Infrared people detectors

Street prices on the infrared people detectors are dropping very fast, so now is a good time to review how those electronic devices work. Several important uses now include burglar alarms and occupancy sensors.

Any object not at a temperature of absolute zero will radiate heat. At lower temperatures, a *black body radiation* pattern will be produced.

A human will normally radiate at 98 degrees Fahrenheit, compared to other objects in the room which will typically radiate at a 70-degree range. A human body is a very weak radiator which becomes even more so when compared against the ambient. Figure 1 is a typical curve of human body radiation in a normal room. As you can see, the radiated energy is centered on the eight-micrometer range in the far infrared.

One sensor which is capable of detecting the radiation from a person is known as a *pyroelectric infrared detector.* They are available at a very low cost from the *Amperex* division of *Phillips*, among others. As we'll see shortly, Amperex has lots of good ap notes and data sheets available.

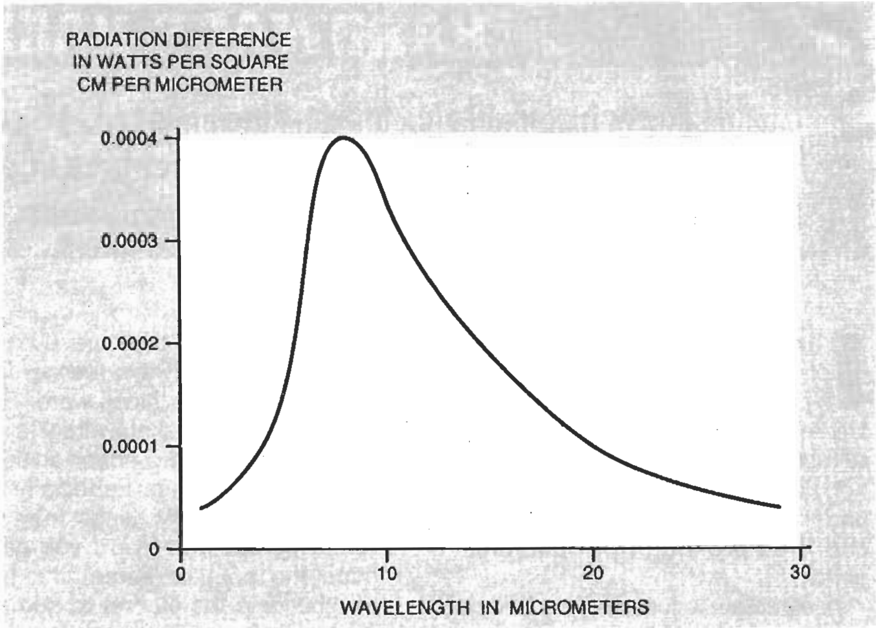

FIG. 1—THE FAR INFRARED SIGNATURE of a 98-degree F person in a 70-degree room environment. Note that these are extremely weak power levels.

A pyroelectric infrared detector consists of one or two detectors that, in turn, input to a field effect transistor (FET) source follower. The basic detector is a capacitor, across which several hundred microvolts DC will be generated in the presence of a warm and non-moving human body. The detectors are often used in side-by-side differential pairs that are imaged slightly differently. They then tend to cancel out stationary sources.

One very big gotcha here: The sensors are basically a capacitor so they cannot indefinitely produce a DC output. Even the tiny bias current of a FET's gate is enough to flatten any long-term DC level. Thus, the pyroelectric infrared detector is able to respond only to *changing* levels of infrared energy. Stationary sources are ignored.

So, the trick is to make the infrared signals appear to be rapidly changing. One obvious way is to have the person run through the beam. That can produce a usable transient. But something better is clearly needed.

The traditional method was to chop the beam by putting a bladed fan in front of it. That would input an infrared square wave that represents the difference between the body and fan blade temperatures. By knowing how fast those blades whipped past you, you could also do a *synchronous demodulation* that would increase your detection sensitivity. But moving fan blades and synchronous detectors are expensive.

Somehow you have to gather the infrared energy from your area and concentrate it on the detector surface. While mirrors are one solution, a plastic *Fresnel lens* is better.

Now for the tricky part. Instead of making the lens operate uniformly over the surveyed area, it is purposely striped so that there are "strong" and "weak" sensing areas. A typical lens pattern is shown in Fig. 2. As the person walks through the beam or otherwise moves, they travel between the strong and weak lens areas, creating more of a varying signal than they would otherwise.

Figure 3 shows you a schematic of a simple people detector using a dual-element pyroelectric detector and a quad op-amp. The Fresnel lens has strong and weak areas that alter the strength of the infrared signature of a moving person. That is sensed by the detector and routed to a ×600 AC amplifier. The combined frequency response of the detector and the amplifier is in the 0.3- to 5-Hertz range. That is usually optimum for most people movements.

