Automated Home Security System: A Review

Oyebola Blessed Olalekan, Gateway (ICT) Polytechnic Saapade, blessedolalekan@gmail.com
Odueso Victor Toluwani, University of Ibadan, vodueso797@stu.ui.edu

Abstract — This paper succinctly reviewed motion detector in automated home security system. It attempts to concentrates on usage of motion sensor for domestic security system, its reliability and application or benefits in concise. These are achieved by critical reviewing the existing technologies to excerpt datum for discussion. The paper proffers that IR sensor effective range thirty feet and a field of view less than 180 degrees can be extended by installing a pre-activation button some meters before the range of the sensor to help users activate the automation system before reaching the range of the sensor. It concludes that home automation through motion sensors has capability to improve human way of living; be an assistant aid for the aged, helps to reduce stress and also stand in place in case of carelessness and hence bolster the nation economy.

Keywords — automation, detector, home, motion, security, sensor

I. INTRODUCTION

Imagine how helpful it would be to be able to switch on your air conditioning system ten minutes before you get home on a hot afternoon in January (Shruti, Updesh, Yash, Yashdeep, & Kumar, 2015). How about having a security system that will detect smoke, excessive electrical power usage, burglar attempts and unauthorized movements in your house and alert you? This is what home automation is about and there is no end to its application (Olalekan, 2013). In fact, sophisticated home automation systems are now being developed that can maintain an inventory of household items, record their usage through an RFID (Radio Frequency Identification) tag, and prepare a shopping list or automatically order replacements. Home automation has made it possible to have what is often referred to as a 'smart home', a home that can detect and identify you, automatically adjust the lighting to your predefined taste, open doors automatically, play your favorite music, water your flowers in the morning, switch on the security lights at night and switch them off in the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in and around your house (Gunasekaran, Moha, Dhalapathi, & G. Syed, 2016). It makes it possible to link lighting, entertainment, security, telecommunications, heating, and air conditioning into one centrally controlled system. This allows you to make your house an active partner in managing your busy life (Olalekan, 2013).

Automation is the use of control systems and information technology to control equipment, industrial machinery and processes, reducing the need for human intervention. In the scope of industrialization, automation is a step beyond mechanization. Mechanization provided human operators with machinery to assist them with the physical requirements of work while automation greatly reduces the need for human sensory and mental requirements as well. Home Automation also known as domotics or domotica is the residential extension of building automation and involves the control and automation of lighting, heating (such as smart thermostats ), ventilation, air conditioning ( HVAC ), and security, as well as home appliances such as washer/dryers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring (Boselin, Balakumar, & A. Johnson, 2017). Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, mobile phone software, tablet computer or a web interface, often but not always via internet cloud services (Home automation, 2017). Home Automation through Motion detective can be referred to as the act automating some home equipment or appliances with the help of motion detector (IR Sensor). This simply means that the automation the house would be effective using IR Sensors instead of Bluetooth, Wi-Fi, Ethernet, Mobile applications or soft wares (Wikipedia, 2017). Automation is applicable in different forms and places which includes;
Office Automation: Office automation, Office automation refers to the varied computer machinery and software used to digitally create, collect, store, manipulate, and relay office information needed for accomplishing basic tasks and goals. Raw data storage, electronic transfer, and the management of electronic business information comprise the basic activities of an office automation system; office automation helps in optimizing or automating existing office procedures (Pheonix, 2017).

Building Automation: Building automation describes the functionality provided by the control of a building. The control system is a computerized, intelligent network of electronic devices, designed to monitor and control the mechanical and lighting systems of a building. The building automation system (BAS) core functionality keeps the building climate within a specific range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering staff. The BASED functionality reduces building energy and maintenance costs when compared to a non-controlled building (Alessandro, Maurizio, & Stefano).

Power automation: Power automation is the automated control and monitoring of power plants, substations and transformers for effectiveness, efficiency and fault detection. It has made it possible to have a reliable municipal or national electricity system, which often comprises remote and hard-to-reach transformers and power sub-system units. It makes it possible to monitor different power units, relay their status and health information, and even carry out fault detection and correction without human interference. Example of power automation system is the Supervisory Control and Data Acquisition (SCADA) system.

