Multispectral Deep Learning Models for Wildfire Detection

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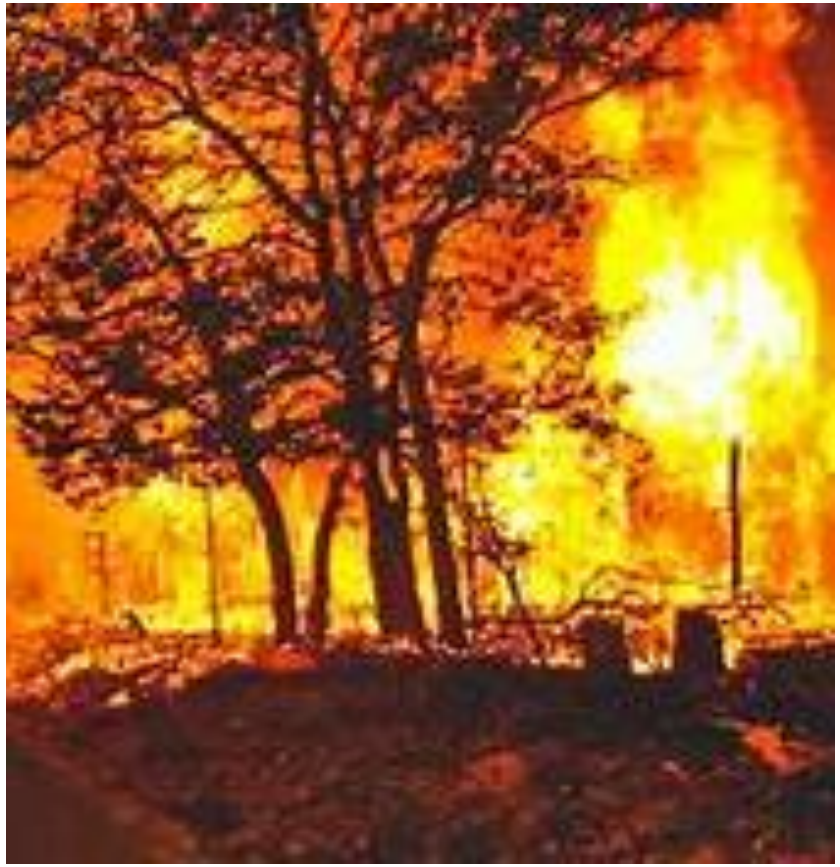
Outline

- Introduction
- Problem Statement
- Dataset
- Methodology
- Experimental Protocol and Results
- Conclusion and Future work

Introduction

Wildfires are large destructive unexpected fire often caused by human activity or natural phenomena

90% of wildfires are caused by human for example, campfires left unattended, burning debris, downed power lines, negligently discarded cigarettes and intentional act of arson



