sound and safe

A new type of fire alarm, which can guide the occupants of a building to the emergency exits, is set to make life a great deal safer for all of us - particularly those with impaired vision.

The ‘Localizer’ alarm has been developed by Sound Alert, a company which manufactures innovative products based on research carried out by Dr Deborah Withington and a team of scientist at Leeds University. The company has received funding from BNFL Enterprise, a BNFL subsidiary set up to help stimulate growth in industry and commerce.

A conventional fire alarm merely alerts us to the presence of danger. It gives no information concerning the direction to, or location of, the nearest exits. Even if such an alarm were to be placed over an exit door, we would not be able to find it because a conventional alarm produces a sound, which our brains cannot localize. (In other words, we don’t know where the sound is coming from.)

Dr Withington explains: The larger the frequency content of a sound, the greater our accuracy in locating it. For a sound to be localizable, it must contain as much of the audible frequency range as possible (20-20,000Hz), and this is the primary reason why conventional alarms will not work in this situation.

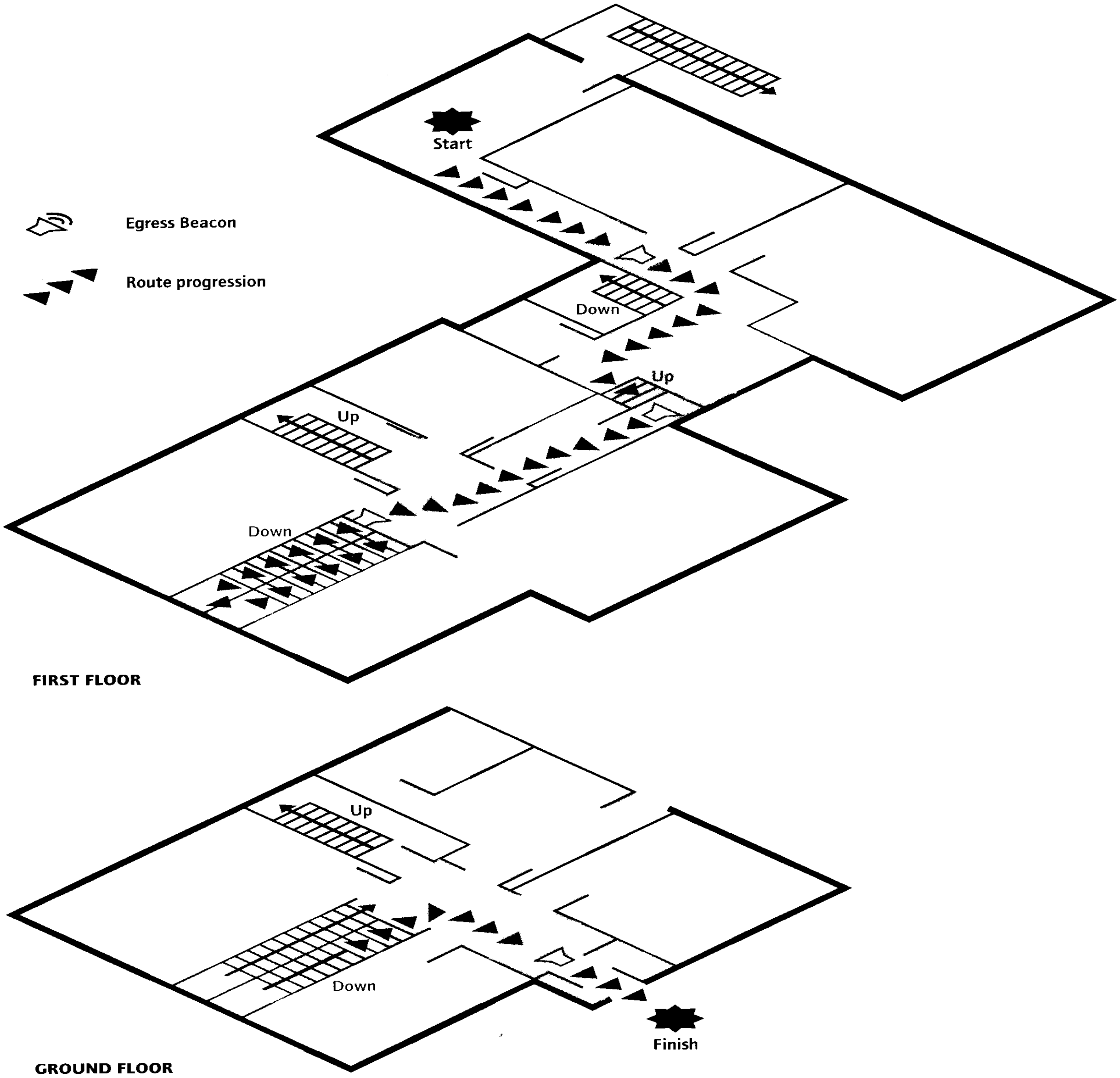
Human Hearing

‘Existing alarms operate over only a tiny portion of our hearing range, approximately 800Hz to 3kHz. Indeed, the range in which they operate, although maximally sensitive to our ears in terms of loudness, is the worst band for localization!’ (For more information on how our brains tell us where sounds are coming from, see the separate panel.)

