In the name of Allah, Most Gracious, Most Merciful

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Paper Title

Computer Vision Based Industrial and Forest Fire Detection Using Support Vector Machine (SVM)

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Presentation Structure

- Introduction
- Problem Statement
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- Methodology
- Design
- Outcome and Impacts
- Conclusion
- Future Work

Introduction

- Wildfires are one of the biggest catastrophes faced by our society today causing irrevocable damages.
- These forest fires can be man-made or caused by mother nature by different weather conditions, torrential winds.
- These fires cause damages not only to the environment they also destroy vast homes and property.
- In industries, faced by many unwanted fire incident & losing valuable life with asset

Hence we developed a system “Computer Vision Based Industrial & Forest Fire Detection Using Support Vector Machine (SVM)” to fight this disaster and help our planet.

Problem Statement

- ✓ Forest fires are one of the most worrisome natural disasters, destroying thousands of acres of forests and nearby urban zones, affecting plant and human life.
- ✓ The forest fires are a fact of nature, and we have been serving as means of self-regulation of forests. However, these phenomena have become more frequent during the last few decades.
- ✓ Besides, in industries we are facing unwanted fire incident. Fire extinguishers have existed for years but are still very difficult to maneuver. They are also very confusing when trying to use one in panic situation.

Literature Review

1) Fast and efficient method for fire detection using image processing. [T. Celik]

- ✓ Proposed fire color modeling and motion detection.
- ✓ The proposed fire color model achieves a detection rate of 87.4% on the ten tested video sequences with diverse imaging conditions

2) Computer vision based fire detection in color images. [T. Celik and K.-K. Ma]

- ✓ The proposed algorithm exploits the *YCbCr* color space to separate the luminance from the chrominance.
- ✓ The proposed rule-based color model 31.5% false-alarm rate.

Literature Review (Cont.)

3) An intelligent fire detection cameras based on computer vision methods. [H. Wu, D. Wu, and J. Zhao]

- ✓ A motion detection method based on background subtraction is used for reducing computations.
- ✓ A motion detection method based on background subtraction is used for reducing computations.
- ✓ An object detection model and an image classification model are constructed and applied for fire detection.
- ✓ The proposed framework achieves 87.4% fire detection and the false alarm rate achieves 16.3% based on the fire image dataset.

