An Intelligent Analysis System for Wildfire Management Using AI

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- *Took charge of* Application of 5G, AI and other emerging technologies in various industries

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Background

Our Project

Future Work

# Status：Stern situation of wildfire safety

Owing to climate change and human interference, the wildfire, especially forest fires, have been increasing steadily. Many countries are reeling under wildfire, for instance, Amazon Rainforests in 2019 has experienced double the number of forest fires compared to those in 2013.

Record Number Of Wildfires Burning In The Amazon
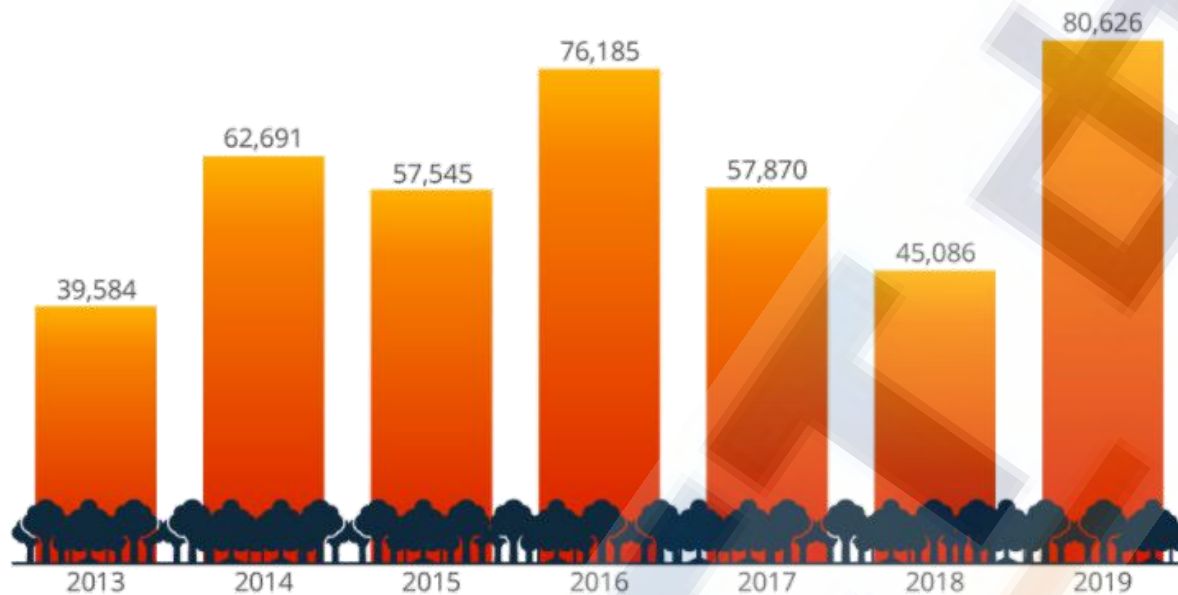
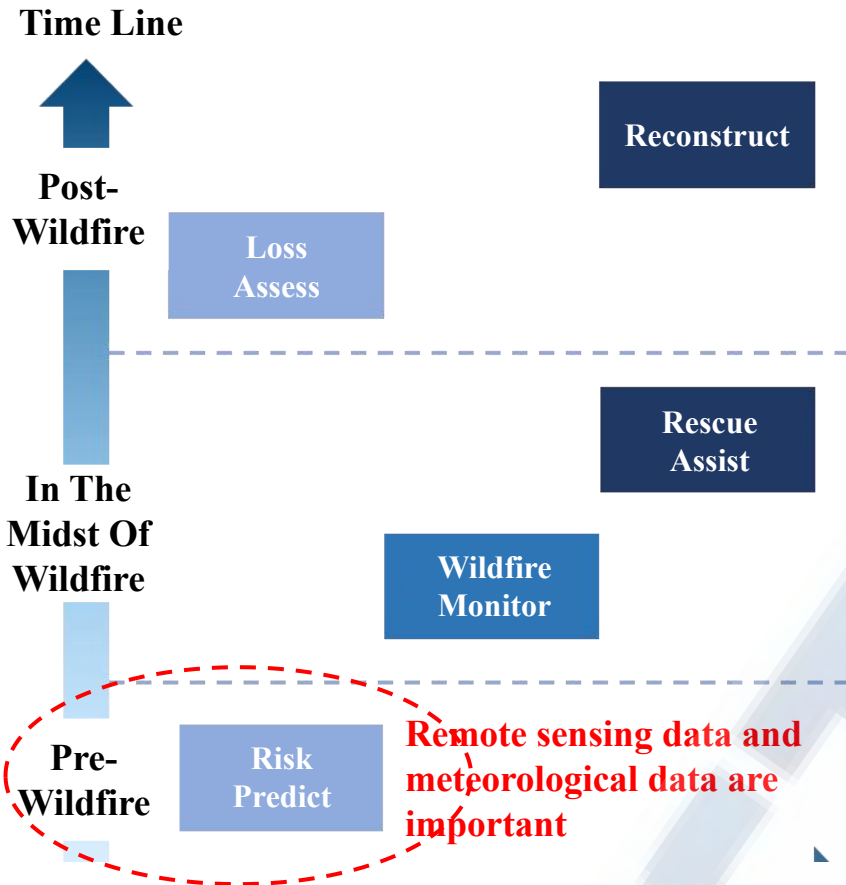**2021's wildfire season is predicted to be another severe one**