The output of your amplifier is routed to a *window detector* or dual comparator. The detector will output a signal on any sudden change in the infrared signature. Usually, the output of the window detector is routed to a counter of some sort to minimize false alarms.

In security applications, an alarm output is created. For the occupancy detectors, the lights are quickly turned on, and then left on for a selected number of minutes. A fifteen-minute delay is often optimum for people who are usually sitting at a desk or bench. Each time they move, the on time gets extended.

One commercial source of ready-to-go occupancy sensors is *Leviton*. They fit in an ordinary power outlet. Occupancy sensors can dramatically reduce the power bills in most larger commercial buildings.

Another alternative to pyroelectric detectors is the *Kynar Piezo Film* from *Atochem* (formerly Pennwalt). While less sensitive to infrared and much more tuned in to motion or vibration, this approach can let you integrate your lens and sensor into one single thin assembly.

While the electronics involved in people detection are both simple and straightforward, your mirror or lens design is not. Thus, you are better off using some already developed and debugged commercial lens/detector combination than trying to work one up from scratch.

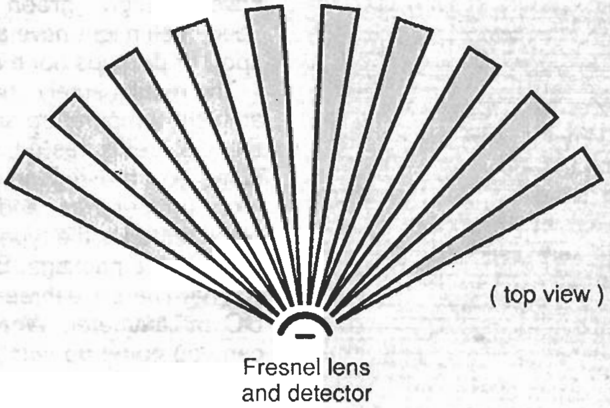

FIG. 2—SINCE PRYOELECTRIC INFRARED SENSORS are capacitors, they cannot hold a DC or stationary level. To emphasize changes in motion, special Fresnel lenses are often used that have "hot" and "cold" areas as shown here.

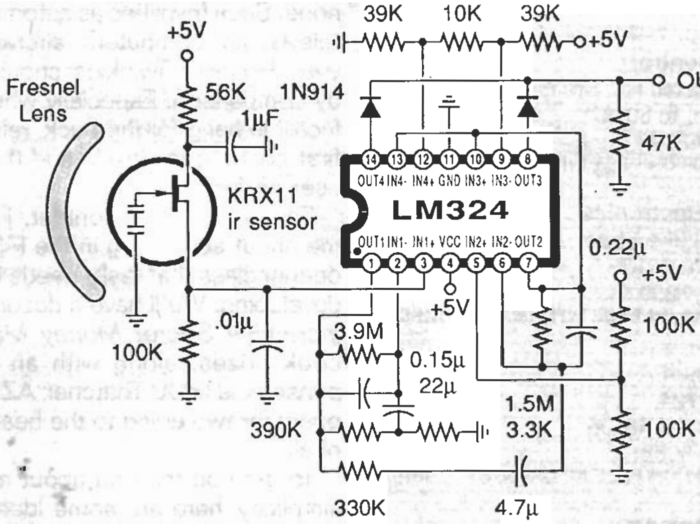

FIG. 3—A "PEOPLE DETECTOR" intended for use as an office lighting control. The output goes high on any motion detection that would increase or decrease the input far infrared signature.

Pyroelectric infrared detectors for movement sensing.
Technical publication #134, 1984

Remote level sensing using pyroelectric infrared detectors.
Technical publication #135, 1980

Low cost remote sensing radiometer using the RPY89 infrared detector.
Technical publication #138, 1980

Low cost automatic light switching using passive infrared sensors.
Technical publication #147 February 1985

Ceramic pyroelectric infrared sensors and their applications.
Technical publication #163

Passive infrared (PIR) intruder alarms.
Technical publication #213 April 1986

Movement sensing using a multi-element fresnel lens.
Amperex ap note, November 1988.

KRX10 dual element pyroelectric infrared sensor.
Data sheet, September 1988.

KRX11 dual element pyroelectric infrared sensor.
Data sheet, September 1988

RPW100 dual element pyroelectric infrared sensor.
Data sheet, September 1988

Fresnel lens data sheet and explanatory notes.
Phillips data sheet, April 1986

FIG. 4—AMPEREX AP NOTES and data sheets on pyroelectric infrared detectors.

Figure 4 lists some of the more readable *Amperex* ap-notes and data sheets on people detecting. It is a very good starting point for picking up all the infrared sensing basics.