For most of us, vision is the primary means of interpreting the world around us. Many of the aids designed to help us in an emergency such as a fire are visual - emergency lighting, signage, colour coding and luminous guidance strips. But how efficient are such aids when the part of the building you are in is completely filled with smoke? What if you are one of the one million people in the UK who are registered as visually impaired?

Additionally, there are many thousands of people in the UK who have moderate to severe learning difficulties. Such learning difficulties often give rise to a limited ability to understand the spatial layout of the environment so, for many people, the existing emergency wayfinding devices are of only limited use.

It was these considerations, which led Dr Withington and her team to develop the new alarm



beacon which emits pulses of easy-to-locate broadband noise, as well as a series of rising or falling tones to indicate when an emergency route leads upstairs or down.

The system was tested in the former Leeds Grammar School building, now owned by the University. Subjects in the trials included the sighted, the visually impaired and children. Each had to follow a complex escape route, which included staircases and many alternatives to the correct path.

The building was filled with artificial smoke and the subjects taken to the start of their escape route, on the first floor, via an external fire escape. Thus, the subjects had no idea of the route they were about to take. Nor did they have any prior knowledge of the meaning of any of the alarm beacon signals.

The route was marked by four beacons placed at strategic points (mainly above fire doors) on. the way. At one point on the route there was a small flight of stairs which led upwards to a mid-level, and a beacon was designed which, as well as having rapidly pulsing broadband noise, also included an upwardly sweeping melodic complex which indicated ‘go up the stairs’.

Towards the end of the route, the main staircase led down to the final exit point. Similar to the ‘up sweep’, a ‘down sweep’ was built into the beacon at this point.

As the beacons were placed closer to the exit point, so their ‘pulse rate’ increased. This concept relics on human intuition with regards to faster events signaling the nearing of a final goal.

The effectiveness of the beacons was unquestionable. None of the subjects took a wrong turning or ended up in a room which they were not supposed to enter. All reported that the 'up' and 'down' tones informed them not only of the presence of a staircase but also of the intended direction of travel, even though they had never come across these sounds before. Evacuation times were close to what would be expected from people who already knew thc building and were able to see their way. Indeed, it was interesting to note subjects' responses when the building was cleared of smoke and they were asked to go through it again. Without the aid of the navigation beacons and with full visibility, several of them got lost on a route they had traveled only a few minutes earlier!

Following the success of these trials, systems have now been installed in a home for the visually impaired in Somerset and a resource centre for the blind in Cumbria.

LEARN MORE ABOUT

sound

We hear sounds over a huge frequency range of about 20Hz to 20,000Hz, although this range diminishes as we age. It has long been recognised that identifying the direction of a sound source (or 'localizing' it) requires a vast amount of neural processing.

For accurate localization, we require the neural computation of a variety of clues. When a sound comes from one side of us, say the right, it arrives first at the right ear and is also louder in that ear. At low frequencies, the brain processes differences in the time of arrival of the sound at each ear. At higher frequencies, the important clue is the difference in loudness perceived by each ear.

The final main piece of information is the way that our ears modify sounds - amplifying some frequencies and diminishing others - as they pass over the convolutions of the pinna.

This is called the head-related transfer function (HRTF) and the HRTF of any one person is unique to that individual.

The role of the HRTF is particularly important when we are trying to determine whether a sound comes from directly behind or in front of us. In such a case, the differences in timing and loudness at each ear are negligible and there is consequently very little information on which we can base a decision.

Each type of sound localization clue operates over a different and relatively narrow frequency range. Information from all clues is combined by our brains to provide us with a sense of where a sound is coming from.

Only certain types of Sound are easy to localize and the crucial component is that they contain a large spectrum of frequencies i.e. broadband noise. (It can most easily be described as the Sound of a rushing river or waterfall.) With broadband noise, the brain has the maximum number of clues available to process. Pure tones, simple tone combinations or narrowband noise cannot be localized.

In separate research, Sound Alert has shown that the sound of conventional police, fire and ambulance sirens is particularly difficult to localize. In laboratory tests involving some 200 drivers, 56 per cent were unable to tell whether the sound of an approaching siren was directly behind or in front of them - a potentially dangerous situation if they were at the wheel of a real car.

Sound Alert's solution - a new siren utilising the Localizer principle - is currently on test with the emergency services in Merseyside and West Yorkshire.

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