A touch less sensitive edge for elevator doors

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1. Abstract

Sensolift^{TM}, a new safety device for elevator doors was developed in Sensotech. The system is capable of protecting door edges from the top to the floor. It covers a volume having the shape of a cone and thus can protect both the car and the hoistway doors.

The system is using an ultrasonic technology, which is accurate and very safe to use. It detects people or their belongings without having to touch them.

The system is a step towards the Total Entrance Protection.

2. Discussion

2.1 The Need for a new Sensor System

The safety of passengers entering and exiting elevator doors is a paramount issue to elevator industry.

The most common methods of sensing, applied to elevator doors today are the:

- Photodiode Sensors
- Multiple Optical Sensor

The first, has been an industry standard for many years, and the second, now available from several producers (known as "Light curtain" or "Infrared screen") is becoming more and more popular during the last years.

Both of these devices cover the car door but do not protect the landing doors. A system that will cover both landing doors and car doors is needed.

There were several attempts to develop sensor systems based on electromagnetic radiation or even ultrasonic energy, but none of them was adopted by the industry.

2.2 Background - Ultrasound Technology

Sound is a human experience of the propagation of a pressure wave through a physical elastic medium (water, air etc.). These pressure waves are generated from some type of mechanical disturbance. Mechanical energy is converted to a wave-form that radiates energy away from the disturbance, transferring energy both to the medium and to objects that the wave reaches.

Human hearing is limited. If the frequency of vibration is too high or too low, humans are unable to hear it. Ultrasound vibrations refer to frequencies higher than human hearing (beyond about 18 kHz).

Generally, higher frequencies are used for medical imaging, like checking a fetus in the mother's womb.

Ultrasound waves propagate through the air at a basic speed of 330 meters/second (in the air at sea level) compared to the velocity of light which is about $300x10^6$

meters/second. The speed of sound varies, of course, with pressure, temperature and medium.

Most applications of ultrasound involve sending ultrasound energy by means of a transmitter and analyzing the energy echoed by a target or transferred via an examined object. (Dolphins and other this effect to locate their prey and bats use the same effect to 'see' their way in the darkness).

The main advantages of using ultrasound technology are:

- Speed of sound waves is considerably low for modern detectors and analyzing electronic devices, so it is easy to handle and process.
- Sound waves are associated with mechanical energy and as such are considered very safe for use.
- Ultrasound is not interfered by light conditions or electromagnetic radiation

2.3 Method of Operation

A method of utilizing ultrasound technology was developed. This method is able to integrate ultrasound and digital signal processing technologies for use in non-contact sensing systems.

The Sensolift™ system is comprised of the following basic units:

a. A central control and processing unit a case with one electronic board – (SEU)

b. Sensors kit - one or two sensors with connecting cables – (SU)

The sensors are installed on the door edge, "looking" down to the floor and searching within a defined "virtual" volume for passengers or their belongings. A schematic installation diagram is shown in Fig. 1

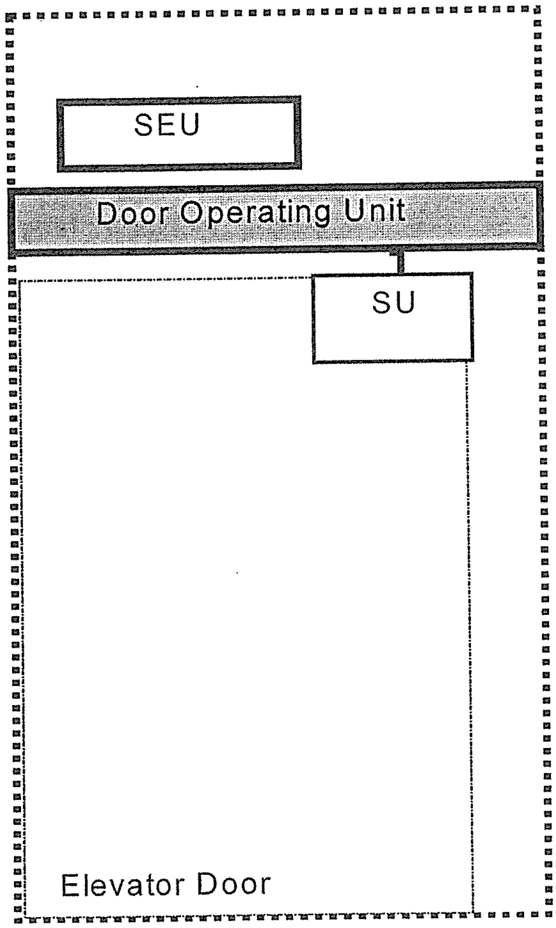

Figure 1 - A schematic installation diagram

The sensors method of operation as illustrated in Fig. 2, can be described as follows:

a. The Transmitter (A) sends sound waves or a set of conic sound waves towards the reflective wall of the door.

b. The reflected sound cone is sensed by the Sensing Unit (B).

