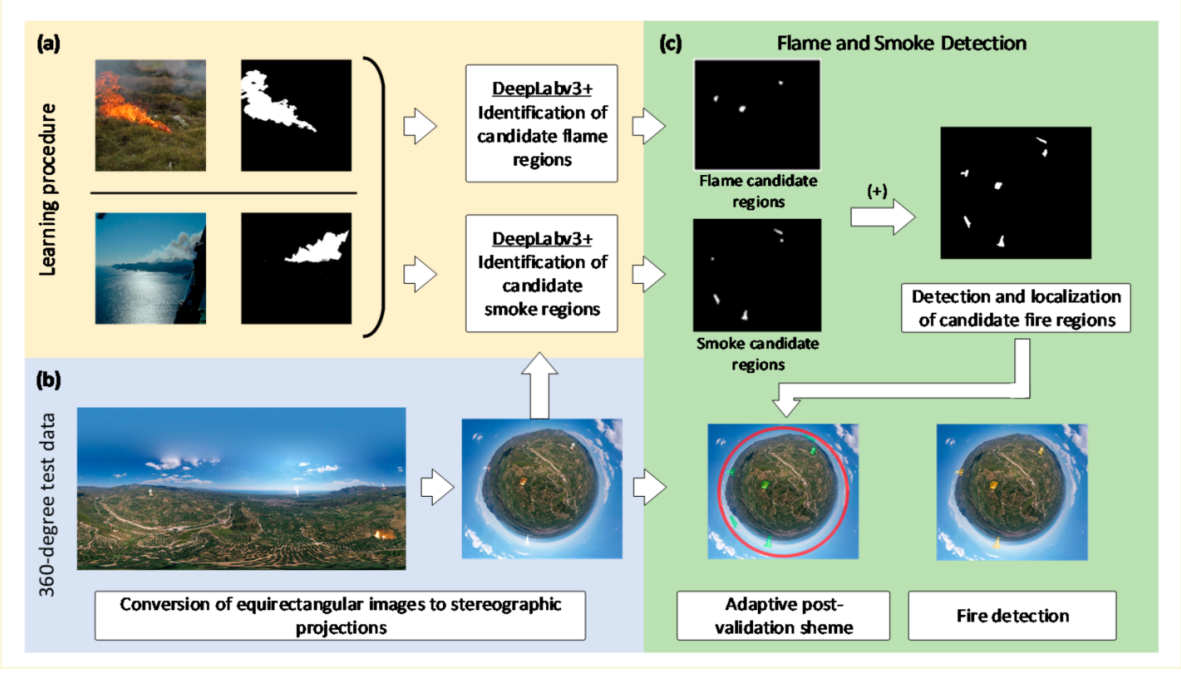
Deep learning based

- Deep convolutional network(15 layers)
- Subregion selecting + YOLOv3 backbone + ZenMuse(4k) = detection
- YOLOv3(on ground station) + UAVs capturing → UAV flight path planning and replanning.
- fog computing + CNN = reducing the false alarm rate.
- 360-degree CMOS + DNN + fire dynamic texture = reduce the false alarm caused by the sunlight reflection and cloud.[1]

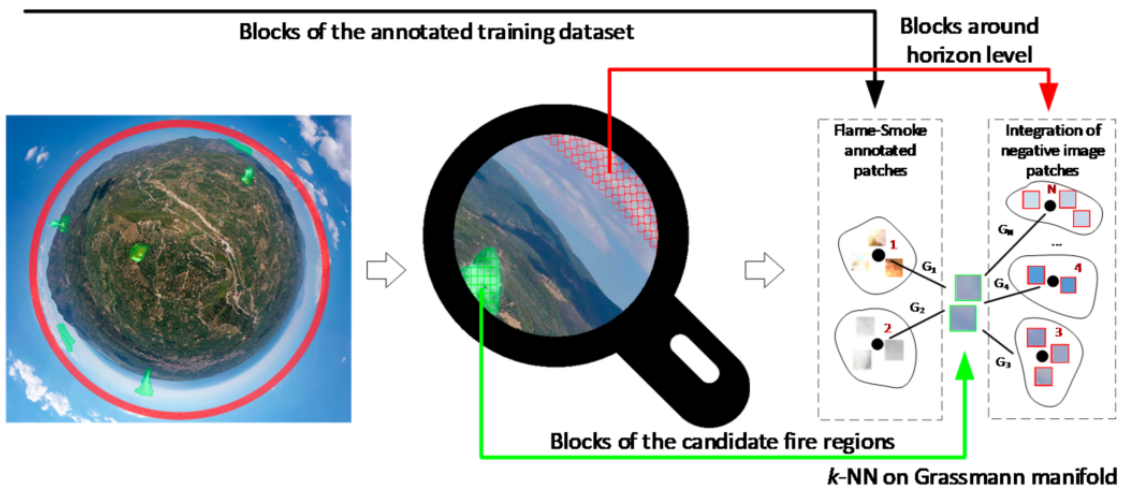
[1] The following paper

A multi-stages objection detection method is proposed, using:

