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Vision Based Fire Detection System

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Abstract—*Detecting The Presence Of Fire In Images And Videos Can Be A Very Helpful Technique.Once This Technique Is Honed And Works Well, It Has The Potential To Save Not Only Lives, Butalso Property Such As Office Buildings, Schools, And Homes. Nowadays, Many Institutionssuch As Manufacturers, Prisons, Offices, Restaurants, Schools, Etc. Have Harnessed The Use Ofclosed Caption Television, (Cctv) Or Video Surveillance Systems. Implementing A Systemthat Would Detect The Presence Of Fire Through These Video Surveillance Systems Has Thepotential To Yield Many Benefits, Such As A Quicker Detection Of Fire Than Other Methods,Such As Smoke Detectors. The System Proposed In This Paper Was Modeled According To Various References Where They Used The Temporal, Spectral, And Spatial Characteristics Of Fire In Orderto Detect It.*
Key Words:*Video Surveillance System, Rgb Color Model, Ycbcr Color Model, Background Subtraction*

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I. Introduction

Fire Detection Systems Are Among The Most Important Components In Surveillance Systems Used To Monitor Buildings And The Environment. Fire Is One Of The A Natural Serious Phenomenon That Is Out Of Control Due To That It Can Cause Irreversible Serious Loss Of Human Life And Property.It Is Also A Cause Of Atmospheric Pollution Once It Has Occurred. Fire Is A Great Threat When It Affects Highly Populated Area Or An Area Of High Environmental Value. In Last Few Decades It Is Found That Human Activities Have Enhanced The Fire Rate. As A Part Of Early Mechanism, A Detection System Should Generate An Alert At Earlier Stages Of Fire. Currently, Almost All Fire Detection Systems In Use Have Built-In Sensors In These The Detection Depends Mainly On Thelocation And Density Of Sensors. It Is Essential That For A High Precision Fire Detection System These Sensors Should Be Densely Distributed.

In Some Fire Detection System Sensors Are Used To Cover Large Area For Over An External Environment, Coverage Of Large Areas Is Impractical Due To The Necessity Of A Regular Distribution Of Sensors In Close Proximity. Due To Rapidly Growing Technology Digital Camera And Video Processing Techniques, There Is A Major Trend To Replace Conventional Fire Detection Methods Withvision Based Systems. Fires Are Usually Easy To Extinguish In An Early Stage; Once A Fire Has Reached A Fairly Largesize, Operations For Fire-Fighting Become Very Complicated And The Control Of The Fire Depends Largely On The Meteorological Conditions That Determine Fire Spread. In Sparsely Populated Areas,Where Fires Are Not Extinguished, Fire Detection Is Only Needed For Monitoring The Environmentalimpact. So It Is Of Prime Importance To Detect Occurrence Of Fire At Early Stages. These All Circumstances Need Development Of A Reliable System Which Can Detect An Occurrence Of Fire Atearly Stage So That The Losses Can Be Reduced.Existing Fire Detection Automated System Can Not Detect Fire At Early Stage Because It Require Someinput To Sense Which Is One Of The Most Considerable Disadvantage. These Systems For The Purpose Of The Sensing, Sensors Have To Be Placed At Appropriate Locations And The System Needssome Specific Level Of These Inputs To Sound Alarm. Also As The Area To Be Sensed Increases The Density Of Sensors Is Also To Be Increased Due To Which The Cost Of The System Increases.

In Vision Based Fire Detection System, There Are Three Major Features For Fire: Color Pixel, Moving Pixels And Shape. The Fire Pixel Can Be Classified As Both In Grayscale And Color Video Sequences. Most Of The Fire Detection System Works On Color Video Sequences. It Is Assumed That The Image Capturing Device Produces Its Output In Rgb Color Format And These Color Information Is Used As A Pre- Processing Step. During An Occurrence Of Fire, Smoke And Flame Can Be Seen. As The Fire Intensity Is Increases Smoke Will Be Visible.

II. Model For Fire Detection

In This Section We Will Discuss The Techniques Proposed For Fire Detection. In Order To Create The Color Model For Fire We Analyzed Several Images Having Fire. Since The Color Of Fire Is Generally Closer To Red And Has High Illumination And We Can Use This Property To Derive The Required Color Model.