- From January 1 to June 17, 2021 there were about 28,200 wildfires, compared with 21,737 in the same period 2020, according to the National Interagency Fire Center.
- About 1.03 million acres were burned, compared with 936,861 in 2020.
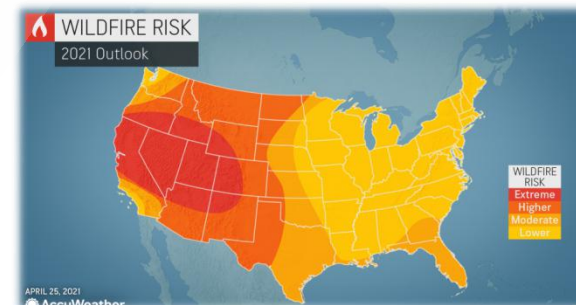
AI has been used in wildfire risk prediction

> In the pre-wildfire stage, combined with remote sensing data, observatories data and so on, AI can generate forest distribution map, which includes topography, tree species, density and oil composition, to predict risk of wildfire.

AI + Wildfire Application Map

Time Line

Reconstruct

Post-Wildfire

Loss Assess

In The Midst Of Wildfire

Rescue Assist

Wildfire Monitor

Pre-Wildfire

Risk Predict

Remote sensing data and meteorological data are important
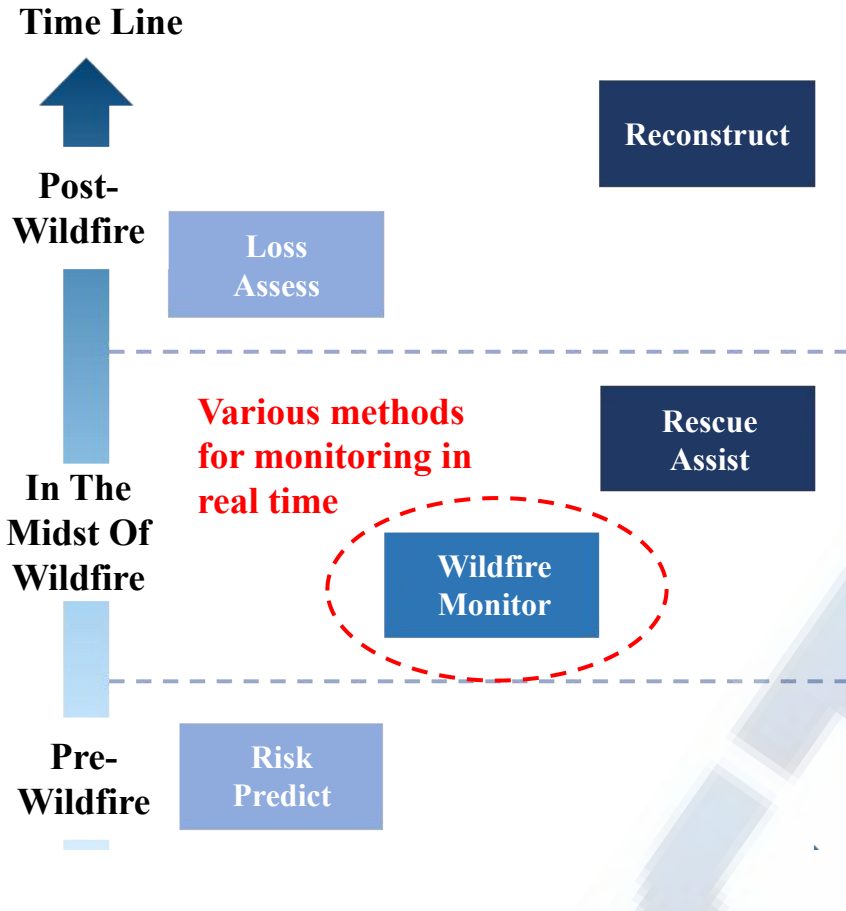
AI In Wildfire Risk Prediction

① Collect data from satellites and monitors, then develop AI models to identify **forest species and distribution, but not dryness, plant oil position, leaf density and leaf thickness** and so on.