Home automation: Home automation may designate an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent decades. Home automation includes all that a building automation provides like climate controls, door and window controls, and in addition control of multimedia home theatres, pet feeding, plant watering and so on. But there exists a difference in that home automation emphasizes more on comforts through ergonomics and ease of operation (KERALA).

Research Questions
The answers to these questions were discussed in the section four of this paper paper.

a. What is a Motion Sensor?
b. How can a motion sensor be used in home automation?
c. How effective and reliable is using motion sensor for home automation?
d. Where can home automation through motion sensors applicable?
e. How can home automation through motion sensors help in the Nigeria economy?

II. LITERATURE REVIEW

The first smart homes were ideas, not actual structures. For decades, science fiction has explored the idea of home automation. Prolific writers, such as Ray Bradbury, imagined a future where homes were interactive, and seemingly ran themselves. In Bradbury’s cautionary short story, “There Will Come Soft Rains” he describes an automated home that continues to function even after humans have died out (The History of Smart Homes, 2014). This timeline below focuses on hardware; meaning actual inventions leading up to the actualization of home automation through Motion Sensors.
1901-1920–The invention of home appliances: Although home appliances aren’t what we’d consider “smart,” they were an incredible achievement in the early twentieth century. These achievements began with the first engine-powered vacuum cleaner in 1901. A more practical electricity-powered vacuum was invented in 1907. Throughout two decades refrigerators would be invented, as well as clothes dryers, washing machines, irons, toasters, and so much more.

1966 - 1967–ECHO IV and the kitchen computer: Although it was never commercially sold, the ECHO IV was the first smart device. This clever device could compute shopping lists, control the home’s temperature and turn appliances on and off. The Kitchen Computer, developed a year later, could store recipes, but had the unfortunate tagline, “If she can only cook as well as Honeywell can computer” and therefore sold no models.

1991–Terotechnology: Terotechnology combines gerontology and technology and makes the lives of senior citizens easier. In the 1990s, there was a lot of new research and technology in this sector.

1998 – Early 2000s - smart home: Smart homes, or home automation, began to increase in popularity in the early 2000s. As such, different technology began to emerge. Smart homes suddenly became a more affordable option, and therefore a viable technology for consumers. Domestic technologies, home networking, and other gadgets began to appear on store shelves.

Today’s Smart Homes – Today’s smart homes are more about security and living greener. Our smart homes are sustainable, and they help to ensure that our homes aren’t spending unnecessary energy. They also help alert us to intruders (whether we’re home or not). Current trends in home automation include remote mobile control, automated lights, automated thermostat adjustment, scheduling appliances, mobile/email/text notifications, and remote video surveillance. Home Automation through Motion Sensors also falls into the class of the Today's smart home category (The History of Smart Homes, 2014).

A. Technologies used in home Automation

There are a wide variety of technology platforms, or protocols, on which a smart home can be built. Each one is, essentially, its own language. Each language speaks to the various connected devices and instructs them to perform a function.

**UPB**

Another wired technology, Universal Power line Bus (UPB), while similar to X10, was intended to be an X10 replacement, given its superior reliability (less susceptible to power line noise and increased range (it can transmit over one mile). The technology uses a home’s existing power lines, which reduces costs a bit, to send signals that will control devices both inside and outside the home. However, UPB and X10 products are not compatible. Thus, if you already have X10 products and want to add UPB products to the mix, a special controller will be required that will talk to both.

**INSTEON**

Introduced in 2005, Insteon devices communicate over both power lines and wirelessly, ensuring multiple pathways for messages to travel. Insteon is also X10 compatible, which means that users can add wireless capability to an existing X10 network; doing so can be an effective and cost-efficient way to make a full-blown transition to wireless. Insteon technology even supports home automation novices so that non-technical individuals can set up and add devices to the network.
Z-WAVE

One of the most popular of the wireless home automation protocols, Z-Wave runs on the 908.42MHz frequency band. Because this is a much lower band than the one used by most household wireless products (2.4 GHz), it is not affected by their interference and “traffic jams.” A significant advantage of Z-Wave is its interoperability. All Z-Wave devices talk to all other Z-Wave devices, regardless of type, version or brand. Further, the interoperability is backwards- and forward-compatible in the Z-Wave ecosystem; that is, Z-Wave products introduced today will work with Z-Wave products from a decade ago and with products in the future (although possibly with some limits on functionality) (Home Automation Protocols: A Round-Up, 2016).