Thousands flee in the wake of Wildfire

U.S. Fire Administration
Working for a fire-safe America

https://apps.usfa.fema.gov/firefighter-fatalities/

Firefighter Fatalities in the United States

56

Firefighter fatalities in 2022

News

NEWS

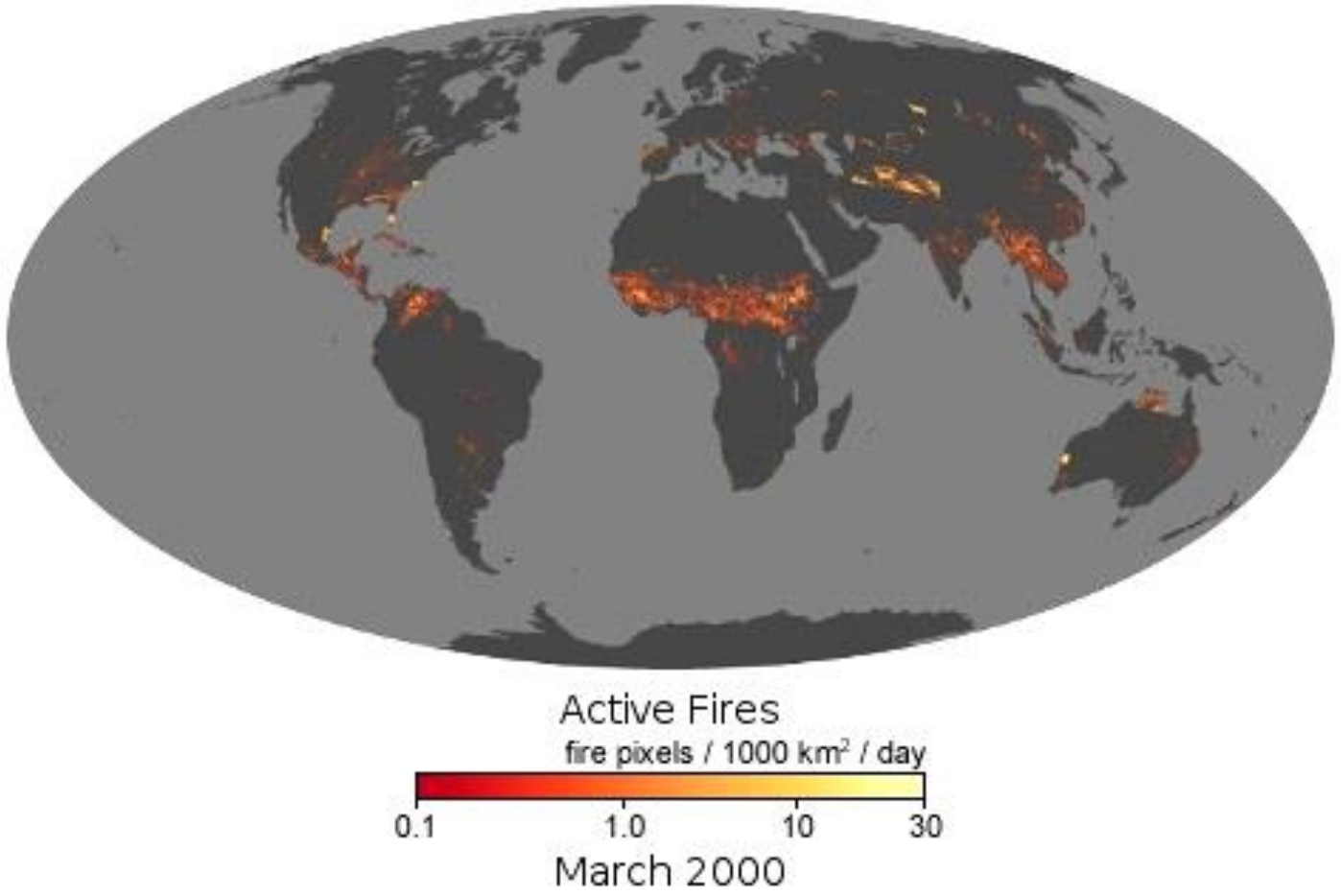
Wildfires force Germany, Greece and Spain to evacuate residents

Europe continues to struggle with a heat wave, though some have seen a respite from record high temperatures for the time of year. One of several wildfires has raged out of control on Greece's second-largest island.

Spain, Germany battle wildfires amid unusual heatwave in Europe

Experts have linked the abnormally hot period in parts of Europe to climate change amid high temperatures and low rainfall.

Fire map
Source : NASA Earth Observatory
https://earthobservatory.nasa.gov/global-maps/MOD14A1_M_FIRE



Motivation

Early Detection and instant reporting of such fire incidents are very important to mitigate the damage caused by wildfire.

Existing System

Traditional Fire Detection Systems – Sensor based smoke detectors

Sensor based smoke detectors installed indoors must be in proximity in order to detect fire or smoke

But they do not give location of fire / smoke

Existing Methods

Sensor based systems

Computer Vision based Methods

Machine learning Methods

Deep learning Models

Problem Statement

The aim of our work is to propose multi-spectral deep learning model that combines information from three different spectrum for accurate fire detection

Dataset




FD dataset

Firesense

DeepQuest

Furgfire

Dataset

FD dataset

consists of many fire incidents like fire on car, boat, forest. It also consists of fire like objects like burning clouds, sunset, glare and red elements in no fire images

Firesense:

contains vidoes with fire in outdoor and indoor settings like fireplace, kitchen, campfire, grassland and forest fire. It also contains videos of night traffic, indoor decorations in the no fire category.

DeepQuest:

contains images of fire accidents including vehicles, buildings, kitchen and wildfire

Furgfire:

contains videos of fire that include occlusion, clutter, different scales, camera vibration, motion blur, reflection and a variety of bright and contrast conditions

