DEMAND CONTROLLED VENTILATION (DCV) SYSTEMS : PERFORMANCES OF INFRARED DETECTION

A.M. Bernard [1](CETIAT) – J.G. Villenave [2] (CSTB)
Marie Claude LEMAIRE [3] (ADEME)

[1] CETIAT, 25 avenue des Arts - BP 2042- F 69100 Villeurbanne-France
Tel : (33) 04 72 44 49 46 - Fax : 04 72 44 59 46 - email: anne-marie.bernard@cetiat.fr
[2] CSTB, 84 avenue Jean Jaurès, Champ sur Marne – F 77421 Marne la Vallée Cedex 2-France
Tel (33) 01.64.68.83.11 - Fax : 01.64.88.83.50 - email : jg.villenave@cstb.fr
[3] ADEME, Département Bâtiment et Collectivité, 500 route des Lucioles, Sophia 2 – F 06560 Valbonne-France
Tel : (33) 04.93.95.79.56 - Fax : 04.93.65.31.96 - email : marie-claude.lemaire@ademe.fr

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ABSTRACT

For energy savings, DCV systems are more and more used in ventilation systems. In France, in non residential buildings, these systems are generally controlled by either a CO_2 sensor, or an optical movement detection (infrared). The part of the study we present here was to determine laboratory tests methods to assess the performances of optical sensors for ventilation application. The point was to characterise them by checking their detection in front of some determined movements or events. Results on the different methods tested to characterise sensors and the best method chosen will be given.

INTRODUCTION

The aim of the study was to :

- ✓ determine tests methods both for CO_2 and optical sensors : CO_2 sensors can be calibrated but optical sensors need to be characterised by checking their detection in front of some determined movements or events.
- ✓ determine main parameters to be checked in the overall system (check list)
- ✓ consider real performance of the sensors on site : different sensors installed in different positions in a meeting room have been compared.
- ✓ enquire on real occupation on site for offices and meeting rooms : in more than 30 offices and 10 meeting room, occupation rate have been monitored either by webcam or by enquiry to the users.

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THE SYSTEMS STUDIED

Optical sensors can be used either to just detect occupation of the room or to count the number of persons present. In the last case, it is mainly the algorithm associated to the sensor that determine the number of present persons from the number of movements noted in a certain period of time.

Pyroelectric detectors are thermal type infrared detector sensible to temperature variation. To amplify the signal for movement detection, they are associated to Fresnel lenses which will create several zones : those where the energy is focused and those which are blind to detection. The fact then that a hot object passes from one zone to another is detected by the sensor.

These sensors can be installed on walls or ceiling depending on their type. They generally detect on a conic volume. They shall be positioned in order to cover correctly the occupation zone, avoiding dead zones or over detection as shown in figure 1

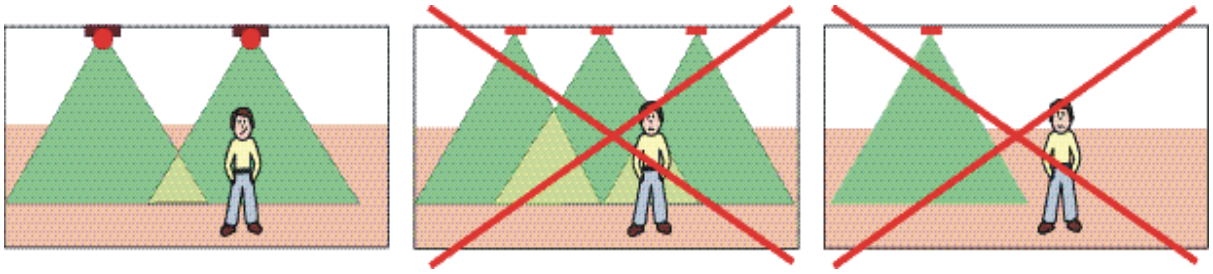

Figure 1 : correct position of infrared sensors in the room

TEST METHOD

The aim was to determine a test method of the sensors in lab to characterize these sensors. After other tests, the best results have been obtained by a “robot” simulating a rotation movement (ie like someone moving shoulders or hand during a meeting) in several points of the detection volume. The installation (see figure 2 and 3) was made of

- 2 heated surfaces : 100 x 75 mm, with surface temperature around 32/33 °C.
- a support of adjustable height. The axis, supporting the two heated surfaces separated by 450 mm, can rotate with various angle to simulate rotation movement more or less large.
- The tested sensor is installed at 2.50 m from floor (standard conditions).

