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Thermal Anomaly Detection of a Datacenter with a Thermal Camera

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ECE Senior Capstone Design Project – Spring 2013
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Motivations

- Servers can easily overheat and not work properly if not maintained
- A failed server can cause large delays in the network
- Overheated servers are not energy efficient and become costly; a server that is operating correctly will have a longer lifetime

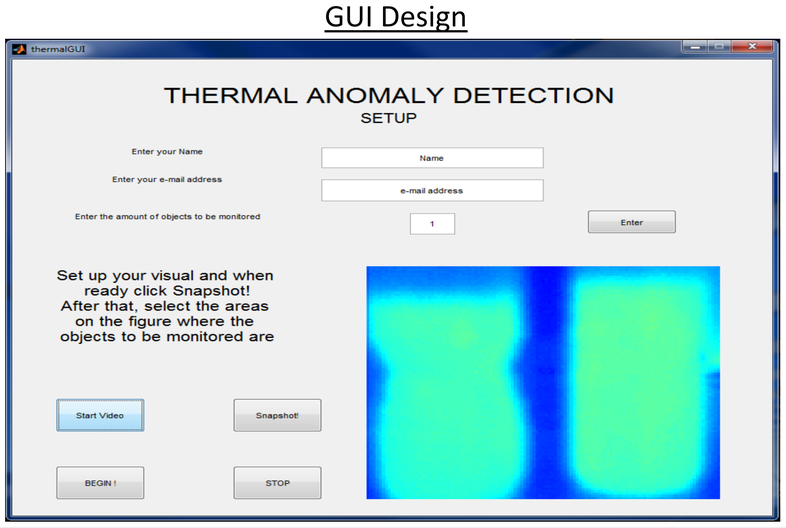
Goals

- Design a system to detect thermal anomalies in a data center (server room) in real time
- Extract features from data such as temperature and presence of a hot spot and location of said hot spot
- User notification of the operating status of servers and a warning system if an anomaly is detected

Design

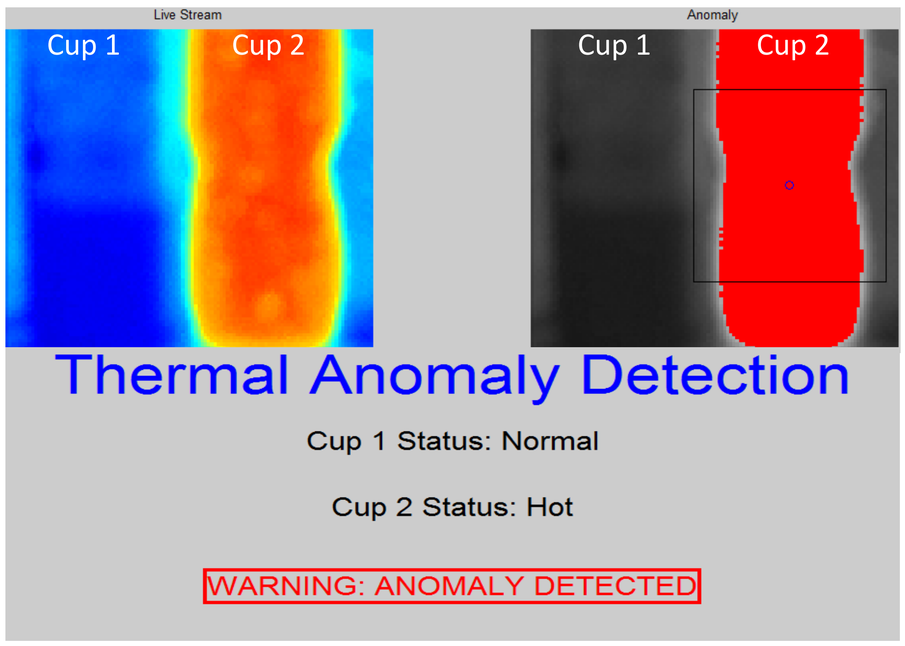
- Designed a GUI in MATLAB that analyzes the captured video from the thermal camera in real time
- Converts pixels of image to value between 0 to 255 based on intensity and then stores values in an matrix that we analyze

GUI Design



Thermal Detection Example

- Demonstration of our anomaly detection system implemented on two bottles of water, one with room-temperature water (Cup 1) and one with hot water (Cup 2)