Once the rebounding wave has been sensed, the system will determine what this signal represents.

c. By comparing the wave received at (B) to the signal expected from the system's normal closing mode, the Comparator (C) detects if there are significant differences between these waves.

d. After processing the reflected signals, the Detector Logic Block (D) decides if the obstacle is legitimate. If so, it informs the Control Unit (E) of the obstacle, and will direct the Control Unit to take any necessary measures, such as keeping the door open for a longer period of time or reopening the door.

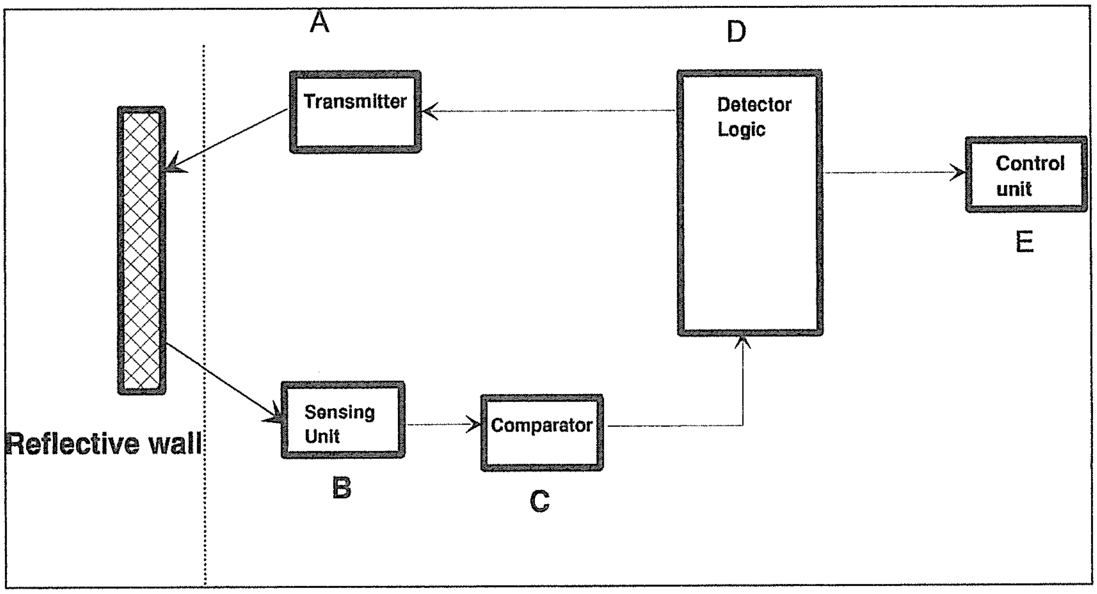

Figure 2 - The sensors simplified method of operation Block Diagram

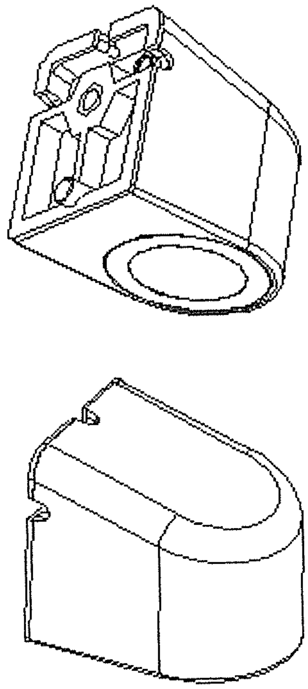

Figure 3 - The sensor unit outline

Both the Transmitter (A) and the Sensing Unit (B) are encapsulated in one sensor unit which is shown in Fig. 3.

The system is executing a learning process where it scans the protected volume and learns to neglect certain objects.

During the operational process it uses the learning mode data and prevents the door from hitting passengers.

The general operational process referred to, as: “Detector logic (D)” in fig 2, is shown in Fig 4 - “typical operation scenario”.

Once the car stops at the entrance, the sensor unit is activated and as long the sensor detects a passenger at the exit, it will keep the door open.

When the door is fully opened, the sensor unit surveys the entrance to see if the door way is clear. If so, the door is allowed to close. When the door is in motion, the system is looking for an obstacle in the door path. Within the defined volume, the method is capable of detecting both moving and motionless objects. Since the system have learnt its surroundings, those objects that form a part of the background are recognized as such while looking for relevant obstacles. This results in a safe and friendly door, which retreats when it senses that a passenger is in the way.

