How FLIR Infrared Cameras Can Help the Search for Swine Flu and Other Viral Diseases
Your presenter

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- ITC Licensed Thermography Instructor
- 20 years experience in thermography
- 15 years experience in training of thermographers
- Many published papers
- Develops training material and writes articles and books
- Veteran from “the battle against SARS”
- Very often find myself in the business of killing myths...
SARS facts

- Cumulative cases: 8096
- Cumulative deaths: 774 (9.6%)
- Health care workers affected: 1706 (21%)
- Imported cases: 142 (1.8 %)
- Needle in the haystack – but worthwhile looking for!!!
What I learned from SARS

“It is easier to convince people of false things that they like to believe, than to convince them of inconvenient truths.”
10 Questions!
Question 1:

- Can the infrared camera see through walls?

- Yes, of course! But only in Hollywood movies...
Question 2:

- Can we detect H1N1 (“swine flu”) with IR cameras?

- No. We can see thermal radiation with the IR camera!
Question 3:

- Can we measure body temperature with the IR camera?

- No. Body temperature is internal, the IR camera looks at the surface.
Question 4:

☐ Is the IR camera accurate enough to measure body temperature?

☐ No. The accuracy is typically +/- 2°C. On the best models it is +/- 1°C.
Question 5:

☐ Can we scan a crowd of moving people for fever?

☐ No. That will give us false results.
Question 6:

- Can you set up the camera and let it do the work on its own?

- No. But it seems that people think so...

- With a well designed automated system, it could be done!
Question 7:

☐ **IS** the IR camera an effective tool for fever screening?

☐ At present, it is very questionable...
Question 8:

☐ **CAN** the IR camera be a useful tool to detect people with fever?

☐ YES, definitely! If a correct methodology is applied...
Question 9:

☐ Are there any internationally recognized standards or documents for fever screening methodology?

☐ Yes.

☐ ISO/TR 13154 – Medical electrical equipment – Deployment, implementation and operational guidelines for identifying febrile humans using a screening thermograph

☐ IEC 80601-2-59 – Medical electrical equipment – Part 2-59: Particular requirements for the basic safety and essential performance of screening thermographs for human febrile temperature screening
Question 10:

☐ Is it possible to acquire the equipment and training necessary to implement a working system for fever screening?

☐ Yes. IR cameras specially adapted for the job and dedicated training packages are available.
How can IR be made useful?

- You must look at the corner of the eyes
- At a maximum distance of about 1 meter
- With the patient standing still for 2-3 seconds
- With correct focus
- One by one
- We do screening for exceptions, not actual temperature measurement
Three parts

- Physiology
- Technology
- Practicality
Physiology

I am not a doctor, but those who are may protest at any time 😊
Can we feel temperature?
Fever

- Fever is a condition when the body temperature is elevated due to disease.
- Fever indicates that the person may be ill.
- We don’t know what illness it may be.
- "Normal" body temperature varies between individuals, day-night, excitement, exercise, etc.
Emotional effects
Emotional effects

Difference 0.3K

33.6°C

33.3°C

+ 3 min 45 sec
Why use infrared thermography?

- Usual methods (oral, rectal, armpit, IR-ear) are intrusive and time consuming.
- IR can be used without touching the subject and with minimal obstruction in people flow, because it is fast (real time).
Body temperature

- The body will have many temperatures...
- "Body temperature" is the inside, or core temperature of the body
- Always higher temperature inside than outside
- Surface temperature varies
  - Variations over time
  - Variations according to temperature control needs
Body temperature

- Non-contact measurement
  - We need to measure at a point with high correlation between inside and outside temperature
Body temperature

- Hypothalamus, a part of the brain, controls temperature. Has a stable temperature.
- Points close to the brain will have high and stable temperature.
- Other areas of the body will have relatively large variations in temperature compared to the core temperature.
Body temperature

- What points are available?
  - Eardrum
  - Corner of the eye

- Eardrum is not accessible enough

- Conclusion – corners of the eyes is where we should look!
Technology

- In this part, I am pretty sure I know what I am talking about!
Two main issues

- Spot size – there is a limitation to how small objects we can measure at a distance
- Thermal drift – the measurement stability of the camera is very important
Camera principle

The camera converts invisible infrared radiation into a visible image.
IR images

-1.7°C
4.9°C
0
2
4

-2.9°C
22.1°C
0
5
10
15
20

-6.2°C
27.3°C
0
10
20

-7.0°C
1.4°C
-6
-4
-2
0

23.6°C
34.9°C
24
26
28
30
32
34

27.7°C
36.0°C
28
30
32
34
36

A person's face
Most cameras have measurement compensation factors (emissivity, reflected apparent temperature, distance, etc.)

