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MOTION SENSORS AS A MEANS OF SAVINGS ELECTRICITY

Rasulov B.B., Toshxodjayeva M.U.
Tashkent State Technical University named by Islam Karimov,
Tashkent, 100095, Uzbekistan

Abstract
Experience shows that significant energy savings in buildings can be achieved by installing integrated automated systems for monitoring and controlling electric lighting. We will show the possibilities of reducing energy consumption through the use of motion and presence sensors that control lighting installed in the entrances of multi-story buildings located in the city of Tashkent.

In Uzbekistan, more and more attention is being paid to energy saving issues when designing new and reconstructing existing engineering systems of buildings and structures. Therefore, there is considerable interest in foreign, already proven methods and developments that allow for significant energy savings.
Energy-saving measures implemented in Germany have proven themselves well at Uzbek facilities. Thus, automatic control using special sensors has found wide application in building interior lighting systems. Germany has made great progress in this direction: the country has adopted a law at the federal level regulating the mandatory installation of presence and motion sensors in buildings in order to save electrical energy spent on artificial lighting.
Without the implementation of these energy-saving requirements, it is impossible to design a new building or reconstruct an existing one. Their implementation is not difficult, because the market offers a wide range of motion sensors, presence sensors, twilight sensors and related equipment necessary for automatic lighting control in buildings.
Let's look at the principle of operation of an automatic lighting control system and show in which case one or another sensor should be selected.
One of the effective ways to solve the problem of saving electricity is to install motion and presence sensors. The principle of their operation is simple: the sensors automatically turn on/off the lighting in the room depending on the intensity of the natural light flow and/or the presence of people. This is made possible by passive infrared radiation technology: built-in IR sensors record thermal radiation and convert it into a measurable electrical signal. People emit thermal energy, the spectrum of which is in the infrared range and is not visible to the human eye.

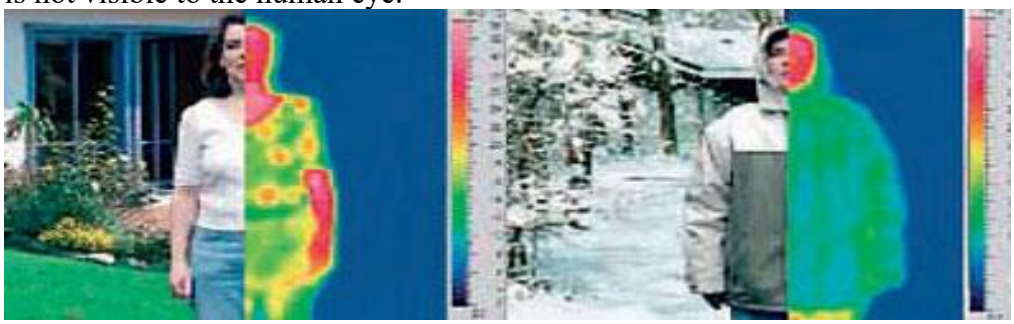

Figure 1.Distribution of human body temperature in the infrared spectrum
Figure 1 illustrates the distribution of human body temperature in the infrared spectrum. Thermal radiation

is collected by an optical lens and projected onto infrared sensors. Changes in thermal radiation, i.e. temperature differences caused by movement, are recorded by sensors and converted into an electrical signal. The electronics built into the sensor processes the received signal and performs pre-set actions (switching on/off lighting groups).

The optical lens system captures thermal radiation and projects data to an infrared sensor. The sensor detection area is divided into active and passive zones. Only active zones are designed for the infrared sensor. As a result of changing the readings of infrared radiation, a signal is sent from one active zone to another (Fig. 2).

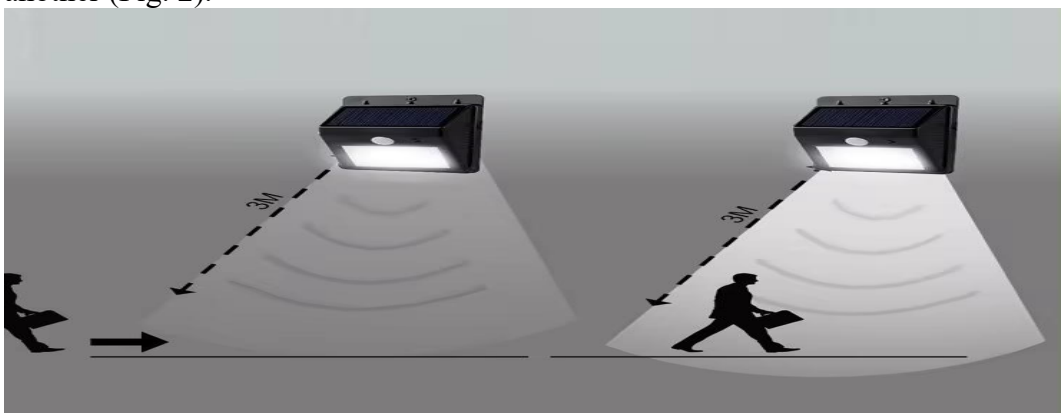

Figure 2.Active and passive zones of the infrared motion sensor

The table will help you navigate the choice between using a motion sensor or a presence sensor. In any case, the decision should be made carefully, taking into account various parameters: from the place of the intended placement to the desired work scenario. It is also necessary to take into account the range of sensors and their sensitivity, which depends on a number of factors that can vary depending on the state of the environment and other reasons:

- range of action (for example, an increase in the coverage area with an increase in the height of the sensor installation) (Fig. 3a, 3b). In this case, the sensitivity decreases as the passive and active zones become larger (Fig. 3b);
- determining the optimal diagonal of human movements to trigger the sensor (Fig. 2);
- the influence of seasonal fluctuations in ambient temperature. In the middle of summer, the difference in ambient and human body temperatures will be small, while in winter most of the surface of the human body is tightly covered with clothing (Fig. 1). Also, weather phenomena such as snow, rain and fog absorb infrared radiation and can reduce the sensor response range (Fig. 3a).