Methodology

Experiments

Expt #1: Performance evaluation of Individual models

Expt #2: Performance evaluation of fusion of two spectrum

Expt #3: Performance evaluation of fusion of three spectrum

Models used for our experiments

MobileNetv2

NasNetMobile

DenseNet121

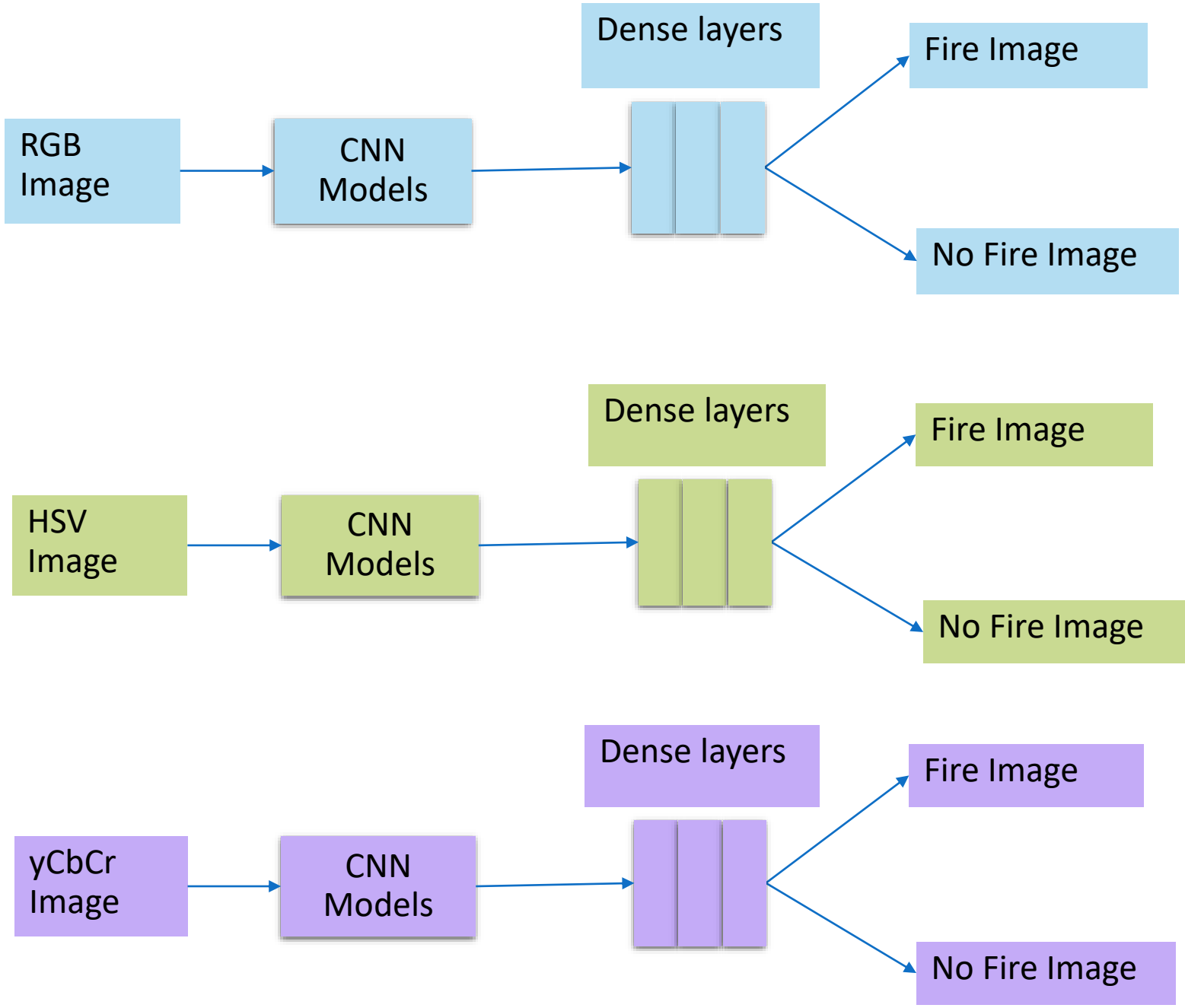
Xception

Inceptionv3

InceptionResNetv2

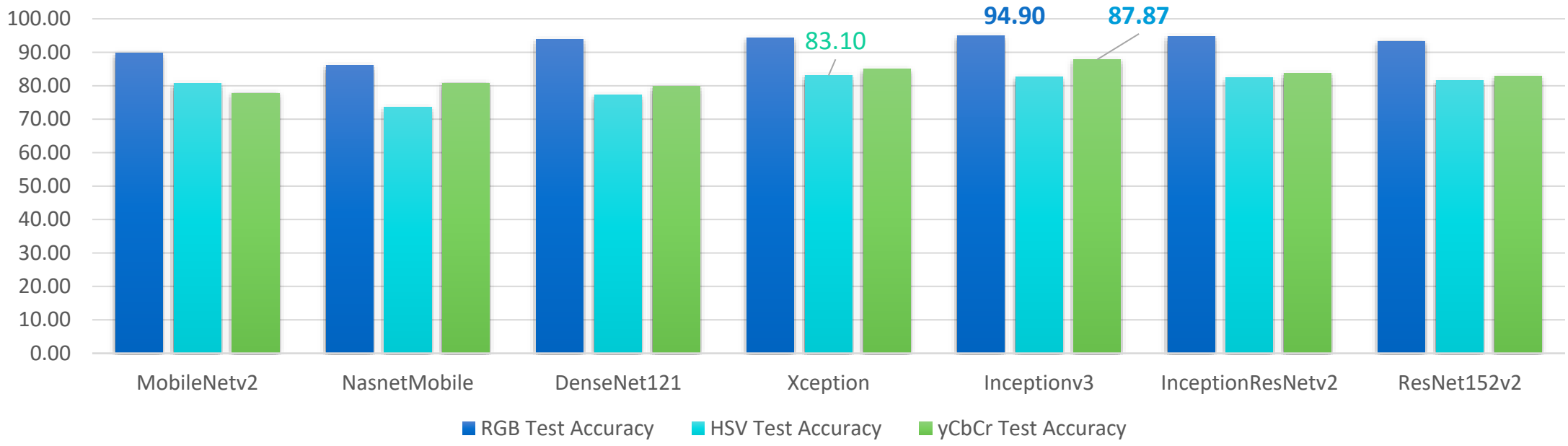
ResNet152v2

Individual Model Architectures



Performance of Individual Models

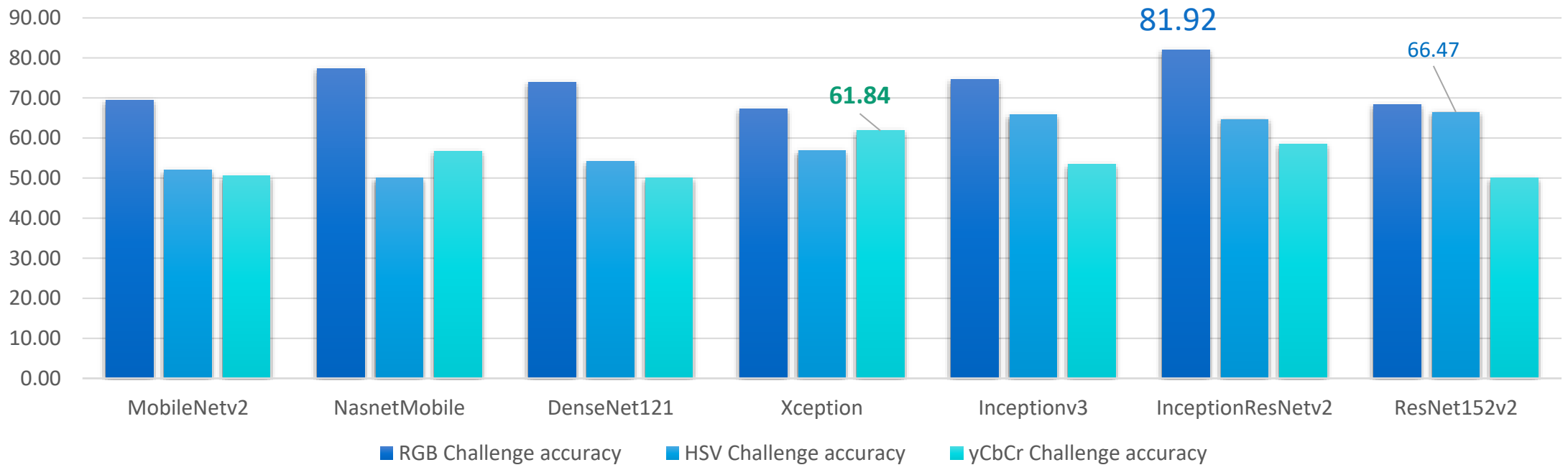
