2^n factorial design of view of thermal images for detection correlation coefficient variants factors of object for environmental issues

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Abstract: Thermal imaging to improving a visibility and clarity of objects in a dark space environment by detect of the objects through camera via infrared radiation. The objects emit infrared energy (heat or flame) at the time of utility in their temperature, hotter object to emit more radiation, flame and it cannot predict the wave of heat sprite. A thermal image can be identify by heat sensor and detecting the different tiny hotness of the object. The collects the infrared radiation from captures the scene, creates an angle position and outcome as based on information view. The research focus on 2n factorial design to finding various angle object and identifying the correlation coefficient factors capture image of front, back, right, left, bottom ad top view of object. To prove the 22 factorial design is an example for, i.e., 'X' view and 'Y' view i.e., right side view by help of Yates methods and identify affecting area objects.

Keywords: thermal image; 2^n factorial design; thermal image object view; correlation coefficient factors.

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1 Introduction

Thermal image sensing technology, analytic and practice with observe measure can normally detect radiation in the long-infrared range of the electromagnetic spectrum. Every object emits the infrared radiation, when thermal imaging sensor provides superior visibility in comparison to typical digital cameras in dark environments. The best examples are surveillance of nuclear radiation, surveillance on water evaporate from agriculture land, electronic packaging and intelligent traffic systems.

Thermal imaging sensors have found widespread use in applications such as characterise the heat (i.e., temperature) signature of different objects with angle of the emission or in law of blackbody radiation. Thermal imaging sensor is implemented to obtain the complete temperature information of each point on the object. However, successful segmentation of an object in a thermal image remains difficult due to uncertain of the emission power of the object in region margin (Yawale and Raskar, 2017; Li et al., 2017).

Intelligent traffic system requires accident avoidance modelling and electronic packaging needs monitoring system with analytic modelling (Namdari et al., 2017). Disadvantage of practice: The colour differences between the current pixel, merging the segments that contain non-contour pixels, non-visited pixels, cross-reference data and share the same angle as those of the shadows.

Thermal imaging extend with various application in real practices such as infrared machine vision for deep learning of the system, to elaborate the closed-loop process in step-by-step, to increase the quality of the image with different angle position to analysis

for elaborate view of the object with competitive edges and increase the profitability of thermal images. Moreover that automation given a better quality of image than analystic study, and it is security and safe for the application such as temperature variations, power generation, fire detection, etc. The clinical application of infrared image capture analysis is an outstanding methodology to find out the various diseases investigation of biological reaction of the patients. Thermal image is fast growing field in agriculture for monitoring the nursery, soil salinity detect of crops, plants diseases and the bruise detection analysis for fruits and vegetables, etc., the agriculture image to identify the higher temperature of soil and find the resolution of image spatial resolutions of objects. Thermal image have no limitation of fast development, this session is to articulate the various application of thermal imaging. This research deals with thermal image, which is burning the object and the various dimension of angle view the object and measuring the distances, quality of picture and it is proved through the 2^n factorial design of mathematical analysis.

2 Application of research issues in thermal image

This session 2, to provide the precise elucidation about the various research works carried out by the thermal image of different application techniques and how the flames or smokes are emission from heat and finding the direction affect of emission in different view of the object. The objective of this research to find the different view of object affect by emission of heat with correlation angles of all view of design.

Thermal image camera (TIC) is device for firefighter as well to maximise the safety measures and minimise the fire losses from uncertainty occurrence (Szajewska, 2016). TIC equipment is a part of many applications such as natural disasters, finding the missing people and dangers animals in dark place. TIC equipment design with advances parameter like barium strontium titanate detector technology with un-cooled of high temperature, spatial resolution, weight less handy cameras, efficient battery, built-in-infrared pyrometer. Colourisation function show the threshold temperature of object to indicate the bright colour of hot spots place which is most dangerous area affect by fire.

Yawale and Raskar (2017) reported the survey the author suggests that most of accidents cause at light due to the low vim of the human being at time of driving the any type of vehicles when compare with day time. The risk instead (or) accident at darkness places only, so it is necessary to find a good solution for reducing the accident in down. Author introduce a new proposed technology is pedestrian detected by video proving using thermal and light vision system with help of IR led, hog (histogram of oriented gradients) algorithms as well as support vector machine (SVM) by using of mat lab. Two type of system were introduced to the night vision for vehicles. High quality of system with IR night vision came with high cost and another low quality system IR hear high vision came from the range of 200–250 m for first proposed and 100–125 m of range of second proposed segmentation of image is make the desired region for image and it convert the grey seal image to binary image based on the HOG algorithm to remove the error of the object and emerge the actual object. The grey scale image is converting into binary image for finding the corner detecting using FAST algorithm and feature extraction using HOG algorithm. These tested cases for getting a good and efficient result for image to avoid the frond of vehicles. The system is very low cost as well as safety for the human being and automatic.