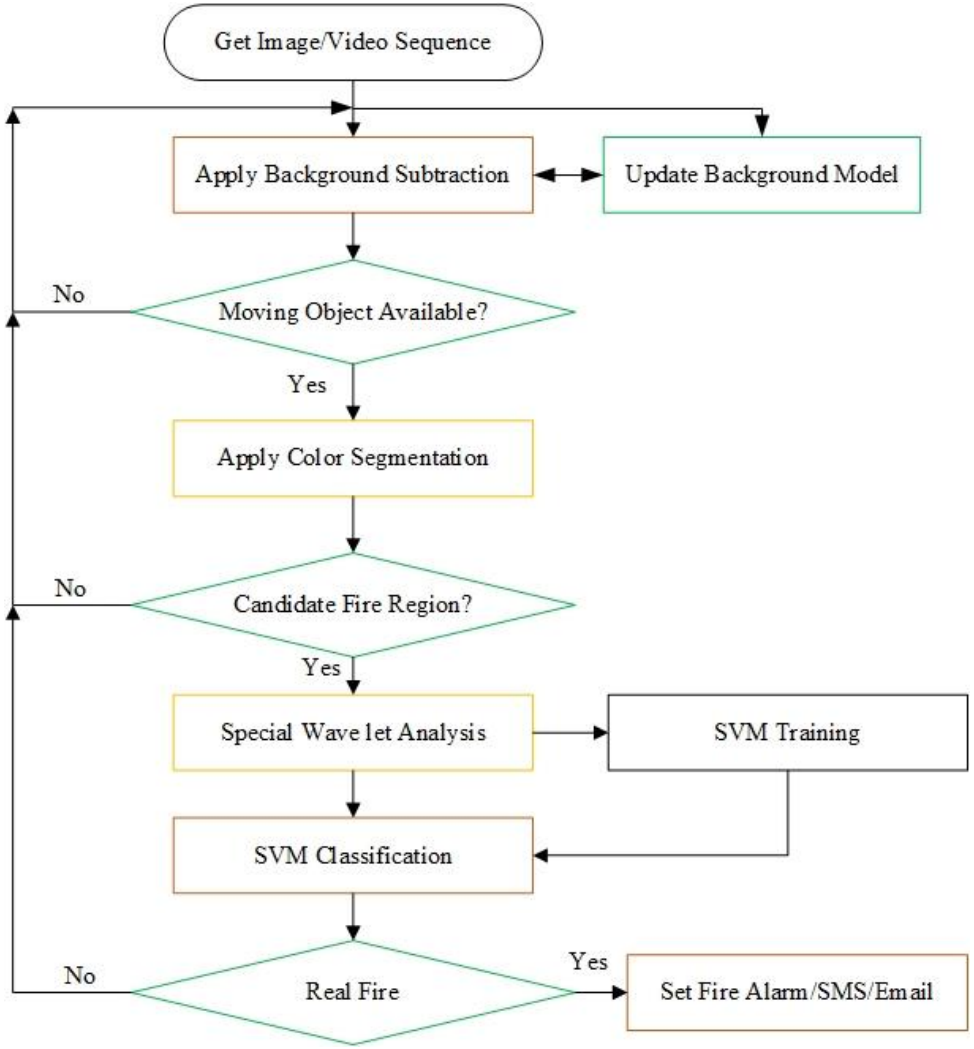
Objectives

The main objective of the project is to develop a fire detection technique in real time. The main points of the project objectives are given below:

- To detect fire while they are still small and have not grown too large.
- To develop a low cost fire detection system in real time.
- A system that detects a fire earlier than conventional fire detectors and more accurate.

Methodology

Flowchart



Methodology
Background Subtraction

Current Frame

Background model

THRESHOLD

T

Foreground mask

Methodology

Background Subtraction (Cont.)

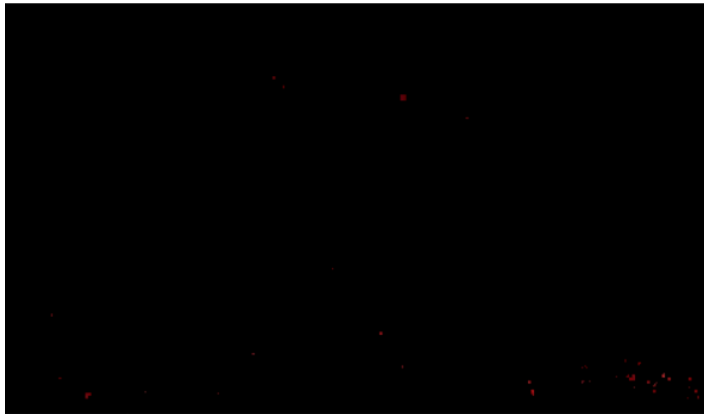
$$|I_n(x,y) - B_n(x,y)| > thr$$

$$B_{n+1}(i,j) = \begin{cases} B_n(x,y) + 1 if I_n(x,y) > B_n(x,y) \\ B_n(x,y) - 1 if I_n(x,y) < B_n(x,y) \\ B_n(x,y) if I_n(x,y) = B_n(x,y) \end{cases} \quad (2)$$

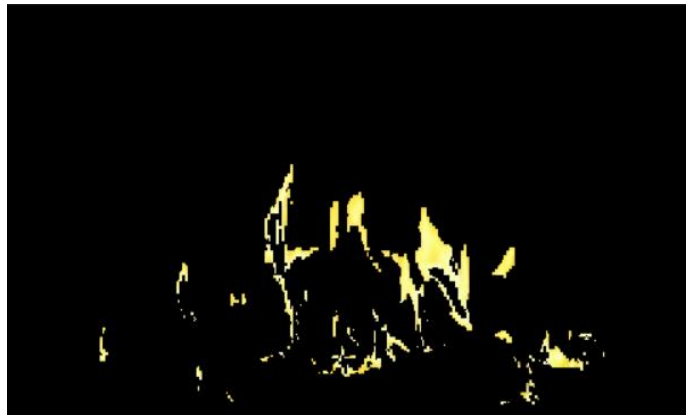
Methodology
Color Segmentation

Input footage

Red



Green



Blue

Result

Methodology

Color Segmentation (Cont.)