Test Accuracy



Spectrum	Highest Test accuracy obtained
RGB	94.90
HSV	87.87
yCbCr	83.10

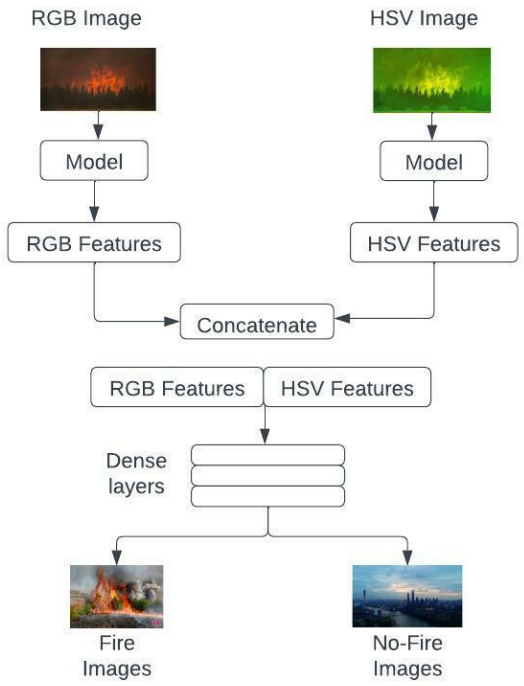
Challenge Accuracy

Spectrum	Highest challenge accuracy obtained
RGB	81.92
HSV	66.47
yCbCr	61.84

