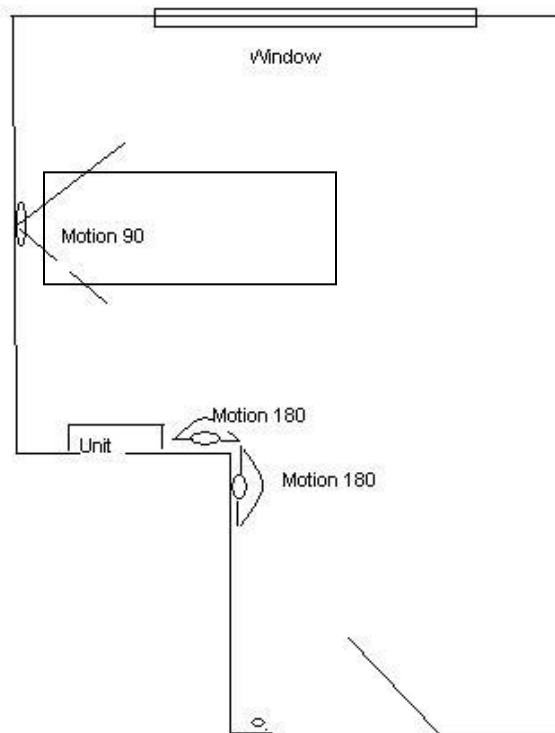


ESP D-Lux Prototype Testing Phase II

Test Environment

In this phase the test unit was placed in an unoccupied patient room within the clinical services area of Via Christi Hospital on St Francis Street. The room was 18 by 13 feet with a window on the south wall and the entry door on the north wall. To the east of the entry door was a bathroom. The device was placed next to the north wall on a table 12 feet from the entry door and 3 feet off the floor. A continuous recording video camera was placed 18 feet from the door in a position to record both the door opening and the activation of the unit. Temperature was maintained between 68°F to 75°F during the test period. Tests were done on November 15th and 16th 2012.



Device Settings

The test device was set to detect the signal from a door sensor installed on the entry door, a pressure sensor on the bed, and three thermal motion detectors placed in the room as illustrated in the figure above. The UV bulb lamp was installed in the circuit. The time between door closing and device shutter reopening was set to 5 seconds. The delay on the light circuit was set to turn on 3 seconds after the shutter opened. This resulted in a total delay of 8 seconds between entry door closing and shutter opening and device lighting. Once the device was installed and the video camera functioning, one of the test personnel sat at the nurse's station with a view of the outside hallway and the door. They also observed the video monitor receiving the video feed from the room containing the test device. A second person performed the maneuvers specific for each experiment.

Experimental Activities

Experiment 1 Door opening all sensors on

Experimental Parameters

In this series all sensors were activated including the pressure sensor on the bed the three motion sensors and the door sensor. The door was opened and closed then opened and closed two minutes later. A fault would be recorded if the light failed to go off when the door opened (door sensor fault) if the unit failed to turn back on within 8 seconds of the door closing (door, motion, or pressure sensor fault) or if light turned back off during the 2 minute waiting period before the next actuation (motion, pressure or door sensor fault). 50 repetitions.

Results

After 50 repetitions there were no faults of any kind.

Discussion

This experiment demonstrated that the motion and bed sensors that turn off the unit did not activate inappropriately with no one in the room. It also demonstrated that the door sensor system functioned every time the door was opened or closed.

Experiment 2 In-Room Movement with Motion and Door Sensor On and Bed Sensor Off

Experimental Parameters

In this experiment the room was set with the door and motion sensors on and the bed sensor off. An investigator entered the room closing the door behind her. She performed the motion maneuvers in the results table below for 2 minutes.

Results

Maneuver	Count	Number of faults	Time to fault	Description	
Constantly walk around room	5	0			
Walk slowly around room	5	0			
Stand by window and wave	5	1	<10 sec.	Light turned on	
Sit in chair rocking back and forth	5	0			
In bed moving around	5	2	12 and 13 sec.	Light turned on	

Discussion

It is apparent from the above table that the thermal motion sensors as currently configured are only sensitive to relatively large movements of a person in a room. Walking and sitting in a chair rocking did not produce activation of the light while standing still waving and lying in bed and moving around was not enough activity to prevent the light from turning on.

Experiment 3 - Schedule Function

Scheduling mode pertains to the programming of the system to turn off and on automatically based on a computer controlled timer or clock function.

Experimental Parameters

Door sensor only on, Unit programmed to switch from scheduled mode to non scheduled mode and from nonscheduled mode to scheduled mode. In this series the system was scheduled on and when the door was opened the system converted to off then when the door was closed the unit converted to on and then off and then to schedule on in two minute programmed cycles. The series was repeated 50 times.

Results

There were no faults in the function of the door sensor.

There were no faults in any reset time either from program off to program on or program on to program off.