Kamatchi (2017) analysis the various technologies about the detecting deception using thermal imaging and subject to design the architecture and testing the image using the KNN classifier and find the detection rate of the particular image. Facial-based approaches is introducing by author as an example, as well as to measure the skin temperature of the emotion state in the human behaviours, stress level and physiological states of the human body. Methodology established with the service of cooled mid-infrared camera of FLIR E5 series. Two sessions of image are tested from thermal image as true image and lie image and these two images on the question asked from the person and those outcomes is based on the facial-based approach with FLIR Tools. The FLIR tool is a typical software to check the cross validation to improving the deception of thermal image attributes of accuracy, precision, negative predictive, sensitivity, etc., and to identify the non-deception image by support of KNN classifier.

Barron (2017) used methods as a smart phone-based of thermal image to limb perfusion and tourniquet effectiveness for military setting purpose. Three type of experiment are made for tourniquet placement hemorrhaged and non-hemorrhaged animals. These methods to find out the thermal image for reading the temperature to reduce slowly after fixing proper tourniquet placement of the animal position. The qualitative thermal image analysis, the clear visibility of perfusion of animals about baseline and adequate tourniquet placement for both the hemorrhaged and non-inadequate groups. Infrared radiometry device help getting the accuracy and reliability by using the smart phone-based mobile thermal phone in black out conditions.

The outcome of this various application analysis shows that thermal image used in medical, military and fire alarm purpose to identify the clear image of the object to detect the risk factor to avoid the initial harmful problem to minimise from affecting factors in environment.

2.1 Quantitative objective of research issues in thermal image

The thermal image capture by camera in only one view vision (front view), not the all the view such as side view and back view of the image of the object. Based on the one view, cannot predict the thermal image, which can affect and damage the object affect by heat (Giitsidis et al., 2015). The research focus to try to find all the view of thermal image affect by image and such kind of the problem are given below as quantitative objective of the research issues of thermal image based on the above session 2 of the literature review.

- Heat transfer from fire accident and mixing become it is difficult as the viscosity of reaction mass to increases in environment.
- The highly exothermic of synthesis environment in round area.
- Very low molecular heaviness is obtained from temperature based on the martial or flames.
- Uncertainty or risk factors occur from heats of fusion, transition, reaction, etc.
- Dimensional instability of visual of thermal image.
- To pollutes the atmosphere or air population due to the making of large amount of smokes and fumes.
- It is very difficult to measure the stream flow or moment of flame.

- Gas or smoke composition must typically to be known for direction moment surrounding.

3 Technical issues of thermal images

Thermal energy can be reflected off shiny surfaces of the material such as polished metal, glass, etc. Thermal imaging cameras can not see the visualisation of burning, only through glass which acts as an immediate indicator of a low tech device demanding to offer the infrared imaging to the camera or end user. New technology developed the new tablets and smart phones with IR technology which incorporate an actually presenting a visual image to include the digitally manipulated such as thermos-gram. For example, to stand in front of a window even though looking a thermal imaging camera about object, the window reflecting thermal energy objects in the glass (Vaghani Rushikumar and Srivani, 2017). Thermal imaging cameras cannot be used for deciding factor that occurs at the time of problem exists and also used other instruments like a moisture meter, borescope, multi-metre and blueprint drawing martial are used to finding the existing problem to damage in the building (Chen et al., 2016).

4 Motivation of research proposal work

Thermal imaging is a technique to improving the visibility of objects in a dark environment by detecting the objects infrared radiation of flame or smoke and identification about the object image based on that information.

Ever objects emit infrared energy or heat with smoke or flame depends upon the function of their temperature ad environment direction and this infrared energy by an object is called as heat signature. In broad-spectrum study of this infrared heat by object is hotter of the material of object and it emits more radiation of smoke and flame. The flame and smoke cannot predict the direction of affect any of the surface by object. A thermal imager is essentially a heat sensor that is capable of detecting tiny differences in direction of flame or smoke depends on the temperature. The capture device gathers image about the infrared radiation of substances mater in the scene of view and it to be creates an electronic image based on information about the direction temperature differences. Because objects are capture the very rarely image are exactly the same or various in the temperature of other objects around them or not, a thermal camera can detect them in all each and every angle of direction view which are related to object and they will appear as distinct between various view direction of the particular object in a specific radius of the surround and capture through in a thermal image.