ZIGBEE

There are similarities between Z-Wave and ZigBee. Like Z-Wave, ZigBee is exclusively a wireless home automation protocol. While it claims many home automation enthusiasts, its full acceptance is limited by the lack of interoperability between ZigBee devices, which often have difficulty communicating with those from different manufacturers. As a result, ZigBee is not necessarily an ideal choice for anyone just starting down the home automation road-unless, of course, they use device from just one manufacturer. Plus, there are different versions of ZigBee which do not necessarily talk seamlessly with each other.

Wi-Fi

Boasting high bandwidth, Wi-Fi is already pretty much everywhere; so many manufacturers are enthusiastically making smart home devices to work with it. A multitude of homes in the U.S. already have wireless routers (which work on the Wi-Fi protocol), so obviously they’ve already got a central hub in place to which Wi-Fi compatible devices can be connected.

Bluetooth

Bluetooth is at the core of hundreds of products; from light bulbs to speaker docks to locks (Kwikset introduced the first Bluetooth lock, Kevo, 2013). It has higher data bandwidth than ZigBee and Z-Wave (though lower than Wi-Fi) but, to its advantage, sucks up far less power than Wi-Fi.

Thread

Thread is a new wireless protocol for smart household devices. The Thread Group was formed in July 2014 by seven founding members, including Google’s Nest Labs and Samsung Electronics. More than 250 devices can be connected on a Thread network and, because the majority of devices meant to be connected to the network are battery-operated, it’s very frugal on power.

Apple Homekit

While not a communications protocol, Apple HomeKit should be mentioned if only for the media attention it is attracting. Announced by Apple at its Developers Conference in 2014, HomeKit is actually a software framework, allowing developers to build smart home devices that will connect directly to the iPhone and iPad and be controlled by a dedicated app (Home Automation Protocols: A Round-Up, 2016).
B. Home Automation through Mobile Sensor Remotes

Before the discovery of motion sensors, one of the devices or technology used for home automation is a remote control. In electronics, a remote control is a component of an electronic device used to operate the device wirelessly from a distance. For example, in consumer electronics, a remote control can be used to operate devices such as a television set, DVD player, or other home appliance, from a short distance. A remote control is primarily a convenience feature for the user, and can allow operation of devices that are out of convenient reach for direct operation of controls (Remote Control, 2017).

The main technology used in home remote controls is infrared (IR) light. The signal between a remote control handset and the device it controls consists of pulses of infrared light, which is invisible to the human eye, but can be seen through a digital camera, video camera or a phone camera. The transmitter in the remote control handset sends out a stream of pulses of infrared light when the user presses a button on the handset. A transmitter is often a light emitting diode (LED) which is built into the pointing end of the remote control handset. The infrared light pulses form a pattern unique to that button. The receiver in the device recognizes the pattern and causes the device to respond accordingly. Remotes can be used in the:

- Industry; for controlling substations, pump storage power stations and HVDC-plants.
- Garage and Gates; for opening gates at home and in companies and also for opening garage doors.
- Military; used for detonation grenades, controlling boundaries line monitoring systems etc.
- The uses of remote control span wide down to the control of home appliances; television, DVD, CD, Lamps, video games etc. (Remote Control, 2017).

C. Limitations of Home Automation through Mobile Sensor Remotes

As effective and useful a remote control can be in both Home Automation and in smart living, military and security, it has a major bottle neck which balls down to the problem of "Distance". Construction may be cheap, design may be effective, but it can only function within a limited space range due to the use of IR Sensor. Except higher technologies like IoT and Wi-Fi is used together which could be more expensive to design and implement it would continue to be limited to a particular distance (Rose, 2015). Due to the above stated limitations, this Paper; Home Automation through Motion Sensors presents an improved technology to counter the aforementioned limitations in Home Automation System.

While putting together this research work, listed below is the ways that provided a brief history and understanding of the paper work Home Automation through Motion Sensors.