There were no failures in schedule function

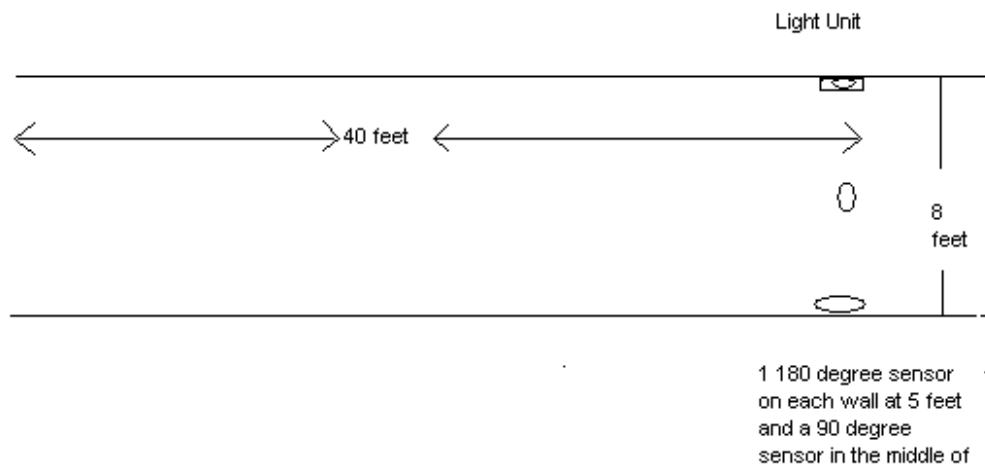
Discussion

The computer controlled scheduling function appears to work properly.

Experiment 4- Hallway walk test

Experimental Parameters

The sensor setup was as described in the figure below



One of the investigators walked toward the sensor in the middle of the hallway from 40' away. The distance from the sensor was measured at the point the investigator was when the unit lamp went on. The test was repeated 25 times with all three sensors on and 25 times with only the ceiling sensor on. In the ceiling sensor only series the walker varied their position in the hallway as they walked from center to left and right sides of the hall.

Results: Feet from sensor when unit turned off

All sensors on	Ceiling Sensor only	Walk position single sensor
20	1	Center
12	2	Center
12	1	Center
17	7	Right side
16	6	Right side
14	6	Left side
17	1	Center
14	3	Center
14	7	Right side
25	2	Center
15	5	Left side
12	2	Center
19	2	Center
18	6	Right side
24	6	Left side
18	2	Center
17	2	Center
13	2	Center
24	8	Right side
14	6	Right side
14	7	Left side
24	6	Left side
13	2	Center
14	2	Center
14	2	Center

Statistics for hall walk tests

	All sensors	Ceiling only	center	right	left
Mean (ft.)	16.6	3.8	1.9	6.7	6.0
Std Deviation (ft)	4.06	2.37	0.53	0.82	0.71

Discussion

The difference between the all motion sensor test and the ceiling only is significant. The unit turned off at least by 12 feet from the sensors when all three were on. When only the ceiling sensor was on the earliest the unit turned off was 8 feet and on several occasions when walking in the center the investigator was almost at the unit before it turned off.

Experiment 5 Unit to unit signaling

Experimental parameters

In this experiment one unit was attached to the door sensor and a second unit with no sensor input was placed in close proximity to the first unit. The units were programmed to communicate with each other so that when a unit received a signal to shut the shutter the second unit would respond with the same action. The first unit was activated by opening the door. The door was opened 50 times to initiate the signaling event.

Results

No signal failures were detected.

Discussion

This series demonstrated that at least when the units are in close proximity (within 5 feet) that the unit-to-unit wireless signaling function works.

Experiment 6 Light and fan function

Experimental parameters

In this series the video monitor was placed and adjusted to detect the sound of the fan running. The unit was then cycled for one minute with the shutter open and one minute with the shutter closed. The units were monitored for the sound of the fan running and the presence of a faint glow indicating that the light was on when the shutter was closed. The series was repeated 25 times

Results

There were no failures of either light or fan function either when the shutter was open or closed.

Discussion

The light and fan functions worked not only in this specific test but in all instances of shutter actuation

Discussion of Overall Results

It is clear that the EXP D-Lux test units as supplied for this series of experiments and the previously reported series function nearly flawlessly. There were no failures of shutter function, computer interface control, lamp and fan function, or wireless communication between units. It is clear to this investigator that the units themselves are reliable in each of the above functions.

The door sensor has been tested over 1500 times during these two series of test and has never failed. We did not test the bed sensor separately from other sensors so we cannot comment on its function. The thermal motion sensors while they did work were not sensitive to relatively large amounts of motion including moving in bed and waving an arm. While the three sensor array was able to signal the unit to turn off when the investigator was at a safe distance from the unit on the hall walk test the same is not the case for the single sensor which allowed the investigator to come within 2 feet of the unit on several occasions.

This investigator is confident of the EXP D-Lux unit's reliability and safety in regards to its function under program control or in manual mode. There continues to be an issue with safety if the unit is used under sensor control in a room with a person in the room. The motion sensors cannot reliably detect the presence of a person in a room at this time. I know that the developers continue to investigate other solutions to this issue and we are confident that it can be solved.

Submitted by

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