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} * \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$L^* = \begin{cases} 116^*(Y/Y_n) - 16, if(Y/Y_n) > 0.008856 \\ 903.3^*(Y/Y_n), Otherwise \end{cases}$$

$$a^* = 500^* f(X/X_n) - f(Y/Y_n)$$

$$b^* = 200^* f(Y/Y_n) - f(Z/Z_n)$$

$$f(t) = \begin{cases} t^{1/3}, if t > 0.008856 \\ 7.787^* t + 16/116, otherwise \end{cases}$$

Methodology

Color Segmentation (Cont.)

$$R1(x,y) = \begin{cases} 1 & if \quad (L*(c,d) \geq L*m) \\ 0 & Otherwise \end{cases}$$

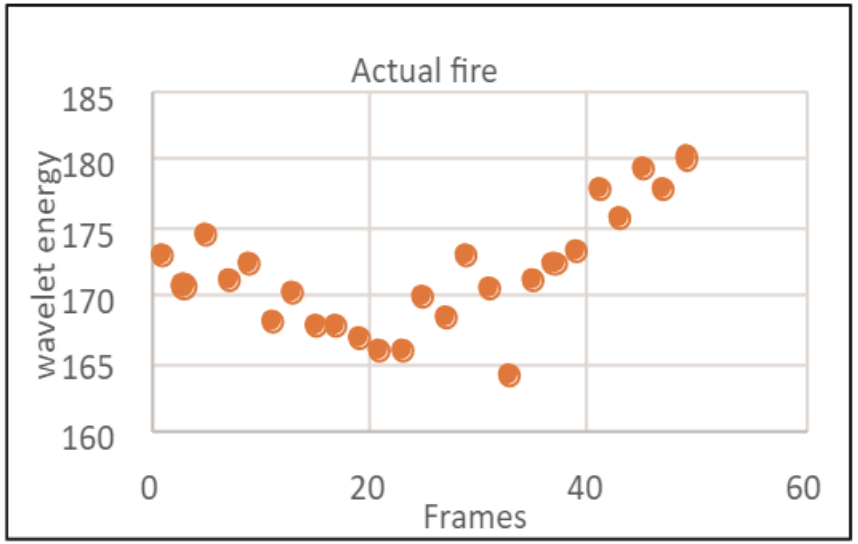
$$R2(x,y) = \begin{cases} 1 & if \quad (a*(x,y) \geq a*m) \\ 0 & Otherwise \end{cases}$$

$$R3(x,y) = \begin{cases} 1 & if \quad (b*(x,y) \geq b*m) \\ 0 & Otherwise \end{cases}$$

$$R4(x,y) = \begin{cases} 1 & if \quad (b*(x,y) \geq a*m) \\ 0 & Otherwise \end{cases}$$