② Combined with data of **temperature, wind, precipitation and historical wildfires.**

③ **Explore wildfire risk map.** Use various colors to mark different levels of risk, such as high risk areas and precautionary zones.
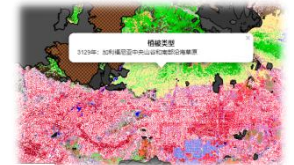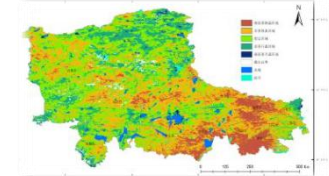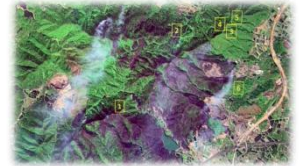
Combination of AI and satellites and webcams drives the development of intelligent wildfire monitoring

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> In the midst of wildfire, AI empowers **traditional satellites and webcams. Image segmentation and target recognition** can locate wildfire quickly. Compared with webcams, **the cost of remote sensing image recognition is lower, but accuracy is worse.**

AI + Wildfire Application Map

Time Line

Post-Wildfire

- Reconstruct
- Loss Assess

In The Midst Of Wildfire

Various methods for monitoring in real time

- Rescue Assist
- Wildfire Monitor

Pre-Wildfire
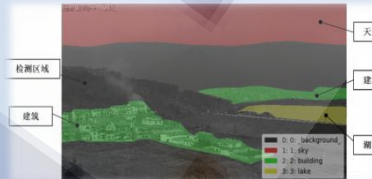
- Risk Predict

Difficulty

AI + Remote Sensing Images

- **Compared with UAV, satellites have high cost performance**
- Collecting satellite thermal infrared images, AI can detect wildfire, but not from long distance and covering large areas.

AI + Security Surveilance Images

- **China has advantages of economies of scale in wildfire monitoring, but still with low accuracy**
- According to cameras, by applying **technologies of thermal imaging temperature measurement, fire and smoke intelligent detection and 3D GIS,** AI can detect and locate wildfire in real time.
- AI will also **automatically distinguish and filter interference factors** such as cloud shadow, fog, water droplets.

Recognition from long distance and covering large areas and multi-dimensional analysis need to be realized

A. **Among the system components, one AI model will provide early accurate identification (detection) of wildfires**

- To ensure the generalizability of this model, we are exploring **the use of AI for detecting fire in images taken from a long distance and in images covering a large area.**

- In terms of detection in images taken from a long distance, the existing single detection model (infrared ultraviolet detection, smoke detection, and image flame detection technology) **does not meet the requirements.**

- Therefore, a new model is needed using AI to achieve the above requirements.

B. **Another AI model is the AI risk assessment model which can generate forest fire risk map and mark high risk areas and precautionary zones**

- Depending on monitors and communications to predict wildfire risk by humans can not satisfy the need of early warning.

- Now we are exploring **wildfire risk map generation model to visualize possibility of fire in different regions.**