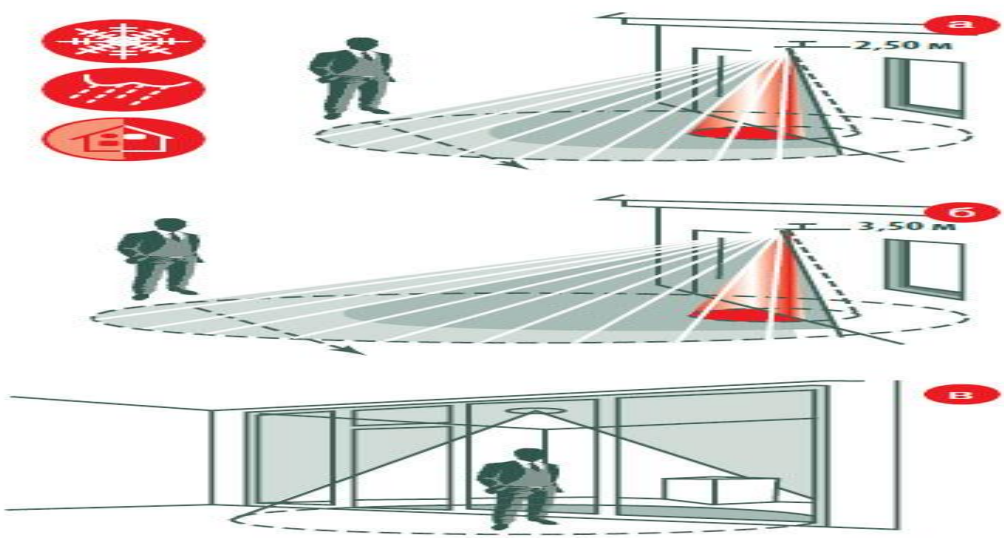

Figure 3.Changing the range and sensitivity of sensors depending on some factors

Thanks to the integrated stabilization of the temperature level, the sensors compensate and smooth out the influence of the environment on the operation of the devices as much as possible. After selecting the appropriate sensor, attention should be paid to possible interference during installation, such as:

• plants (trees, bushes) swaying under the influence of the wind;
• animals (dogs, cats, etc.);
• hot air flows from fans or heating equipment;
• Electronic sources of interference located in close proximity, such as television and hi-fi devices, computers, radio communication systems, etc.;
• Artificial lighting sources installed next to the sensors.

The mentioned interference can cause unintentional sensor activation, therefore, with the help of the supplied blinds, the coverage area can be changed, taking into account individual characteristics. It is important that the sensor has an open field of view, since temperature radiation from a person cannot penetrate solid objects (walls, doors, windows or a glazed room) (Fig. 3v).

The sensors can be programmed using a remote control, which makes it easier to set various parameters and adjust the operation of the sensor, as well as eliminates the need to use additional equipment (tools, ladders, etc.).

Table 1

Indicator	Motion sensor	Presence sensor
Reaction to movement	responds only to active movements	detects even small movements
Turning on the lights	• simplified; • stops when the sensor responds and artificial lighting is turned on	• accurate measurement from natural and artificial light; • continues when the sensor responds and artificial lighting is turned on
Turning on the lights	• simple switching on of lighting is activated depending on the degree of illumination or movement; • as long as there is movement, the artificial light will remain on	• if there is enough daylight (according to a given parameter), artificial lighting will not turn on, despite movement; • two control channels: one – turns on the lighting (depending on natural light and the presence of people), the second – turns on a fan or other HVAC device (depending on the presence of people); • 1–10 V connection interface
Placement	indoors or outdoors	Ideal for rooms where people work while sitting
Installation example	outside buildings: roads, approaches to buildings, stairs, open parking lots, underground parking lots; inside buildings: rooms/offices or hallways with little or no natural light, toilets and ground floor areas	inside buildings: private or open plan offices, school offices, conference rooms, hotel rooms, toilets, gyms, staircases/corridors with natural light

The main advantage of motion and presence sensors for installers is their simple installation and configuration for subsequent work: no need to install special control networks or use additional expensive equipment. The sensors are installed in the electrical circuit and are immediately ready for use.
Despite the almost threefold difference in energy costs, the payback period for installing motion and presence sensors for Uzbekistan is 1–2 years, depending on the rate of growth in electricity prices and the power of the lighting equipment used. Considering the total service life of buildings (40–50 years), the payback period for this equipment is short, and the use of this solution allows the building owner or management company to save significant funds during the operation of the facility.

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