The motivation of this research to analysis the various view of object which is fire condition to reduce the risk factor at initial stage, after capture the thermal image to view the most affected area of the object and find the distance and angle position of the affecting area position.

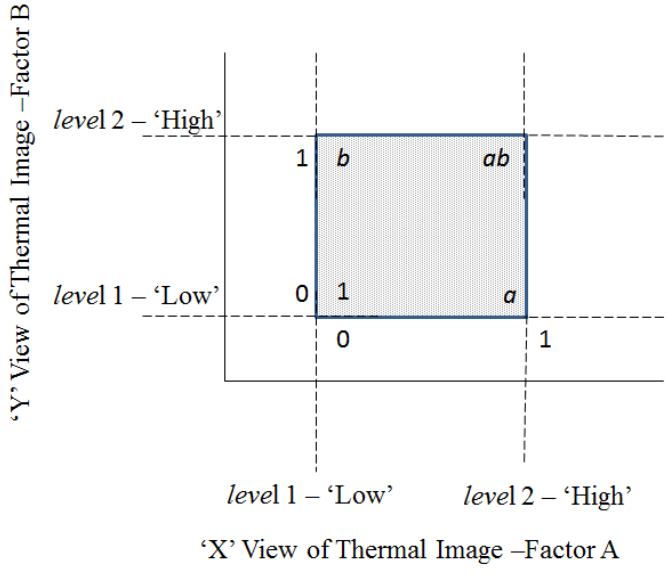
5 Proposal methodology of 2^n factorial design of thermal image

In this proposal methodology, it is aimed to identified the fire of the particular objected can be capture through camera as thermal image and to determine the flame or smoke emission direction which cause the effect the risk by the surrounding area, not in one view direction and to analysis the various view direction like top, bottom, front, back, right and left with proposal research approach of graphical view of 2^n design of factorial.

The Yates algorithm exploits the special structure of these designs to generate least squares estimates for factor effects for all factors and all relevant interactions. Before performing the Yates algorithm, the data should be arranged in 'Yates order'. That is, given k factors, the k^{th} column consists of 2k – 1 minus signs (i.e., the low level of the factor) followed by 2k – 1 plus signs (i.e., the high level of the factor). For computational purposes, the factors are scaled, so that the low level is assigned a value of –1 and the high level is assigned a value of +1. These are also commonly referred to as '–' and '+'.

Two levels of each factor on numbers are called as 2^n design, whereas 'n' is the number of factors relative in the experiment. It is also called as 2^n factorial experimental design. For example, 2^2 is a factorial experiment and it number of factor is 2 then factorial says as 'A' and 'B' level and it denoted level 1 as 'low level' and level 2 as 'high level' as well low level and high level mention as 0 and 1 respectively is show in Figure 1. The basic concept of factorial design is used for problem solving of two factors, which has involved with some correlation.

Figure 1 'X' and 'Y' view of thermal image of object affected by flame of heat (see online version for colours)



1 'X' view of thermal image factor A

Figure 2 depict the 'X' view of thermal image of the object burning in the fire, which circumstance of the 1, *b*, *ab*, and *a* sides to capture the image by camera. From 'X' view, only visualisation the front view of the object but not visual the back and side

view of the object. By using of 2^n factorial design, to visualise front view object affect portion only capture by camera and also analysis the particular position of object burn in fire, but heat and flame cannot predict in one direction of view. The *b*, *ab*, 1, and *a* is an coordinator factor A of the 'X' view of the thermal image to the factor B of 'Y' view of the thermal image to finding the variation of the object burning in the fire.