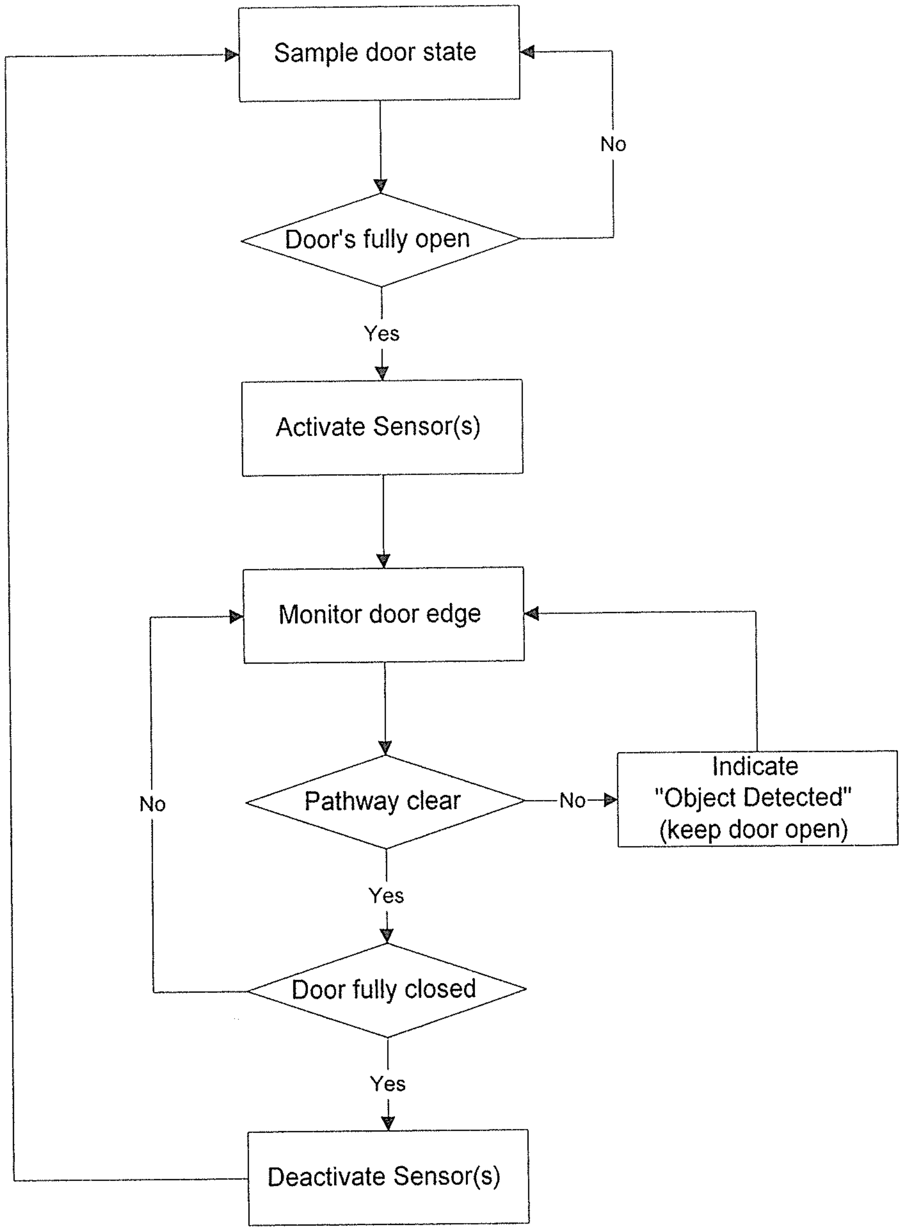

Figure 4 - Typical operation scenario flowchart

3. Summary

We have described a simple, yet useful, technology for door safety systems. This technology was proved successful and introduced in automatic mass transit doors in Canada and the U.S.A. The technology uses ultrasonic waves which are both safe and invisible, it is robust and immune to lighting conditions, dust, mud, humidity and vandalism. It is simple to install and may be installed on both new equipment and retrofit applications. The concept is a step forward towards the Total Entrance Protection

Biographies:

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Ph.D. Chemistry, Bar-Ilan university, Israel - 1986, M.Sc. Chemistry, Tel-Aviv university, Israel – 1979, B.Sc Chemistry, Bar-Ilan university Israel 1975,

1995- Present	Cofounder and a managing director For Sensotech.
1994 - 1995	El-Op, acting as business and technical manager for new products in Thermal Imaging Product Division.
1986- 1994	AlliedSignal, Establishing the Thermal Imaging product line Performing as a manager of engineering and chief scientist.
1982- 1986	Elbit, acting as physicist responsible for development of sensor head. Also responsible for field trail to qualify the design.

Uri has published nine publications, Received two technical Awards (in Allied Signal) and registered seven patents.

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1988 - 1995	Elop, Electrical Engineer and Project Engineer in the Display Products Division.
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1994 - 1995	Elop, R&D Manager. Responsible for the development of all new products, for the Display Products Division.
1987-1994	TAMAM/IAI, Electro-optical division, Responsible for all the R&D and Engineering of the division's products.
1981-1987	Elbit Computers, Ltd. - Head of electrooptics department.

Eli has published seven publications, and registered 14 patents.