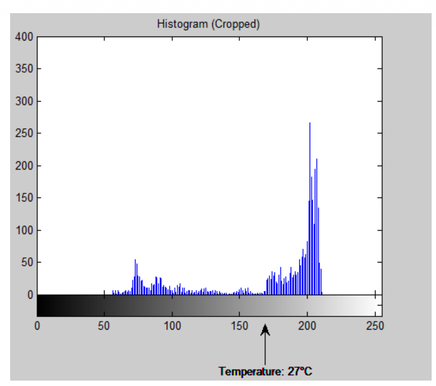
Data Analysis

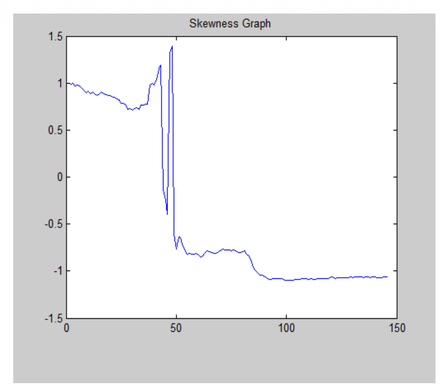
- Image data plotted on a histogram intensity plot and we uses *Skewness* and *Kurtosis* to analyze it: Skewness is a measure of the extent to which a probability distribution leans; Kurtosis is a measure of the 'peakedness' of our data (for both a value of zero represents a normal distribution)
- The more positive the skewness, the more concentrated our data is for lower (cold) values; the more negative the skewness the more concentrated our data is for higher (hot) values [1]
- For positive kurtosis the histogram intensity plot has a more acute peak around the mean and fatter tails; for negative kurtosis, the histogram intensity plot has a lower, wider peak around the mean and thinner tails
- Skewness and Kurtosis values are calculated based on the mean and standard deviation of our data

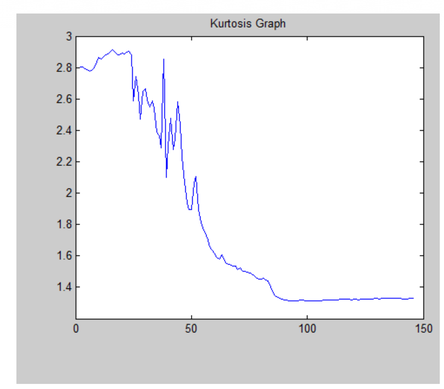
$$\mu = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \sigma = \sqrt{\sum_{i=1}^{n} (x_i - \mu)^2}$$

$$Skewness = \frac{\sum_{i=1}^{n} (x_i - \mu)^3}{\sigma^3} \qquad Kurtosis = \frac{\sum_{i=1}^{n} (x_i - \mu)^4}{\sigma^4}$$

Results







- Graphs are analyzing a live video feed of both cups when suddenly Cup 2 is heated up from room temperature water to near boiling hot water
- Histogram intensity plot constantly changes in real time and showing each frame of video with the number of occurrences of each pixel value
- Skewness and Kurtosis graphs each show how their values are changing over time as Cup 2's temperature is changing in real time

Feature Extraction

- Skewness initially shows positive value, which represents a cool temperature reading; then, as water is heated up, skewness drops to a negative value, which represents a hot spot
- Kurtosis initially shows a positive value due to our initial values all being close to room temperature; then, as water is heated up, the range of temperature values becomes more spread out and our kurtosis drops

Conclusion

- As show in our images, our system can be implemented to monitor anything by simply selecting the number of regions wanted to be tracked in the setup page of the GUI
- Monitoring servers are essential for any company or facility that has a server room; the health and performance of servers are vital for network access and assurance of a stable and fast network
- Running an optimized server room is essential for energy efficiency and will save the operators money in server replacements and operating cost

Acknowledgement

- Dr. Dario Pompili for his support throughout our capstone design project
- Guidance and assistance from PhD student Eun Kyung Lee throughout our capstone design project

References

[1] E. K. Lee, H. Viswanathan, and D. Pompili, "Model-based Thermal Anomaly Detection in Cloud Datacenters," in Proc. of *IEEE Conference on Distributed Computing in Sensor Systems (DCOSS)*, Cambridge, Massachusetts, May 2013