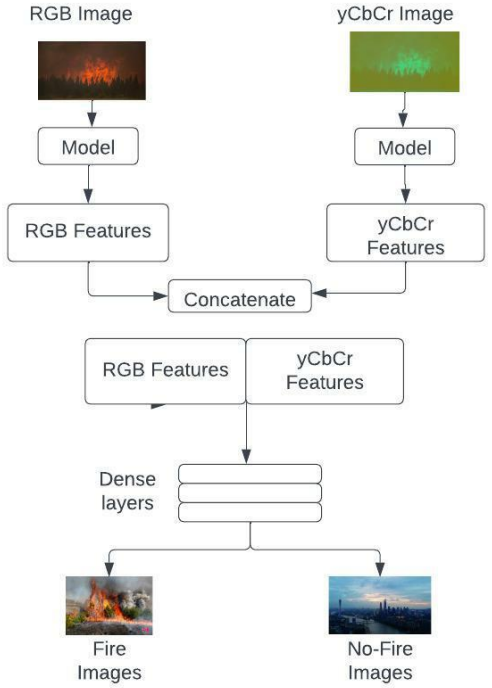


Fusion of two spectrum

Fusion of RGB and HSV

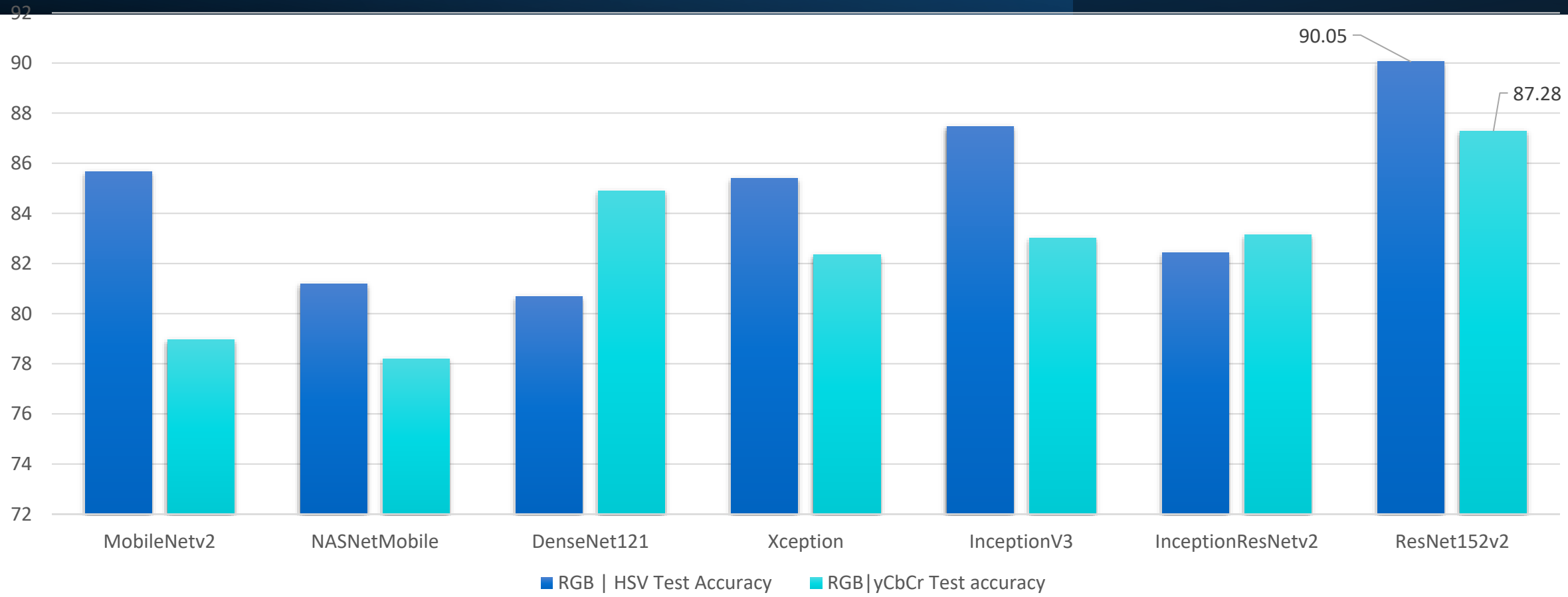


Fusion of RGB and yCbCr



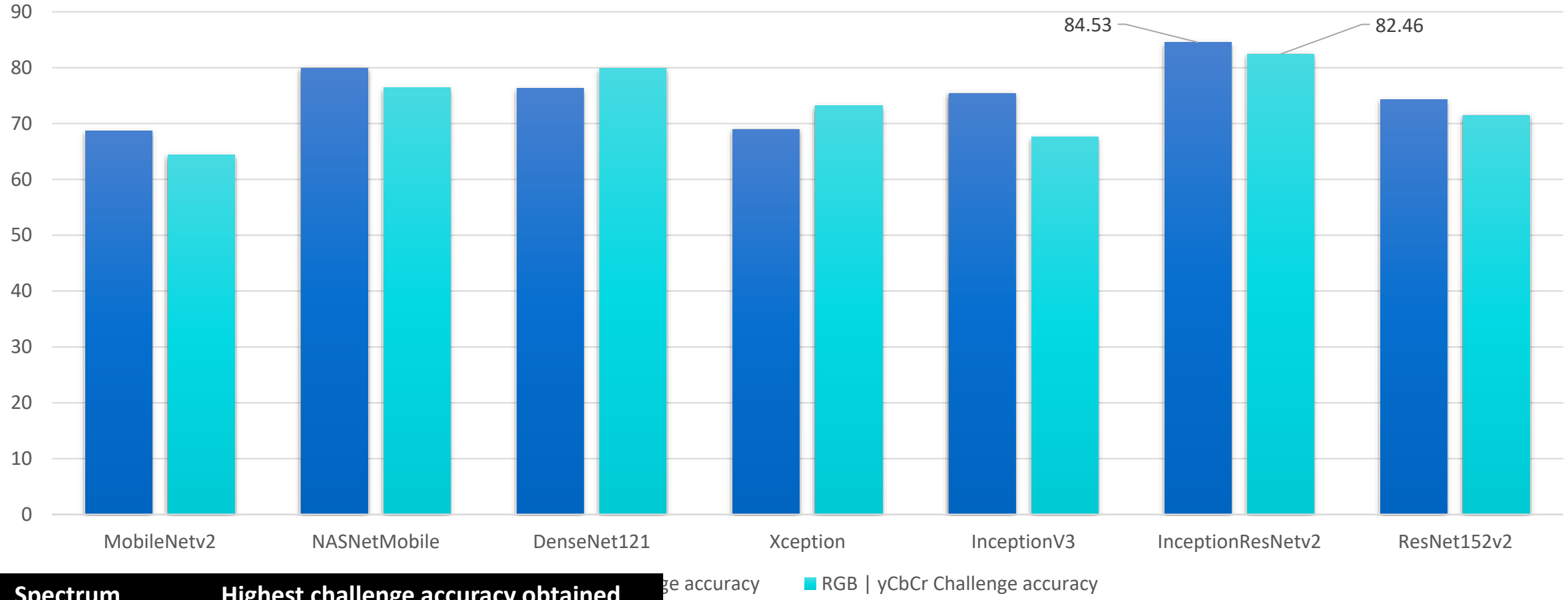
Performance evaluation of fusion of two spectrum