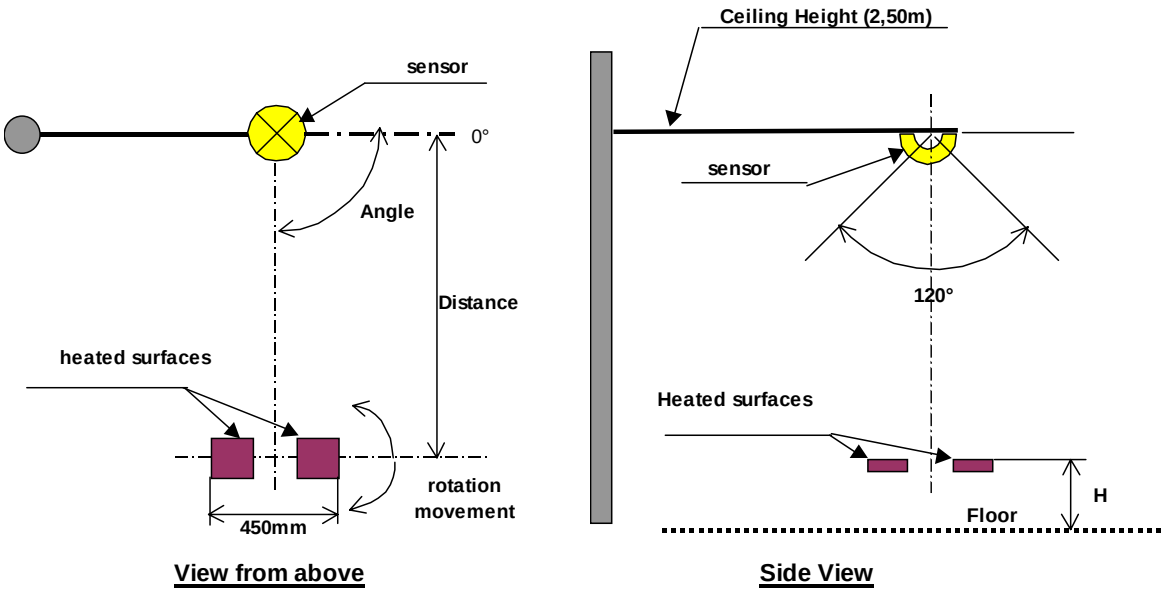

Figure 2 : description of the test installation

Figure 3 : photo of the test installation

4 sensors have been tested and we will now comment for two of them.

A first determination of the cone angle is done close to the sensor (630 mm below) using only one heated surface. This gives an approximation of the detection cone angle. Then, at 1.10 m from floor (1.40 m from sensor), which is approximately the height of a person seated, we monitored the detections obtained in different positions inside the cone and close to its border. In order to be sure that our robot was representative, the same procedure was repeated with two sensors and real person moving shoulders replacing the robot. Results were alike although it is quite difficult to ensure the same movements in the case of a real person.

Figure 4 shows the results obtained on one sensor and compare them to the faces projection given by manufacturer. We can note than close to the cone border, depending where the robot is situated, it may not be detected (because the movement won't cross the limits of the faces projection). To

ensure reproducibility of the method, it is therefore necessary to test several points on a full quarter of the circle. It would also be interesting to test at more distances than only two to have a more fine exploration of the cone.

