Detection of breaking and entering using an eCompass

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To stop breaking and entering a new way of detecting the opening of doors or windows has been developed in collaboration with Verisure Innovation AB. The method is based on sensor data from a device called an eCompass, made up of an accelerometer and a magnetometer.

In home security it is important to determine if a door or window is open or closed, as an opening when the alarm is activated might indicate an attempted burglary, like the one in figure 1. Some sort of sensor to be placed on the door or window for this detection is required. Today a magnetic contact is often used. However, to provide options that could increase power efficiency, decrease cost or simplify the installation, an alternative component has been investigated.

Figure 1: A situation where the detection of the opening of the door is important.

Since it is a consumer product, placed on doors and windows, it will need to be wireless; a component requiring chords everywhere would not be popular. This means that it needs to be battery-powered. To limit the amount of service, the device should still have a life-span of several years. Therefore it simply needs to be very low-power. Recent development of the accelerometers on the market provides just such a sensor; low power and sensitive enough to react to movement of the door or window. Not to forget, it is also affordable.

An accelerometer is a component measuring acceleration acting on it. When a door is opened the outer edges of the door will move in a demi-circle, as shown in figure 2.

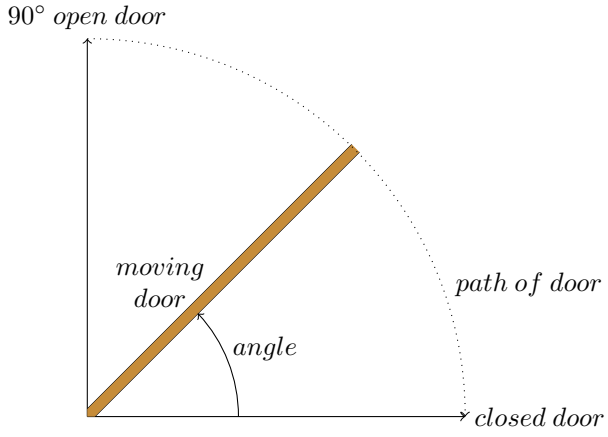

Figure 2: Movement of the door, seen from above.

By placing the accelerometer close to the outer edge of the door, as illustrated in figure 3, the acceleration when opening the door can be measured. From the acceleration it is possible to calculate an angle of the door in relation to the starting position.

These calculations are subjected to certain prob-

Figure 3: A door with the device used for testing attached.

lems: Firstly, errors will cause the calculated angles to drift. Secondly, the noise levels of the accelerometer will hide very low accelerations. During a burglary the burglar might try to escape notice by opening the door utterly slowly. Therefore some kind of verification of the angle is needed to counteract the drift and detect slow openings. One good option for this is to include a magnetometer.

This is a component that measures magnetic fields. Combined with an accelerometer it is often referred to as an eCompass. As the name implies, it measures the compass heading, that is the angle relative to north. When attached to the door this angle will change as the door turns during opening. This can be related to the angle relative to the closed door by simply subtracting the compass heading of the door when closed. Then the resulting angle of the closed door is 0 degrees.

This method has been tested and works in real life on doors, showing the angle of opening. By setting a limit of around 2 degrees for the ”open” state of the door (to combat false negatives due to errors, while still having too small an angle for anyone to pass through) the ”open” or ”closed” state of the door can be determined.

The inclusion of another component for the algorithm will cause the power consumption to increase, especially since the magnetometer has around 10 times higher power consumption than the accelerometer. To counteract this one could decrease the sampling rate of foremost the magnetometer. Since the accelerometer is very good at detecting motion, the main point of the magnetometer is to detect slow opening of doors. For that purpose it does not need to be sampled very often. It should therefore be possible to optimize the algorithm so that the magnetometer only detects openings too slow for the accelerometer, while the latter detects the fast openings.

To sum up, it is possible to use the combination of an accelerometer and a magnetometer to determine the opening angle of a door or window, as can be seen in figure 4. The power consumption can also be controlled by optimizing the algorithm.

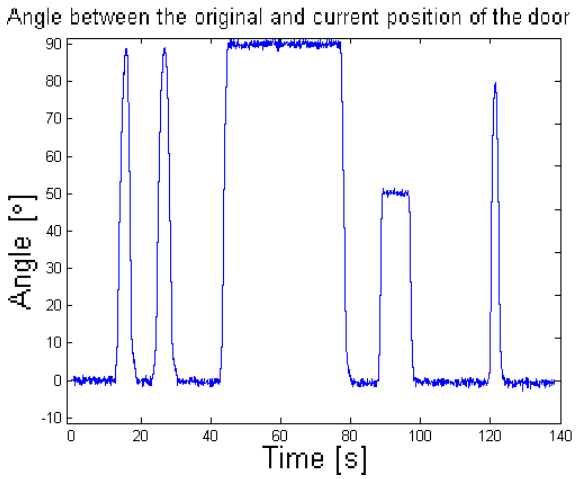

Figure 4: The angle when opening and closing a door.