RGB + HSV & RGB + yCbCr : Test Accuracy



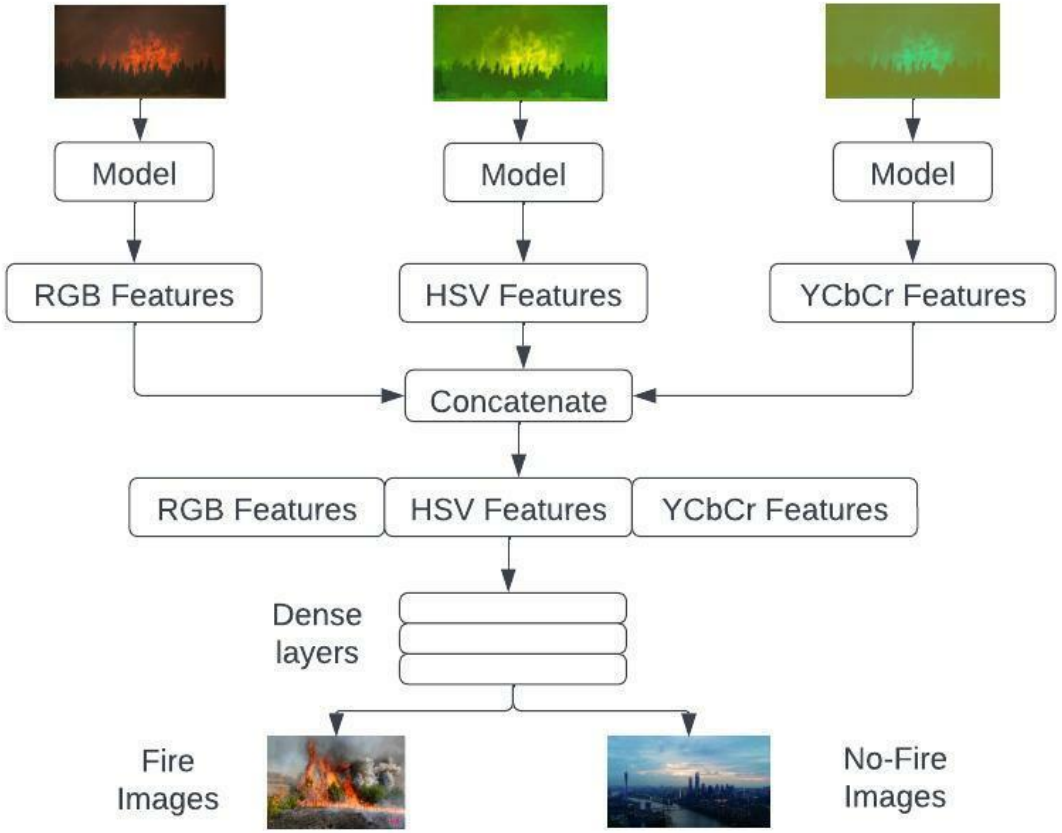
Spectrum	Highest Test accuracy obtained
RGB +HSV	90.05
RGB + yCbCr	87.28

RGB + HSV & RGB + yCbCr : Challenge Accuracy



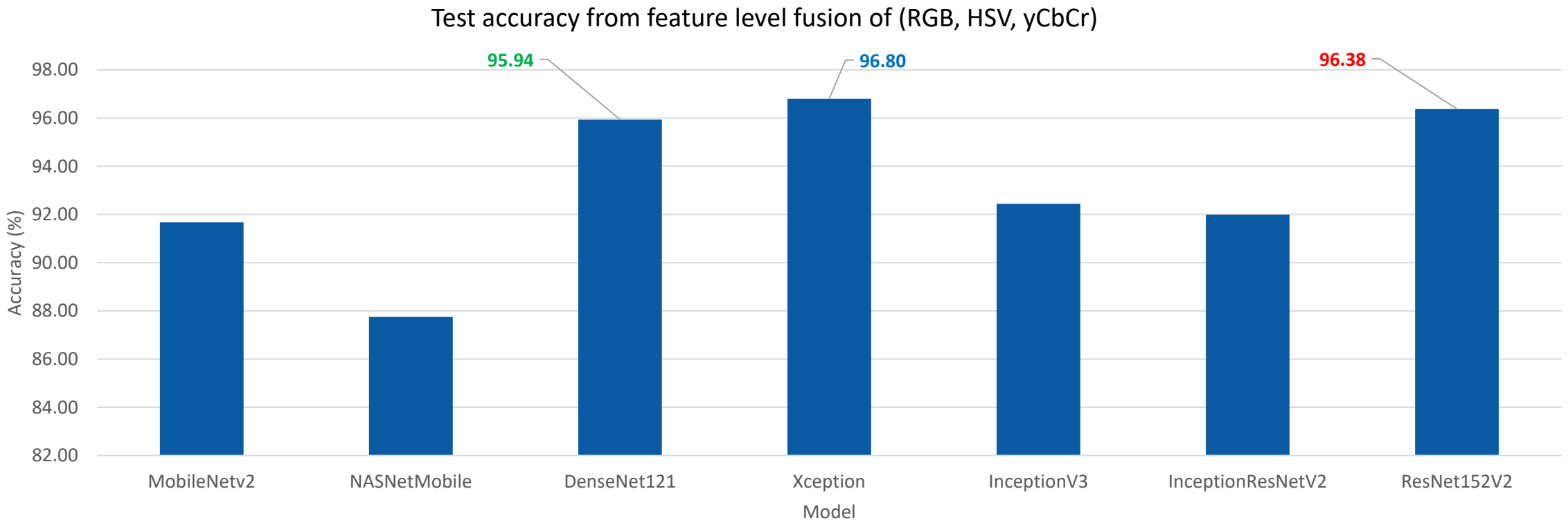
Spectrum	Highest challenge accuracy obtained
RGB +HSV	84.53
RGB + yCbCr	82.46