Internet Research: While putting together this paper, used to Internet to gather information and knowledge from different authors and from sites like Wikipedia, Instruct able, Electronics Hub, and Wiki-How, IoT revolution, About.com along many others which has written works related to the paper work. Majorly had to read the history of Home Automation from Wikipedia and Journals; this gave me a clearer scope for the work.

Literature Study: In putting together this work of research, downloaded several pdf files of previous related project papers and also some company manuals of some Home Automation devices so as to understand the functionality of the PIR Sensor (a type of Motion Detectors).

YouTube Videos: In the process of putting together this paper, so as to understand the functionality of Home Automation through Motion Sensors, videos were watched on YouTube about it modes of operation.
III. MOTION SENSOR/ DETECTOR

This discussion is in view to answer the research questions raised in the section one of this paper.

Research Question 1: What is motion sensor/ detector?

A motion detector is a device that detects moving objects, particularly people. Such a device is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. They form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems. An electronic motion detector contains an optical, microwave, or acoustic sensor, and in many cases a transmitter for illumination. However, a passive sensor senses a signature only from the moving object via emission or reflection, i.e., it can be emitted by the object, or by some ambient emitter such as the sun or a radio station of sufficient strength. Changes in the optical, microwave, or acoustic field in the device's proximity are interpreted by the electronics based on one of the technologies listed below. Most low-cost motion detectors can detect up to distances of at least 15 feet (4.6m) (Ultratonic Sensor). Specialized systems cost more, but have much longer ranges. Tomographic motion detection systems can cover much larger areas because the radio waves are at frequencies which penetrate most walls and obstructions, and are detected in multiple locations, not only at the location of the transmitter. Several types of motion detection are in wide use;

a. Passive infrared (PIR)

Passive infrared (PIR) sensors are sensitive to a person's skin temperature through emitted black body radiation at mid-infrared wavelengths, in contrast to background objects at room temperature. No energy is emitted from the sensor, thus the name passive infrared. This distinguishes it from the electric eye for instance (not usually considered a motion detector), in which the crossing of a person or vehicle interrupts a visible or infrared beam.

b. Microwave

These detect motion through the principle of Doppler radar, and are similar to a radar speed gun. A continuous wave of microwave radiation is emitted, and phase shifts in the reflected microwaves due to motion of an object toward (or away from) the receiver result in a heterodyne signal at a low audio frequency (MJ, 2015).

c. Ultrasonic

An ultrasonic wave (sound at a frequency higher than a human ear can hear) is emitted and reflections from nearby objects are received. Exactly as in Doppler radar, heterodyne detection of the received field indicates motion. The detected Doppler shift is also at low audio frequencies (for walking speeds) since the ultrasonic wavelength of around a centimeter is similar to the wavelengths used in microwave motion detectors.

d. Tomographic motion detector

These systems sense disturbances to radio waves as they pass from node to node of a mesh network. They have the ability to detect over large areas completely because they can sense through walls and other obstructions.

e. Video camera software

With the proliferation of low-cost digital cameras able to shoot video, it is possible to use the output of such a camera to detect motion in its field of view using software. This solution is particularly attractive when the intent is to record video triggered by motion detection, as no hardware beyond the camera and computer is needed. Since the observed field may be normally illuminated, this may be considered another passive technology (Wikipedia, 2017).

f. Gesture detector

Photo-detectors and infrared lighting elements can support digital screens to detect hand motions and gestures with the aid of machine learning algorithms (Wikipedia t. f., 2017).
Research Question 2:
a light to come on automatically, a camera to begin recording, or an alarm to sound. Motion detectors can become the
How can a motion sensor be used in home automation?
Using motion detectors as sensors allow a home automation system to make specific events happen automatically. Motion detectors can trigger eyes of your home automation system. It works by using the most modern motion detector, the PIR (Passive Infrared) sensors. This means the detector doesn’t sense motion but instead measures infrared light (heat), or changes in heat level. PIR detectors measure the ambient heat level of a room and when they sense that level changing quickly, the detector interprets this as motion. How quickly the light has to change is configurable, referred to as the sensitivity of the detector (A Guide to Temperature Effects in Sensors, 2012).