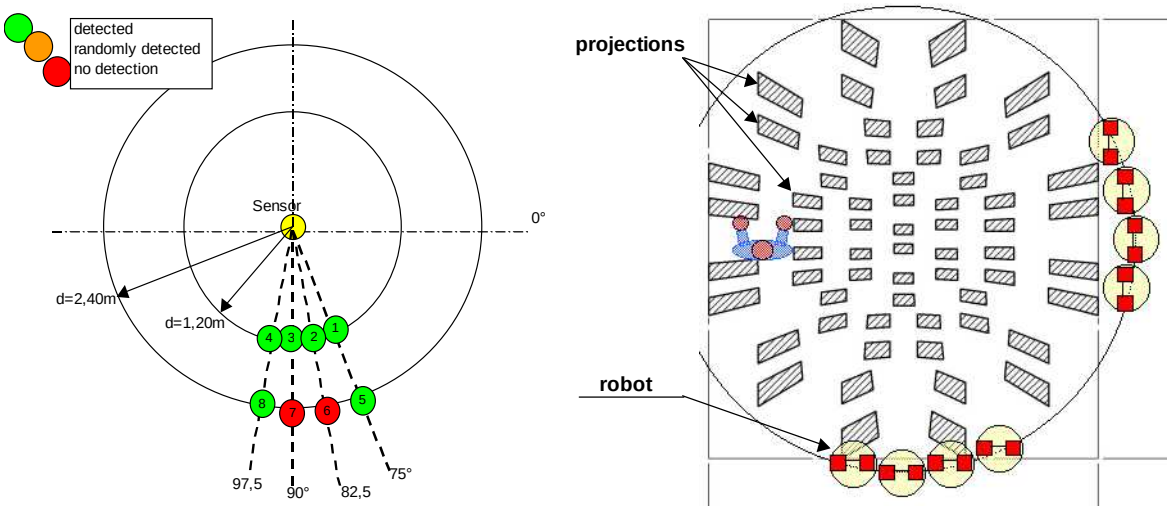

Figure 4 : example of detection from robot compared to the faces projection given by the manufacturer

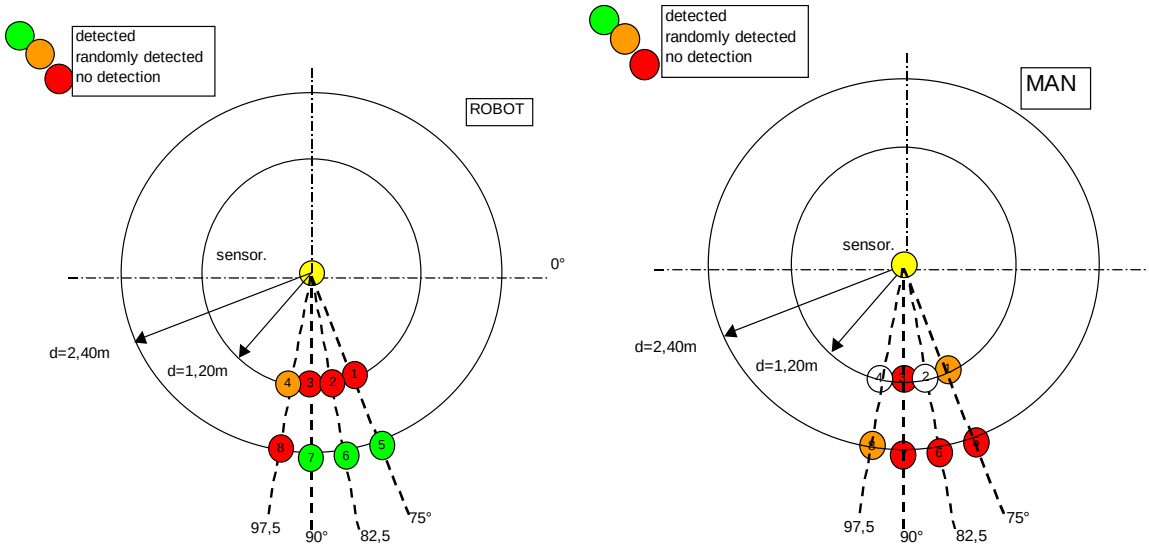

Figure 5 : example of detection by robot on another sensor, and comparison with a detection with man movement

In the case of another sensor, shown in figure 5, we can see that the movement are detected randomly even inside the cone area and not only at the border. This was also noted, and even worse, when the movement were made by a man instead of a robot. This sensor, developed to alarm in case of intrusion has faces projection quite small and with distance in-between them, were our robot was situated. A few centimeters aside, it would have been correctly detected. This sensor can be used to

detect large movement (people walking..) but will under detect if used for a meeting room where people are mainly seated.