Three Spectrum fusion architecture



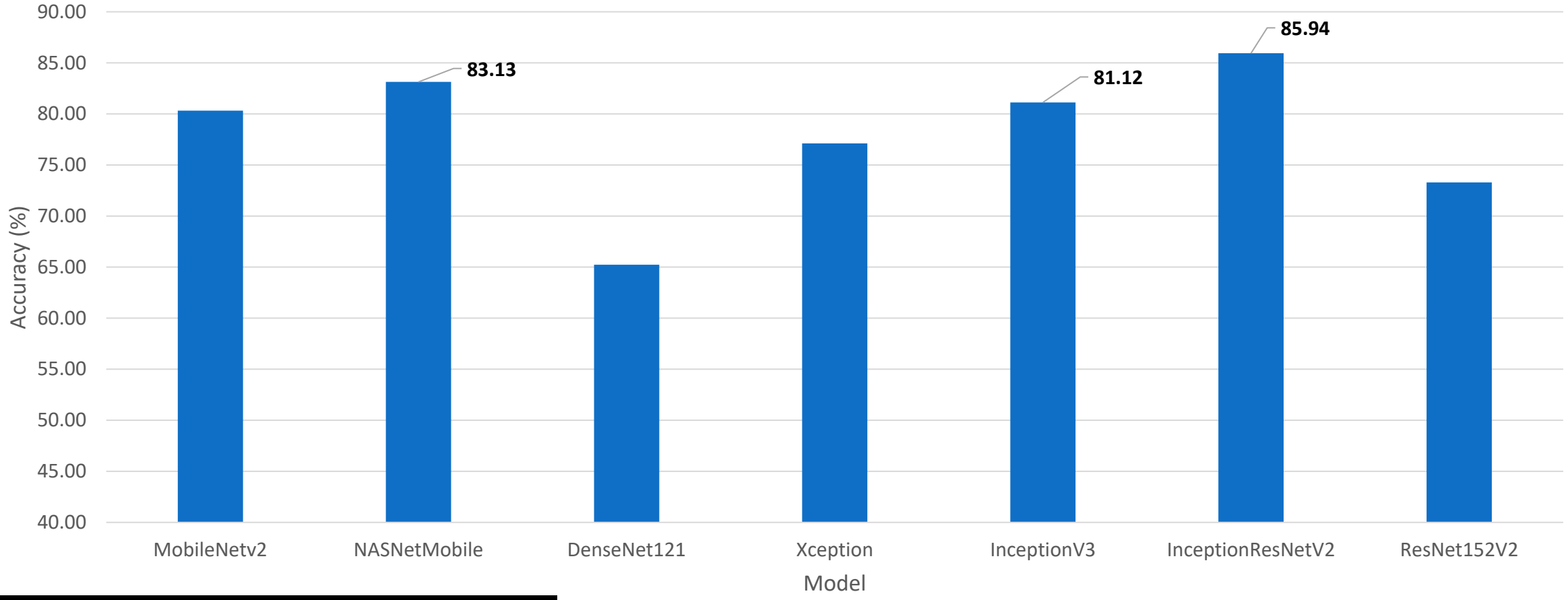
Performance evaluation of three spectrum fusion

Test Accuracy : Three spectrum Fusion



Spectrum	Highest Test accuracy obtained
3 spectrum fusion	96.80

Three spectrum Fusion: Challenge Accuracy



Spectrum	Highest challenge accuracy obtained
3 spectrum fusion	85.94

Comparative analysis of results

Experiments	Test Accuracy (%)	Challenge Accuracy (%)
Individual Models	94.90	81.92
Fusion of two spectrum	90.05	84.53
Fusion of three spectrum	96.80	85.94

Conclusion

Automatic fire detection using computer vision-based methods is a challenging task due to non-uniform shape, color and presence of motion

Multi-spectral deep learning models combining complementary information from various spectrum enhances the performance of fire detection

Future work

Develop an end to end light weight fire detection system

Thank you

Questions?