Methodology

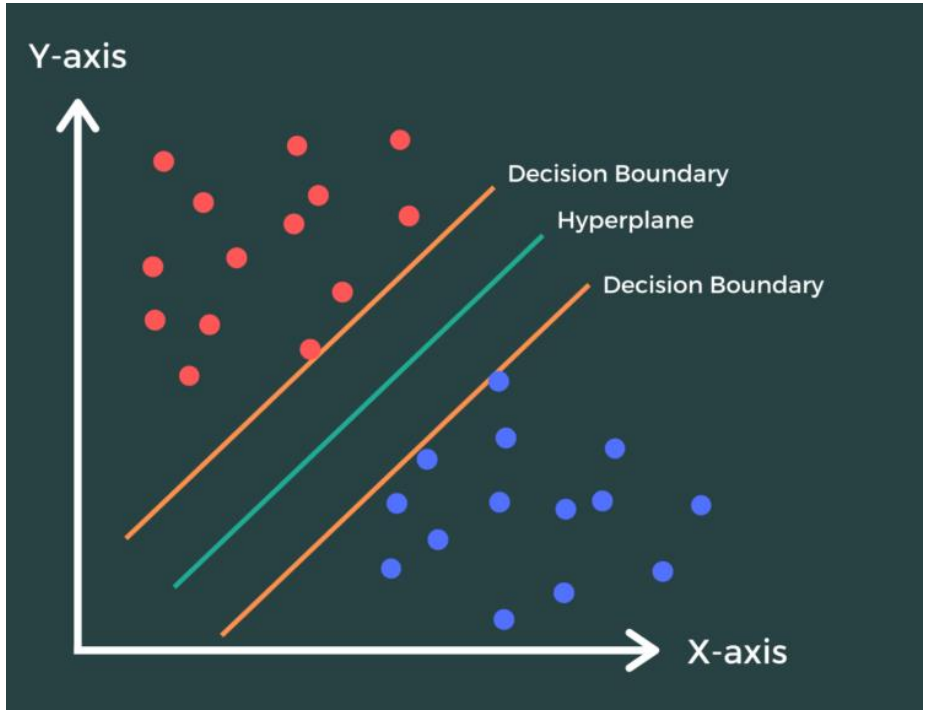
Spatial Wavelet Analysis



$$E(x,y) = (HL(x,y)^2 + LH(x,y)^2 + HH(x,y)^2)$$

Methodology

Support Vector Machine

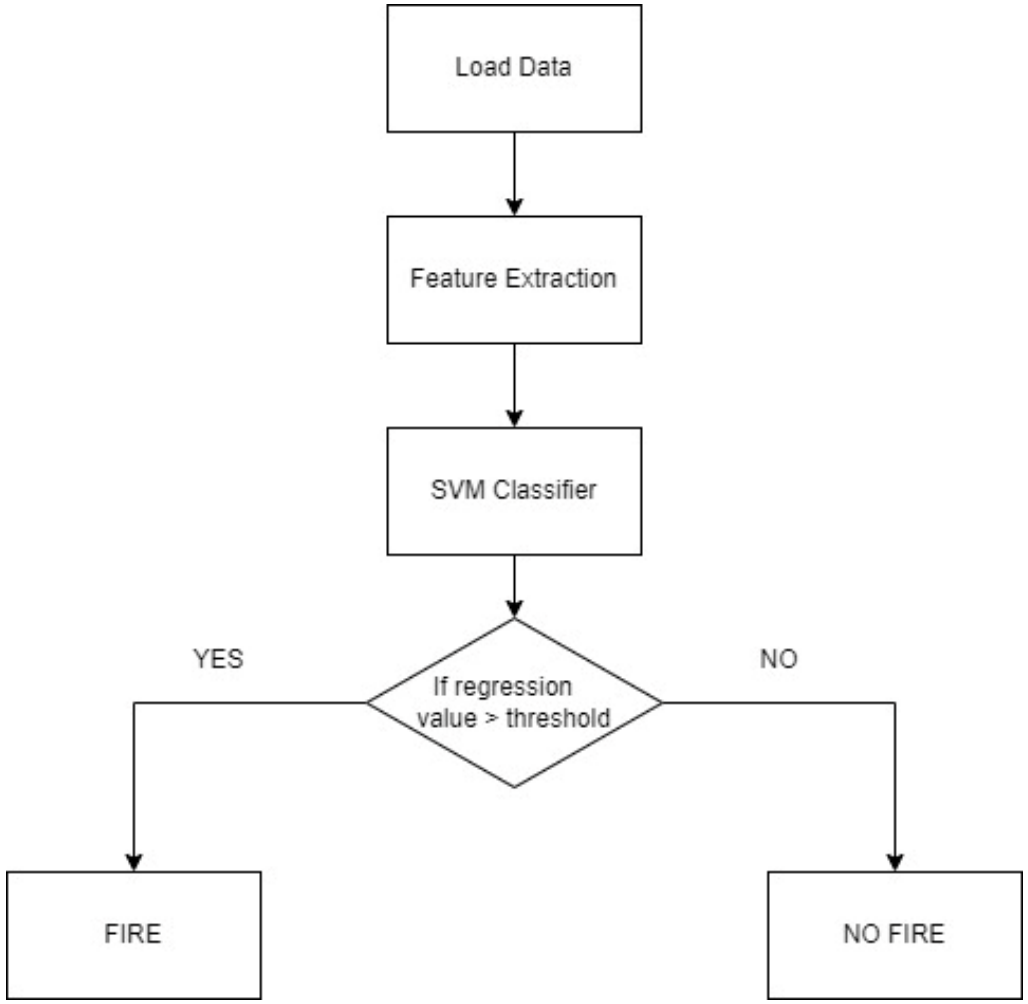


$$f(x) = sign(\sum_{i=0}^{l-1} w_i.k(x, x_i) + b)$$

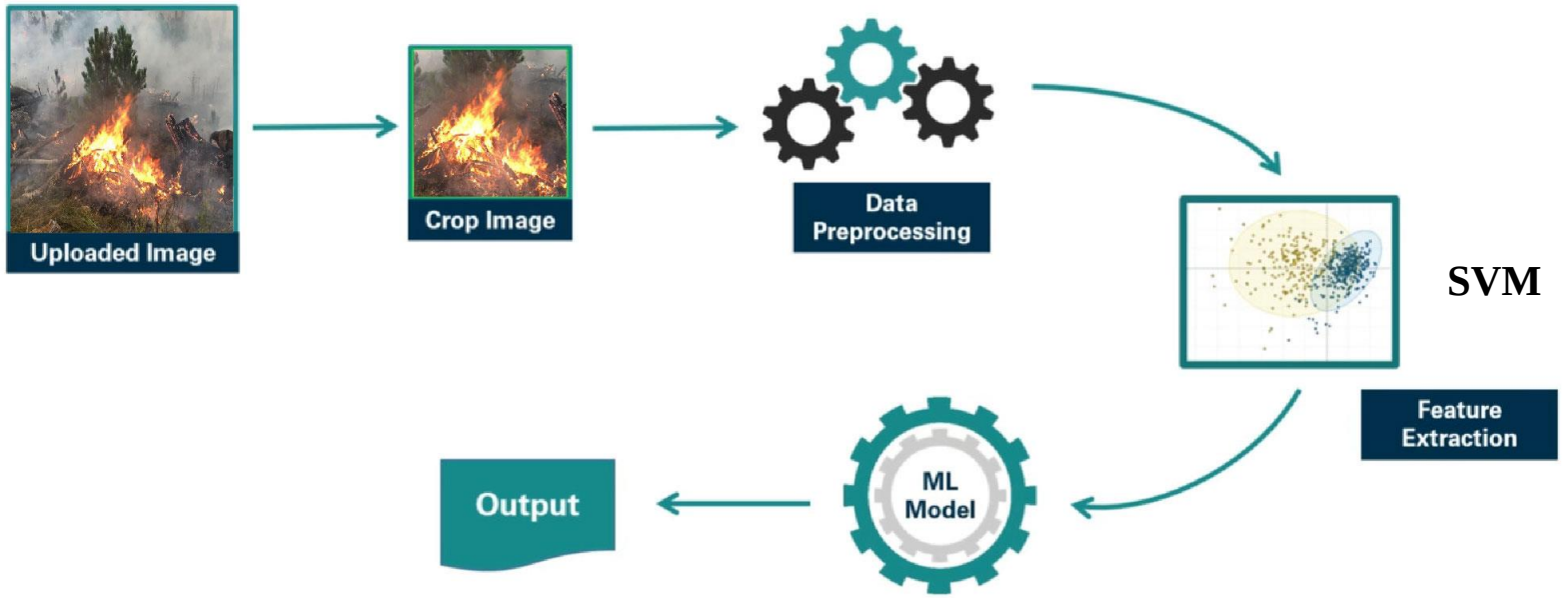