Not all cameras do compensation for all factors

For fever screening, we can set a number of default values for the factors the camera uses

This is not a problem in fever screening
Spot size

- We are looking at small areas, the corners of our eyes
- The camera has a limit to how small objects we can measure at a certain distance
- The distance cannot be too great before we start reading too low temperatures
- You cannot always measure, just because you can see!
Spot size

- Target size must be bigger than the cross hair
Test measurement!

- At a distance, with glasses, bad focus: °C
- At a distance, with glasses, good focus: °C
- At a distance, without glasses, good focus: °C
- At 1m, with glasses, bad focus: °C
- At 1m, without glasses, good focus: °C
Thermal drift

- The IR camera is different to a visual camera in one important aspect
- A visual camera is dark inside, except for the light from the object
- An IR camera has a temperature inside, hence it will itself emit radiation towards its detector!
- The camera temperature will vary over time!!!
Visible light camera

Camera is dark inside!!!
Infrared camera

Radiation inside!!!
Thermal drift

- The extra radiation that comes from the camera itself has to be deducted before the radiation is converted to temperature.
- The camera temperature will not be stable, so the picture and measurement will change.
- The part that needs to be deducted must be continuously measured.
- Several temperatures inside the camera are measured.
- A shutter is periodically inserted in front of the detector to neutralize offset.
What is “precision” and “accuracy”?

- **Precision**
  - How close together will repeated measurements of the same value be; the “spread” of measurements

- **Accuracy**
  - How close are we to the true value
Practicality

- How to make it work...
Screening for exceptions

- We can not measure the actual temperature accurately enough.
- It is not necessary to know what the body temperature is, only if it is a higher temperature than the average of others.
- Using this method will eliminate or reduce the most important measurement errors we have.
Screening for exceptions

- Baseline
- Threshold
- Offset

Exception!
Baseline

- First thing to do is a baseline
- Average of people in the actual situation where we measure
- Assumes that the majority does not have fever (which is reasonable!)
- Anyone who has a significant difference from the average may have a fever
Acquiring the baseline

- First ten people are measured and recorded
  - When you start the day, use yesterday's values for the same hour of the day, and...
  - ...if you move the station, keep the same, until new values have been established
- Calculate the average temperature
- The averages should be recorded for comparison
Establishing the threshold temperature

- People with a temperature that is 1°C higher than the average may have a fever
- If the baseline is e.g. 35.4°C, then the limit is set to 36.4°C (or the built-in delta set to +1°C)
- This is called the threshold temperature
- Anyone over the threshold temperature is singled out for further diagnosis by the medical team
Acquiring the baseline

- Some camera models have a built-in averaging function
  - Sample Average of the active measurement function is updated by pressing a button
  - Alarm threshold at a certain difference to the acquired average can be set
Precision

High

Low
Accuracy

- We need precision, not accuracy!
Principle of the workplace

- Person scanned
- Waiting line
- Host
- Exit
- Operator
- Back-up

[Diagram showing the workplace layout with the mentioned elements.]
Principle of the workplace

- People must be scanned one by one, no mixing
- The area behind the subject should be "clean" from thermal distractions
- The subject should always be at the same distance, and in perfect focus
- The subject must stand still for 2-3 seconds
Personnel

- One camera operator
- One host
- One back-up person
- Medical team
Camera operator

- **Tasks**
  - Looks at the image
  - Points out people with temperature above threshold

- **Challenges**
  - Requires concentration
  - Boredom is the biggest enemy
Host

Tasks
- Controls the flow of people
- Lets people through one by one
- Asks people to remove eye-glasses and other obstacles

Challenges
- Must have a courteous and friendly attitude, yet authoritative, even when the subjects are unwilling
Back-up person

☐ Tasks
  ■ Directs possible fever cases to the medical team
  ■ Makes updated baseline calculations
  ■ Answers questions from the public
  ■ Keeps notes for reporting purposes

☐ Challenges
  ■ Must be self motivated
Work rotation

- All team members should be capable of all tasks
- The camera work is the most tiring, because it gets boring
- Frequent rotation between the tasks makes the work less tedious, and keeps everyone alert
- Recommend switching after 20 minutes
Other aspects

- Where to do it, for example in an airport?
- How would a national defense system develop over time?
Finally...

- There is really no mystery here – this is not science fiction, we can make it work, no problem!
- But there are no shortcuts!!
- Physiology and technology cannot be overlooked or ignored
- Wishful thinking cannot be allowed to rule our actions