Figure 2 'X' view of the thermal image of the factor A

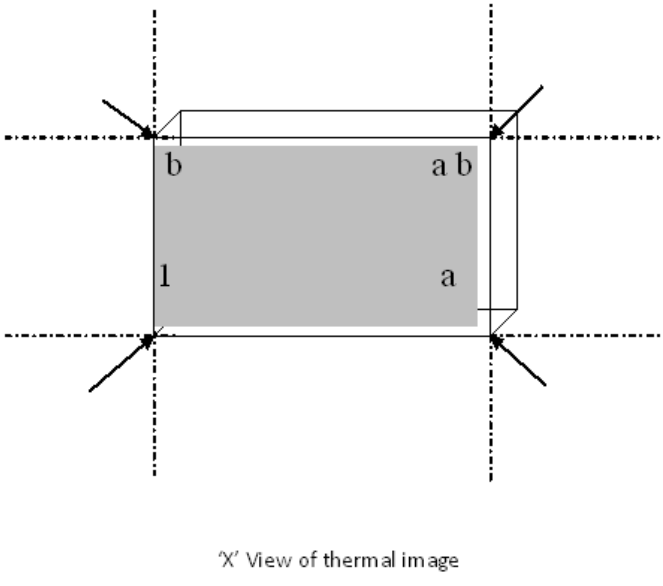
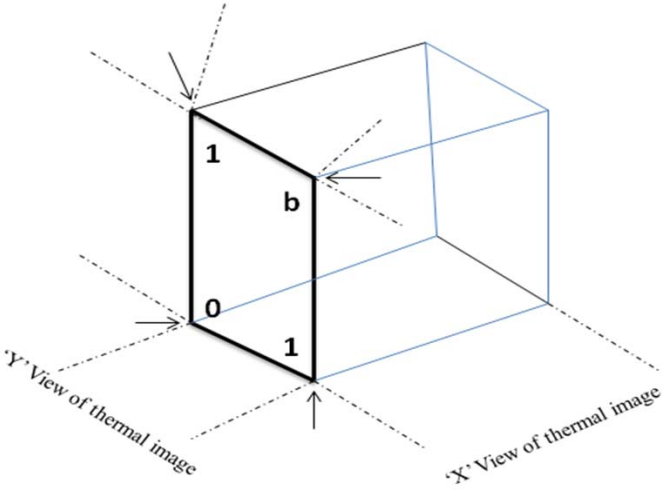


Figure 3 'Y' view of the thermal image of the factor B (see online version for colours)



2 'Y' view of thermal image factor B

Figure 3 depict the 'Y' view of the thermal image of the object burning in the fire, which circumstance of the 0, 1, *b*, and 1 sides to capture the image by camera. From 'Y' view, to visualisation the right side view of the object. The coordinator factor B of the 'Y' view of the thermal image is different variation correlation factor A of the object which burning in the fire.

6 Coefficients of terms of effects of components related of 2^2 design model: Yates order of design model

Table 1 plotted from the sessions 5 and 6 to depict with Figure 1 and 2 of 'X' and 'Y' view of thermal image with various component of edge of image, and based on the Yates order the table plot to find the correlation of between the edges of view of 2^n design.

Table 1 Yates order of 2^n design model

	Effect of graphical view		
Component	*A*	*B*	*AB*
1	–	–	+
A	+	–	–
B	–	+	–
AB	+	+	+

To find the sum of the square = $(\text{contrast})^2 / 2^2 \text{ k} = (\text{contrast})^2 / 4\text{k}$, where 'k' is the number of graphical view of the thermal image, where 'X' and 'Y' view of thermal image of factor A and factor B of thermal image is shown in Table 2.

Table 2 Graphical view of 2^n design of 'X' and 'Y' of view of thermal image of factor A and B

S. no.	*Graphical view design: combination*	*View design of thermal image*	*Effect of a factor*		*'Level change' for effect factor*	*Average changes of effect factor*
1	2^2 design: 1, a, b, ab	'X' view of thermal image – factor A	Low level of factor A	Factor A, 0 → 1	(a – 1)/n	A = 1/2n(–1 + a – b + ab)
			High level of factor A	Factor A, 0 → 1	(ab – b)/n	
2	2^2 design: 1, a, b, ab	'Y' view of thermal image – factor B	Low level of factor B	Factor B, 0 → 1	(b – 1)n	B =1/2n(–1 – a + b + ab)
			High level of factor B	Factor B, 0 → 1	(ab – a)/n	

6.1 Correlation analysis graphical design of 2^n factors

Correlation is the degree of association between two variables or two factors and it terms as a correlation coefficient. The correlation has a combination between the coefficient

and the range of correlation coefficient always lies between the –1 to +1, such combination is given below:

1 Correlation coefficient is –ve, inversely proportion and maximum of –1.

2 Correlation coefficient is +ve, inversely proportion and maximum of +1.

When, the correlation coefficient is ungrouped data of thermal image or grouped data-based, the direction view of capturing of thermal image.