1.1 Rgb Color Model

A Fire Image Can Be Described By Using Its Color Properties. There Are Three Different Element Of Color Pixel: R,G And B. From The Original Image Color Pixel Can Be Extracted And Represented In Three Seperate Elements R,G And B, Which Is Used For Color Detection.

Rgb Color Model Is Used To Detect Red Color Information In Image. In Terms Of Rgb Values, The Corresponding Inter-Relation Between R, G And B Color Channels: R>G And G>B. The Combined Condition For The Captured Image Can Be Written As: R>G>B. In Fire Color Detection R Should Be More Stressed Then The Other Component, And Hence R Becomes The Domination Color Channel In An Rgb Image Forfire.The Above Equation Decided That R As To Be Over Some Pre- Determined Threshold Value R_{th}.[1]

All Of These Conditions For Fire Color In Image Are Summarized Asfollowing:

Condition1: $R > R_{th}$ Condition2: $R > G > B$.

Where R_{th} Is The Red Color Threshold Value For Fire.

1.2 Ycbcr Colormodel

Ycbcr Color Space Is Used In Our Model Rather Than Other Color Spaces Because Of Its Ability To Distinguish Luminance Information From Chrominance Information More Effectively Then Other Color Model. In Order To Create Y, Cb, Cr Components From Obtained Rgb Image. We Will Use Color Space Transformation Equation To Transform Each Rgb Pixel In Corresponding Y Channel, Cb Channel, Cr Channel Pixel To Form A Corresponding Y, Cb, Cr Image.When The Image Is Converted From Rgb To Ycbcr Color Space, Intensity And Chrominance Is Easily Discriminated.Ycbcr Color Space Can Be Easily Model As Following For The Fire:

Y = 16 + R * 65.481+ G * 128.553 + B * 24.996;

Cb= 128 + R * -37.797 - G * 74.203 + B * 112.0;

Cr = 128 +R * 112.00 + G * -93.7864 + B *

-18.214;

InYcbcr Color Space,Y′ is the Luma Component (The"Black Andwhite" Orachromaticportion of the image) And cbandcrare The Blue-Difference And Red-Difference Chrominance Components, Will Be Chosen Intentionally Because Of Its Ability To Separate Illumination Information From Chrominance More Effectively Than The Other Color Spaces. [1]

In Ycbcr Modelcolor Spaceand Analysis Can Be Performed. For A Fire Pixel,

Y(X, Y) >=Cr(X,Y) >= Cb(X, Y),

Where A Non-Fire Pixels Don't Satisfythiscondition, Where (X,Y) Is Spatial Location Of A Fire Pixel. Such System Can Be Useful For Detecting Forest Fires Where We Can't Put Sensors At Each Location.So We Can Summarize Overall Relation Between Y(X, Y), Cb(X, Y) And Cr(X, Y) As Follows:

Y(X, Y) >= Cr(X, Y) >= Cb(X, Y)

Now, We Can Have Some Rules For Fire Detection:

Rule1: R1(X,Y) = 1 , If ((R(X,Y) > G(X,Y)) &&(G(X,Y) > B(X,Y)))

0 , Otherwise

Rule2: R2(X,Y) = 1 , If (R(X,Y) > 190) && (G(X,Y) >100) && (B(X,Y) < 140)

0 , Otherwise

Rule3: R3(X,Y) = 1 ,If Y(X,Y) >= Cb(X,Y)

0, Otherwise

Rule4: R4(X,Y) = 1 ,If (Cr(X,Y) >= Cb(X,Y)[1]

0, Otherwise

III. Proposed System

Detect Fire Before It Becomes A Disaster For The Society Is Very Important Task. Proposed System Detect The Fire In Very Less Time ,Using Low Cost Camera Anddetect Fire Faster Than The Existing System. Due To The Drawbacks Of Sensor Based Fire Detection System And Due To Rapid Development Of Image Processing Techniques Vision Based Fire Detection System Came Into Existence. Proposed Vision Based Fire Detection System Having Several Advantages. Firstly Installation Cost Of This System Is Low As Cctv Cameras Are Required.Secondly It Has Faster Response Time As It Does Not Have To Wait For The Products Of Combustion To Come Near It This Was Not The Case With Sensor Based Systems.Thirdly In Case Of False

Alarm, Confirmation Can Be Done From The Room By Person Without Rushing To Location Of Fire.Fourthly These Systems Can Be Used In Open Environment And On Increasing The Area To Be Covered The Cost Of The System Is Not Much Affected. Lastly Fire Detection Technology Based On Video Image Can Extract Much More Information From Smoke And Flame Which Is Helpful For The Detection.