$$k(x, y) = exp(-\frac{\|x - y\|^2}{2\sigma^2}) for \sigma > 0$$

Methodology

Support Vector Machine Classifier

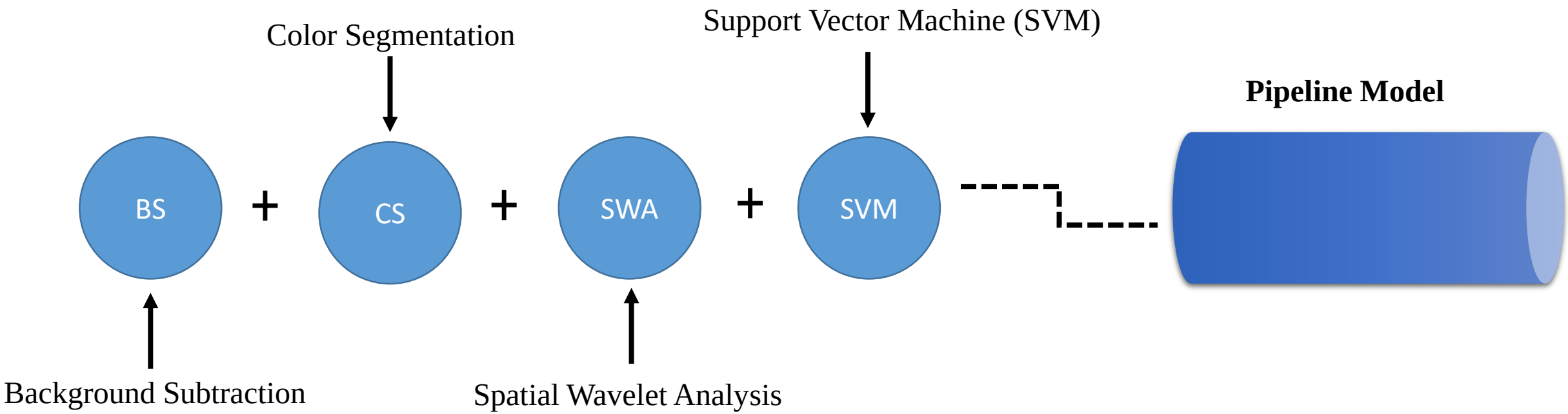


Machine Model Application Flow



Background Subtraction (BS) + Color Segmentation (CG) + Spatial Wavelet Analysis (SWA)