Research Question 3: How reliable is motion detector in home automation?
Motion detectors can be very efficient and reliable in Home Automation by considering the following;

Energy Saving: Motion sensors reduce electricity consumption by eliminating the possibility that the lights will accidentally be left on. Energy consumption uses fossil fuels and produces CO₂ emissions that are harmful to the environment. Using a motion sensor light switch will add to the worldwide efforts to reduce carbon emissions, even if it is by individual households. Motion-sensor switches, by reducing electricity consumption that may happen when lights are left on, also reduces the cost of electricity to a home. How much depends on the individual home and the volume of activity, but typically, they can reduce energy consumption by 35-45 percent, and can go up to as high as 75 percent. To illustrate: if a single 60 watt bulb is used for 8 hours a day at $0.10/kwh, it costs $17.52/year. If that time is cut by 35 percent to 2.8, it costs $6.13/year. If a room has, say, four bulbs, the cost goes from $70.08 a year to $24.52; not such a small number. Changing the light switches is a minor project, but one that can be incredibly convenient - not having to worry about turning off the lights when you are gone or turning the light on when you are around, especially in places that are frequently used, eliminates another common habit that many wish they could get a hold of (Kresser, 2013). Motion-sensing technology is also vastly improved, meaning that there is less of chance the lights will malfunction and reduce the benefit of installing them.

Home Security: Motion Sensor senses an intruder and sends an alert to your control panel, which alerts your monitoring center.

Sensors work when you are not home, or when you tell the system you are not there. Some security systems can be programmed to record events via a security camera when motion is detected (SafeWise).

Motion sensors stand guard, ready to react to various situations, such as movement in your living room, windows or doors being opened or closed, or a broken window. Motion sensors can;

i. Alert in the event that a child breaks a curfew
ii. Trigger a doorbell or opens the door when someone approaches the front door
iii. Alert you when kids enter restricted areas in the home, like the basement, workout room, or medicine cabinet.
iv. Save energy by using motion sensor lighting in unoccupied spaces
v. Notify you if pets enter areas where they're not supposed to be.
Research Question 4: Where can home automation through motion sensors be applicable?

i. Simple lighting control: In small windowless rooms or spaces like utility rooms, pantries, walk-in wardrobes and small toilets, you’ll always want a light on when you or a member of your household is in there. So why use a light switch or pull cord every time? You can simply fit a PIR sensor and configure your home automation system to turn the light on as soon as motion is detected (and turn off again a set amount of time after motion is no longer sensed). Of course this is nothing out of the ordinary, but never the less very useful (Our Top 5 Alternative Uses for Motion Sensors, 2013).

ii. Triggering configured scenes: Simple lighting control with PIRs is all well and good, but can become annoying especially in rooms where you do not always want the lights to come on at full brightness automatically. Let’s say for instance that you have an en-suite bathroom. When you use it in the middle of the night, you might like the lighting soft and unobtrusive and for your noisy extractor fan not to kick in. But when you use it at 7am when you’re getting ready for work, you prefer a brighter light with perhaps the mirror lit up and the fan on to get rid of the steam from your morning shower. A PIR subtly sitting in the corner of the room will notice your entry sending a signal back to the Mini-server, which depending on time of day will prompt your pre-set scenes to kick in. PIRs in bathrooms also remove the need for ugly pull cords.

iii. Safety first, safety second: for concern about safety of walkabout kids or pets, then PIRs can be used to tip you off if someone breaches a specific area. Perhaps you have a swimming pool or pond that you don’t want your children to go near unattended. Or perhaps you live close to a main road and are concerned about your dog escaping and being run over. Installing Infra-Red sensors could be the answer. You can set up your system up so that if a perimeter is breached, you receive a call or text or some lights flash in the house, or alarm sounds, whatever you like.

iv. No more guest-guessing: Set an external sensor up to detect movement by your gate or at or at the start of your driveway and you can get advanced notice of any guests that are coming your way. One way of doing this would be to have the PIR trigger an IP camera that feeds live footage of the outside of your house directly to your iPad or smartphone. The approaching person or car can be seen well before they knock on the door, giving you plenty of time to put on the kettle or hide (depending on who it is!)

v. Save money: Unnecessary room lighting has to be one of the most wasteful things you can do (and don’t worry-we all do it). Whether it’s you or your partner that’s absent-minded or your kids that leave lights on, it’s costing you money. With a smart system a PIR can work in reverse and turn the lights off after a long period of inactivity, even if you switched them on manually.