We have finally performed the same test with the complete procedure decided (smaller steps between points on a full quarter of circle) on a sensor correctly qualified before. Figure 6 shows the results for both small and large movements of the robot. Small movements (circles) corresponds to 77° angle and large movement (square) to 154° angle. We can see that small movements are sometime difficult to detect while a person moving shoulders was detected. It seems therefore that large movement are more representative.

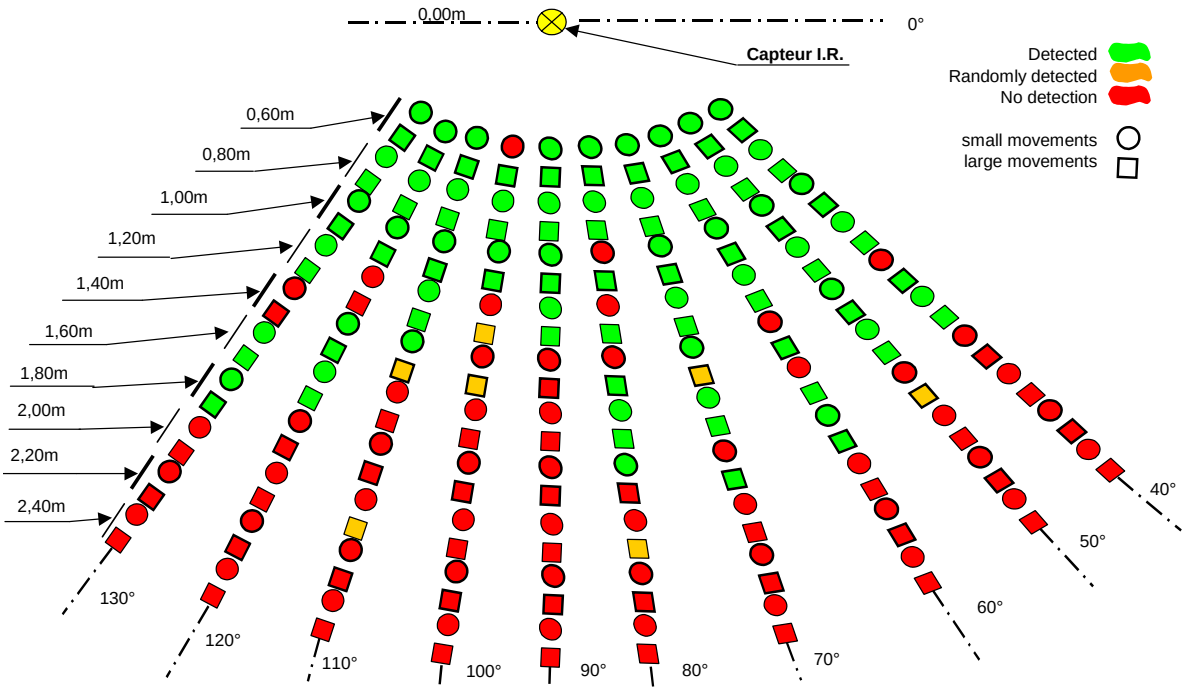

Figure 6 : complete detection on a sensor

CONCLUSION

- The procedure can be applied and reproduced to determine the detection cone but shall be increased (more points on a full quarter of circle) to be accurate. With large movements, it is representative of a seated person in a meeting room.
- It can determine sensors not appropriate for this application (i.e intruder alarm…) by showing the detection zones.
- Although useful for occupation detection, it can’t be used yet to qualify the algorithm used to count the number of persons. This can be checked only on site.