- **360-degree unlimited view image**
- **a novel post-validation adaptive method**
- **DeepLab V3+ model**



- **The 360-degree image:**
  Omnidirectional cameras can cover a wider field with only a single camera.
  Use the stereographic projection to map 3D to 2D.
- **The adaptive post-validation:**
  Use the KNN to cluster the cloud and the smoke around the horizon.

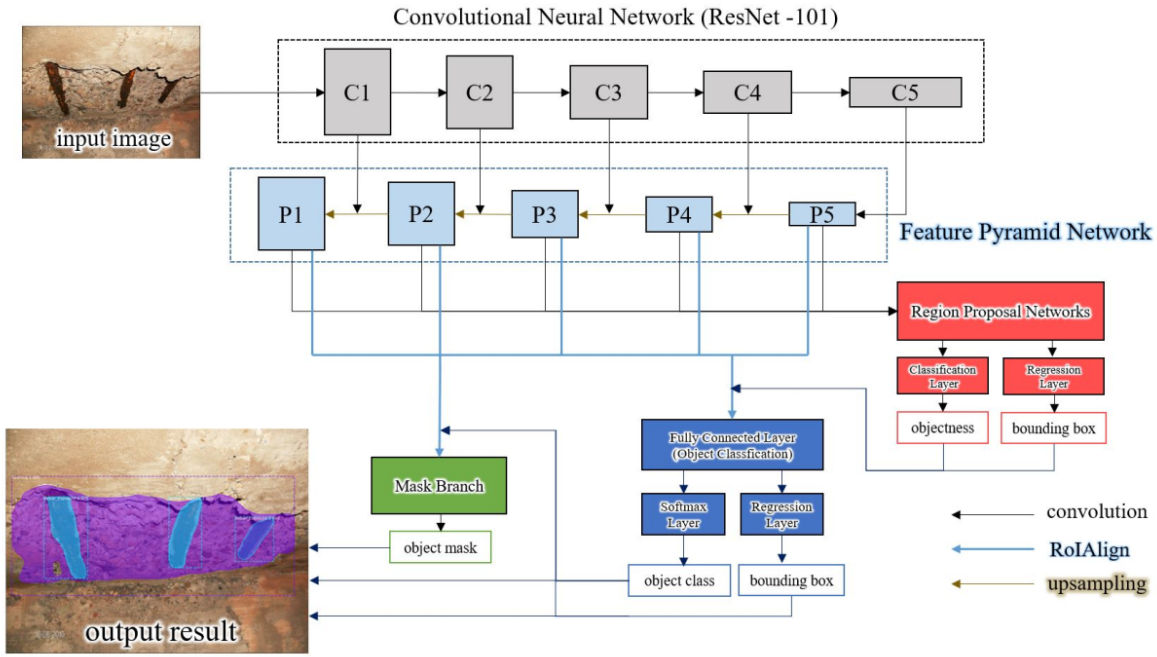


Automated Multiple Concrete Damage Detection Using Instance Segmentation Deep Learning Model

Main Task:

- **A automatic concrete damage detection framework is proposed by developing and modifying the Mask-RCNN, which is developed for the instance segmentation.**
- deconvolution is implemented to improve the accuracy.

Mask R-CNN is an extension of Faster R-CNN for instance segmentation



Conclusion and Ideas:

Conclusions:

- The remote sensing problem can be classified into 3 types according to the platforms:
- Both traditional and deep learning-based methods are already applied on the aforementioned 3 platforms.
- One stage model and multi-stage models are both often used these days. One-stage model are faster, but tends to achieve lower accuracy.

Ideas:

- The next step to implement the aforementioned methods, and use the metrics to reproduce the basic algorithm as well as their derivates: From easy to hard:
  - Color space
  - Mask R-CNN
  - CNN-LSTM
  - SSD
  - YOLO
  - * Transformer

Thank you!