Research Question 5: How can home automation through motion sensors help in the Nigeria connote?

Today in the Nigeria Economy, Home Automation through Motion Sensors can help in the followings way;

i. Can help us improve our way of living; be an assistant aid for the aged, help reduce stress and also stand in place in case of carelessness.

ii. Help save resources such as saving light energy for us, money cost due to electric energy consumption, and money cost due to home security surveillance.

iii. Help reduce the risk of home burglary.

iv. Can be used to restrict movements to military or emergency places or environments.
v. Help join the world in eradication of fossil acids in the atmosphere.

vi. It can be used on the roads; in zebra crossing to help turn on stop light on detecting humans on the line.

The modes of application of this technology in our society are unlimited, we just need to imagine more and implement it.

IV. CONCLUSION

Home Automation through Motion Sensors conclusively is a technology that can be adopted by homes, organizations, institutions and even the government agencies. Some of its unique advantages include;

i. Safety: The ability to control small appliances and lighting by just coming in or around your home can be extra safety to your home. You can make sure appliances are off when it’s needed to be off and on when it’s needed to be on.

ii. Security: The ability to open the door a few steps away is one of the greatest benefits of this technology. This will give you peace of mind knowing even if you are carrying lots of baggage, you can save yourself the extra stress of opening the door. Also, the fact that you can be alerted each time someone enters your home or property also allows you to monitor who is entering your home at all times, especially when you are not there.

iii. Convenience: The ability to just stroll in and out convinced that energy is safe can be really gladden.

iv. Saves Time. Since we are living in a very fast-paced environment, we don’t even have time to worry about our home. With home automation through Motion Sensors, we can save time going back to our home and make sure everything is order, like if the kids close the door from school or turn on the lights when you get home (Systems).

v. Save Money. This is the biggest advantage of home automation. With the ability to control the light, whether dimming or turning on/off on specific time, the technology saves homeowner a great ton of money. In addition, you can save gas, by not driving back home if you forgot to turn off appliances or lock the door.

Despite the advantages of Home Automation through Motion Sensors, it is still vulnerable and has limitations which includes;

i. It can only detect motions within a certain range, which simply means it can't work or perform operations from a distance.

ii. If a motion sensor for the automatic door is not mounted securely, normal vibration, sign, plants and neon light can trigger the door open.

iii. Things may trigger the motion detector that you don't want to. An outside detector mounted too close to a light that stays on at night, will be triggered continuously by bugs.

iv. The reliability of a motion sensor may also be affected by rapid environmental changes and direct sunlight. Also, things like a fireplace, and direct wind from an air conditioner or heater. This is because a PIR sensor actually detects changes in infrared energy - specifically, the "heat energy" emitted by normal human skin temperature (Innocent).

Due to the limitations above this paper proffers solution to some of the limitations from the knowledge of the study:

i. Distance: IR Sensor has an effective range of about ten meters (thirty feet), and a field of view less than 180 degrees. So, anything beyond its range cannot be detected nor recognize. This simply means the subject must be in close contact for the automation to function. It cannot be operated nor used from a long distance. To correct this limitation, installing a pre-activation button some meters before the range of the sensor to help users activate the automation system before reaching the range of the sensor could help reduce the effect of this limitation.

ii. Security: This method of automation is not secured because on detecting anyone it opens the door or turns the light one. This simply means it is not very secured and reliable. To correct this, adding a master activation encrypted security
system to the home automation, which only can be accessed by members of the family or group either by voice recognition or fingerprint recognition could solve or tame this trouble.

Motion detector in home automation aids automatic control and monitoring of household appliances and residential house features like doors, gate, camera, lighting system and even the windows. It concludes that home automation through motion sensors has capability to improve human way of living; be an assistant aid for the aged, helps to reduce stress and also stand in place in case of carelessness and hence bolster the nation economy. The paper proffers that IR sensor effective range thirty feet and a field of view less than 180 degrees can be extended by installing a pre-activation button some meters before the range of the sensor to help users activate the automation system before reaching the range of the sensor.

REFERENCES