The sum of square of A ('X' view of thermal image factor of A) = (contrast A)^2 / 4k = (–1 + a – b + ab)^2 / 4 × 2. Sum of square of B ('Y' view of thermal image factor of B) = (contrast B)^2 / 4k = (–1 + a – b + ab)^2 / 4 × 2. Sum of square of AB (coefficient 'X','Y' view of thermal image factor of A and B) = (contrast AB)^2 / 4k = (1 – a – b + ab)^2 / 4 × 2. In addition, Table 2 to find out the average change of effect factor of A and B of the thermal image, by this formulation it can be correlation coefficient is varying, because 'X' view of thermal image of object is different angle of fire flame of head vice versa to the 'Y' view of thermal image of object in different angle, but few of the correlation coefficient is same of the object, i.e., 2^n design of view of thermal image, which id sum of the square of A, B, and AB.

The generalise algorithm for 2^n factorial of thermal image and example are taken as 2^2 design factorial of the front view and right side of thermal image and the overall processing are made as algorithm is given below in Figure 4 with input and output of the proposal methodology.

7 Interpretation of result

This research tries to describe the characteristics of the respondents in relation to a particular view of the angle of the object, which is burning in fire, or any damage object. The following points are interpretation of research result is:

- Finding the area of region for spread of the heat and analyse the angle of the heat spread (thermal image) with help of UAV sensor equipment, GPS and image acquisition.
- Mathematical proof for finding the angle and probability set for emission of heat spread based on the thermal image.
- Finding the clear full pixel of thermal image and detecting the noise image.
- Possibility set to avoid the uncertainty risk from fire accident through the data set analytic of thermal image object.

The interpretation of this research outcome analysis the various view with the help of 2^n factorial design, and with reference of 2^2 factorial design view the front image, right side image, 2^3 factorial design view the front image, right side image, left side image. 2^4 factorial design view backside image with 2^3 factorial design and so on. Factorial design extended the design view of the all side of the object, which affect in fire and capture by thermal image.

Figure 4 Generalise algorithm for 2^n factorial of thermal image

Generalize Algorithm for 2^n factorial of thermal image

For example: 2^n design of 'X', 'Y' of view of thermal image of factor A, B.

Step 1: Input Image: Capture thermal Image: 'X' ← Front Side Image View

'Y' ← Right Side Image View

Step 2: arrange standard order: View clockwise direction.

Step 3: Set Factors level: Factor A ← level 1(low level) & level 2(high level)

Factor B ← level 1(low level) & level 2(high level)

Step 4: order of 2^2 design factorial: *1, a, b, ab* → 'X', 'Y' of view of thermal image of factor A, B.

Step 5: from Step 4 → 'X' factor A: *1, b, ab, a* Sides, 'Y' factor B: *0,1, b,1* Sides of view of thermal image.

Step 6: Yates Order for 2^2 design: *Factor A = -1+a-b+ab; B = -1-a+b+ab in terms of Contrast*

Step 7: Finding Correlation Coefficient *Factor of A & B (lies between -1 to +1)*

Step 7a: *Low level of factor A → (a-1)/n*

Or

High level of factor A→ (ab-b)/n

Or

Low level of factor B→(b-1) n

Or

High level of factor B →(ab-a)/n

Step 8: Result: Outcome of Design: find the Average of Effect area of image.

Results: 'X' ← Front Side Image View: A = 1/2n(-1+a-b+ab)

'Y' ← Right Side Image View: B =1/2n(-1-a+b+ab)

Sum of square of AB (Coefficient 'X', 'Y' View of thermal image factor of A, B) = (Contrast AB)^2 /4k = (1-a-b+ab)^2/4 x 2.

8 Conclusions

The critical considerations for several thermal image are including field of view of the object (target size, width, height and distance), type of surface area being measured (emissivity considerations), spectral area of response (for atmospheric effects or transmission through surfaces), temperature range of heat and rising the flame (handheld

portable either be a fixed grow). Other major measure the thermal image to be considerations include such as response time, mounting limitations, environment, viewing port or window applications, and desired signal processing.

The field of view is the angle of vision at which the instrument operates, and is determined by the optics of the unit. To obtain an accurate temperature reading, the target being measured should completely fill the field of view of the instrument by using of the 2^n design factorial as well as the 2^2 design factorial can determined in this research paper. The mostly the research applicable to medical related to finding ulcer problem, skin diseases and majorly used to find the fire accident of object and by finding the affect area of the object by view in different angle of 2^n design of factorial as well as to 2^2, 2^3, …, 2^n of factorial experimental design of object.

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