User Of System Is Everyone Who Wish To Secure His Place From Fire Or Want To Be Always Alert About Incident Like Fire.This System Is Useful In Areas Where We Can Install Camera.I.E.

Bank
Residential Place
Office And Workplace
School And Colleges
Home
Bank Atm
Shopes
Streets

IV. System Design

To Improve The Reliability Of Detection Usually Distinguish Sudden Movements Of Flames, Changeable Shapes Etc. In This Proposed System, Continuous Frames Of Images Are Captured By Camera. Thus It Has Faster Response Time. These Video Is Monitored By Software And Extract Multiple Images From Video. From These Images Required Ycbcr Components Are Extracted And Detect Cb,Cr Frames. After The Algorithms Are Applied On The Video And If The Specific Properties Of Fire Pixels Are Detected By The Image Processing In An Image, Then The Software Will Give Command And Alarm Is Raised. The Proposed Method Consists Three Main Stages: - Extract Images From Video, Extract Y,Cb,Cr Component And Detect Moving Fire Pixel Region In An Image. The Proposed Method Is Applied On Video Sequences And Then Fire Isdetected.Thus Smoke Pixels And Gases Are Monitored Continuously. This, In Turn, Will Increase The Efficiency Of The System And Provide Safety To The Environment.[4]

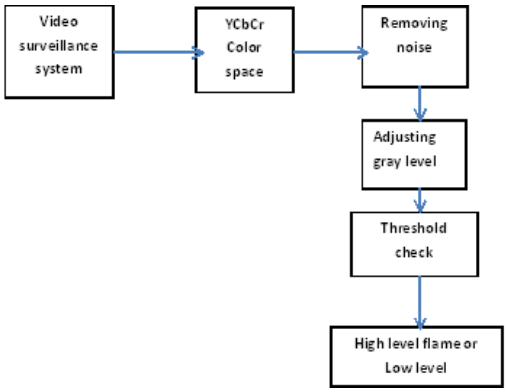

Fig.1. Flow Chart Of Proposed Algorithm For Fire Detection

V. Results

In The Output Fig 3 First Window Shows The Original Rgb Image Captured. On This Image, Grayscaling Is Applied. The Output Obtained Is Shown In Second Window.The White Color In The Window Shows The Fire Pixels.The Cb And Cr Component Is Indicated In The Third And Forth Window After That The Final Output Is Shown In The Next Window Indicated That "Fire Detected". Testing Information Represented In The Test Case Table 1

Fig 2. Fire Alert

FIG 3.Output

Sr No.	Test Description (Input)	Expected Output	Actual Output	Result
1	Camera Not Nconnected	Fire Dete Ction Failed	List Of Camera's Are Showed	Pass
2	Camera Connected	Listings Of Camera's	Listings Of Camera's Are Showed	Pass
3	Camera Will Be Blur And Incorrect Detection Of Fire(Low Pixel Camera)	Fire Detected Before Actual Fire Of Lighter	Fire Detected (Wrong Alarm)	Pass
4	Correct Detection Of Fire(High Pixel Camera)	Fire Detected With One Warning Alarm	Fire Detected With One Warning Alarm	Pass
5	Given Input As Aflash Light In Front Of Camera	Flash Is Not Condidered As Afire	Flash Is Not Considered As Afire	Pass

TABLE1. TEST CASES

VI. CONCLUSIONS

Fire Detection System Are Vital In Saving People Lives And Preventing Hazards Before They Get Out Of Control.Proposed Detection System Is Based On Computer Vision Based Technique.The Proposed System Is Based On Combination Of Various Methods Used For Fire Detection Using Image Processing. The Proposed System Detect The Fire At Early Stage By Using Different Combination Of Image Processing Based Fire Detection Techniques And Implementing The System According To Different Area Requirement. Performance Can Be Further Improved By Installing A Two Axis Robot With Pump Motor, So That The Robot Can Turn Off The Fire At Initial Stages Automatically. When Fire Will Be Detected The Location Will Be Initiated By The Gps System To The Controller And The Controller Will Then Call Upon The Robot To Mitigate The Fire. The Robot Will Then Use The Water Pumps To Turn Off The Fire At An Earlier Stage.

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