- AI model will **identify forest species, density, distribution, dryness and predict forest growth in the future.** Combined with temperature and wind data from observatories, risk prediction model can forecast wildfire risk precisely.
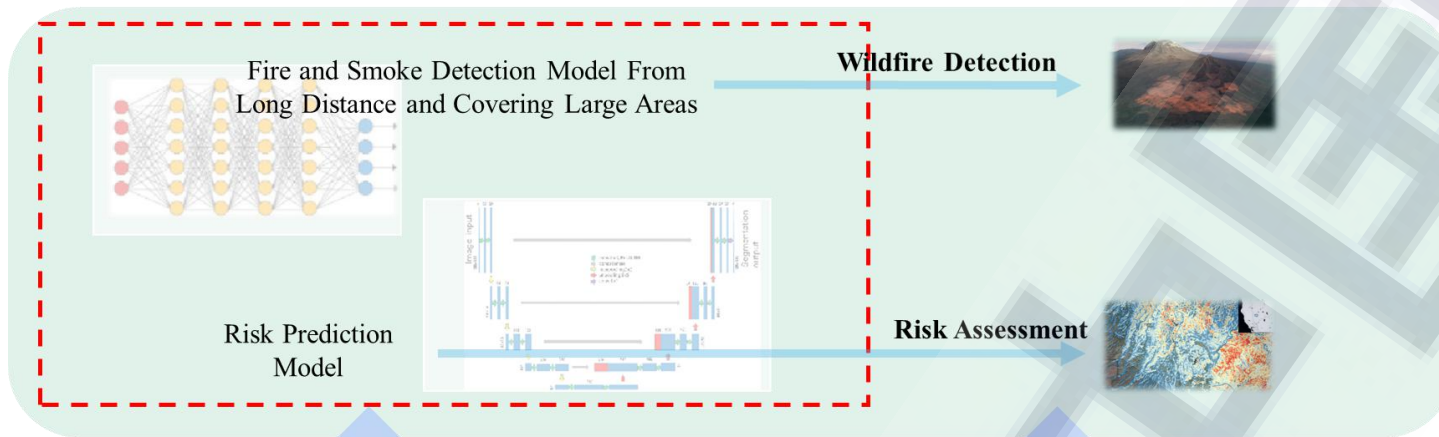
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Project plan

The case study that we present focuses on the Jiangxi province and the northeast China such as Jilin. Science and Technology Department of Jiangxi Province funded the platform from 2019 to 2021.

AI Model & Application Layer

Fire and Smoke Detection Model From Long Distance and Covering Large Areas

Wildfire Detection

Risk Prediction Model

Risk Assessment

Data Layer

Images   Pictures
Meteorology

Popular Image Datasets

Remote Sensing Satellites

Observatories

Monitors

Social Media Application

Perception Layer

how can AI be used to **detect wildfires** in real time and ensure generalizability in images from long distance and covering large areas?

how can methods such as AI-based risk maps help us to communicate the threat of wildfires?

Project plan-AI Wildfires Detection Model

① **In the development period of large-area fire**

temperature rises rapidly in the early stage
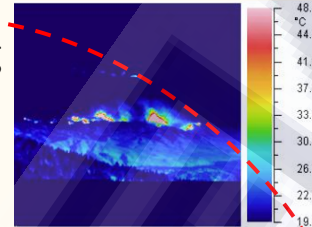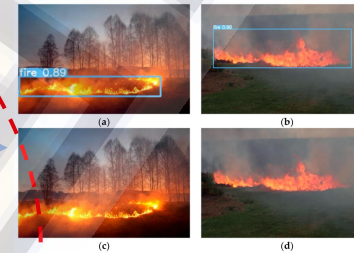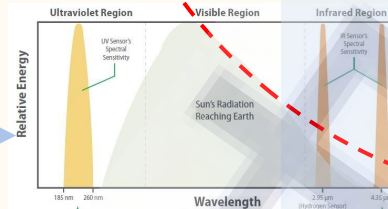
thermal imaging temperature detection

image depth analysis

invisible light can sense the temperature change in advance

infrared ultraviolet spectrum detection

The test platform of large area **multi parameter fusion detection system** is built to realize the early accurate identification of large area fire.

② **To achieve accurate detection in complex environment**

build image recognition template library

study the characteristics of each scene and image features
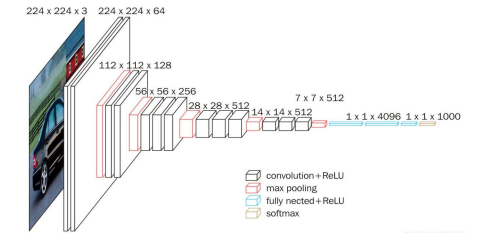
build and deploy model

With the enrichment of data, we can gradually improve the ability of early accurate fire recognition.