Design


Color Segmentation
Support Vector Machine (SVM)
Pipeline Model
BS
+
CS
+
SWA
+
SVM
Background Subtraction
Spatial Wavelet Analysis

Result & Analysis

Dataset & Result

Video	Frame Rate	Resolution	Total Frames	Actual Fire	Fire	Note
Fire01	29	320x240	116	Yes	Yes	A Fire Very far from the camera generated into a bucket.
Fire02	15	320x240	705	Yes	Yes	A fire generated into a bucket and a person walking near it.
Fire03	15	400x256	255	Yes	Yes	A big fire in a forest.
Fire04	15	400x256	195	Yes	Yes	Some Fire in Forest.Video Downloaded from [17].
Fire05	15	400x256	240	Yes	Yes	Some Fire in Box.Video Downloaded from [17].
Fire06	15	400x256	195	Yes	Yes	See the note of fire04.
Fire07	10	400x256	1200	Yes	Yes	See the note of fire04.
Fire08	15	400x256	240	Yes	Yes	Some Fire in a field.Video Downloaded from [17].
Fire09	15	400x256	240	Yes	Yes	See the note of fire04.
Fire10	15	400x256	210	Yes	Yes	See the note of fire04.
Fire11	15	400x256	210	Yes	Yes	Some Fire in a Industry.Video Downloaded from [17].
Fire12	25	320x240	1650	Yes	Yes	See the note of fire11.
Fire13	15	400x256	210	Yes	Yes	See the note of fire11.
Fire14	15	320x240	240	No	No	See the note of fire11.
Fire15	15	320x240	5535	No	Yes	An image from tunnel Road, It's look like a fire. Video Downloaded from [17].
Fire16	25	320x240	1725	No	No	Video from tunnel Road, It's look like a fire. Video Downloaded from [17].
Fire17	15	320x240	900	No	No	Some village video.
Fire18	10	320x240	630	No	No	Some light from window and door side.Video Collected from [17].
Fire19	10	352x288	600	No	No	A red and yellow color Book.
Fire20	10	720x480	80	No	No	A men wearing red and yellow color Jacket.
Fire21	9	320x240	5958	No	No	See the note Fire19.
Fire22	7	720x579	6097	No	No	See the note Fire20.
Fire23	25	480x272	22500	No	No	See the note Fire17.
Fire24	10	352x288	140	No	No	A lab worker carrying a red notebook.
Fire25	10	320x240	342	No	No	Some Light from the car. It's look like a fire. Video Collected from [17].
Fire26	10	320x240	1400	No	No	A moring sun video. Video Collected from [17].
Fire27	7	720x576	847	No	Yes	See the note Fire26
Fire28	10	720x576	600	No	No	Some Smoke in a city covering red building.
Fire29	25	352x288	6025	No	No	Some fog in mountain. Video Collected from [17].
Fire30	15	800x600	1485	No	No	A person moving in a labwith a red notebook.

Result & Analysis (Cont.)

COMPARISON OF THE PROPOSED AND APPROACH WITH OTHER SVM SYSTEM

Method		Accuracy	False Positive
SVM+Motion detection +Color detection	[5]	90.4%	11%
SVM+LAB histogram, SURF texture descriptor	[6]	92.6%	9%
SVM+CE+MD+SW	**Proposed**	**93.33%**	6.67%

93.33%

Outcome and Impacts

Input Footage

Output

Fire Detected

Outcome and Impacts (Cont.)

Input Footage

Output

Fire Detected

Outcome and Impacts (Cont.)

Input Footage

Output

False fire Detected

Conclusion

- The proposed approach is on average 93.33 percent on a random sample, while the false positive rate is only 6.67 percent in two fire-color motion videos.
- The performance of our approach is capable of meeting the requirements for accuracy and control in real-time fire detection.
- Its industrial and forest application will enable the detection of fires at an early stage, the facilitation of emergency management, and a significant contribution to the avoidance of losses.

Future Work

- Integrate live satellite data and process real time processing of the fires .
- Enhance the time complexity of the detection of fires to improve the speed.
- Web based application for fire detection integration with developed system

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