Project plan-Risk Prediction Model

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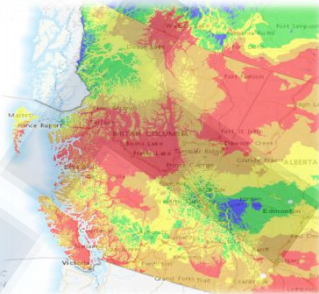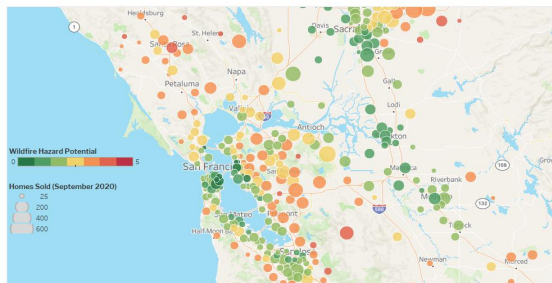**Collect** remote sensing images and monitor pictures

Train and deploy plant identification model

Identify forest species, density, distribution, dryness, forest growth, plant oil composition, and leaf thickness
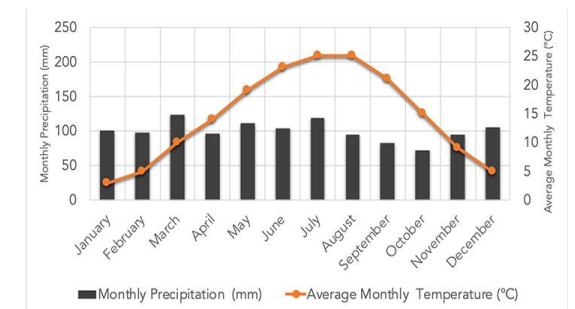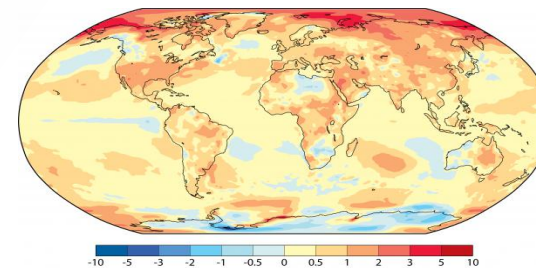
Risk Prediction

Generate forest fire risk map
Mark high risk areas and precautionary zones

Combined data of temperature, wind, and precipitation trends in several days

Data Use and Model Evaluation

> **Training and testing data mainly come from public and private datasets**

☐ **Pre-trained models**

Proved be Efficient for Wildfire Models

☐ **Models Optimization**

a. <u>Popular image datasets</u> like ImageNet, COCO

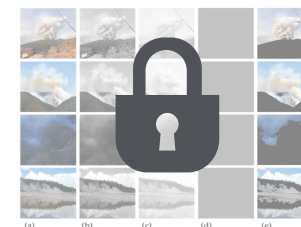b. Data collected from remote sensing satellites, monitoring devices and social media, like fire reflectance, radiance and plant species

FLAME: Drone image dataset of forest wildfire
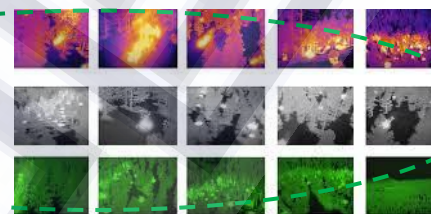
Private Data (Labeled, Unlabeled)

PRIVATE AI

> **Evaluation of model identification accuracy and response time**

- **For risk assessment system,** identification accuracy represents the performance of risk prediction model in wildfire activity.
- **For detection system,** response time indicates the speed of AI reaction, and identification accuracy means detection and location accuracy of wildfire.
- <u>**For the early accurate identification of wildfire based on AI,**</u> the composite image fire detection model for reliable detection distance ≥ 1000m, image flame response time ≤ 20s, image smoke response time ≤ 50s.

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Expected results: Through continuous experiments and AI model development, it can be concluded that neural networks are offered as techniques for the wildfire detection system and risk mapping.

Milestones: Intelligent models, like risk prediction model, wildfire detection model, will be built in multiple wildfire management scenarios. It is expected to become useful in forest regions in China. In the future, the intelligent system for wildfire will be deployed in many places, which can accurately and real-time monitor the wildfire risk.

Future Impact:

Wildfire AI system has profound impacts on economy, environment and society.

- **For economics,** it can reduce labor costs in daily supervision, avoid wildfire damage loss in advance, reduce firefighting costs when wildfire breaks out and save reconstruction expenses after wildfire.

- **For environment,** by preventing wildfire from happening and spreading, wildfire AI system can help reduce carbon emissions and prevent global warming. For society, it can reduce casualties, then minimize the negative effect and ensure social stability.

Based on the experience of AI system for wildfire management, we hope to **summarize a system architecture** to provide reference for AI application and research in natural disaster in the future, including innovative core applications, data requirement, standard AI method.

Thank you!