CAPACITIVE SENSORS FOR SAFETY APPLICATIONS

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ABSTRACT

Indoor human localization is widely used nowadays for majority of the applications. Tag less human localization can really be helpful in the field of health care. Some Machine learning algorithms can fruitfully detect sensor data variability and noises caused by the deployment-specific conditions of environment. We present a system in which we make use of experimental data from a capacitive sensor-based indoor human localization system to detect unauthorized intrusion and abnormal entries that can be further monitored using the GSM modules. Machine learning algorithms like the Weka Collections can be used for human indoor localization for the purpose of exactly identifying the person's location inside a room and further prevent him or her entering furthermore using a shock generator.

INTRODUCTION

Indoor human localization can be performed using various methodologies. Detecting the presence of a human inside a closed area can be very much useful for various purposes like reducing the consumption of energy by turning on or off the room lights, altering the room temperature based on outside temperature conditions and so on.

We aim to detect the exact position of the intruder using machine learning classifier algorithm and prevent him to move further by installing a shock generating system. Among the sensor data processing techniques, the machine learning (ML) algorithms are the most promising. ML classifiers in the Weka collection can be used in order to process sensor data for person localization.

RELATED WORK

Cameras for video monitoring and continuous imaging are most commonly used for human identification, detection and localization. But those cameras are specially designed and mostly require high networking resources. Also a direct viewing angle, sufficient lightning must be present boosts the entire system cost.

Systems using ultrasonics can also be helpful for performing human localization .Unfortunately these type of systems are highly based on the user tags which makes it difficult to implement in various applications. Object exposure to the ultrasonic signals can damage them.

Systems based on WiFi have been developed for human recognition and personalisation. These are cost effective. But it strongly requires the other equipment and devices in the total system to be WiFi enabled and supportive. This criteria would increase the devices cost. Since it is a wireless communication system, the signal might get lost or attenuated and cannot be processed by the receiving devices.

Apart from the above mentioned systems, most of the other systems are tag based and the person must carry the tag always with him or her for detection. Tags are attached with the things the person carries or always be with like pillbox, writing desks, furniture etc.

EXISTING SYSTEM

Since machine learning based classifiers have been researched extensively, long distance capacitive sensors are relatively new. An overview of more than 190 capacitive sensing techniques that are categorised based on the functionality includes indoor localization along with touch, gesture, grip and grasp recognition.

Electrical capacitance can be obtained as a result of dividing electric charges accumulated on any material with conductivity by its potential change. This electrical capacitance relies upon geometrical properties, the distance and dielectrics of the system under consideration.

In our proposed system, we use a sensor based on capacitive sensing and it is fixed to work in load mode. A capacitive sensor might consist of 2 plates between which capacitance are generated. The sensor has one plate inside and another plate is in contact with the human being and environment. We consider the potential change as a constant for measurement purposes. The changes in the capacitance measured by free running frequency and a stable multivibrator, indirectly. The multivibrator is used for discharging and charging the capacitor.

Adaptive Boosting is one of the best out-of-the-box classifier. It is a machine learning meta-algorithm proposed by Yoav Freund and Robert Schapire . To improve its overall performance, it is used along with other similar algorithms. The output given by other learning algorithms is grouped into a weighted sum that is the final output of the boosted classifier algorithm. AdaBoost is adaptive. Subsequent learner algorithms are tweaked in favor of incorrect results produced by previously used classifiers. This classifier is sensitive to noise and outlier data. In some problems it can be less susceptible too. Individual learners can be weak, but as long as the performance of each one is better than random guessing, the final model can be proved to produce a strong learner.

PROPOSED SYSTEM

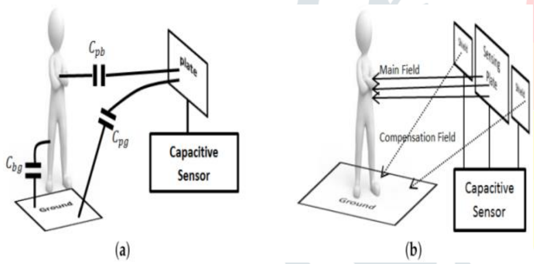

Fig.1 Working of a tag less capacitive sensor

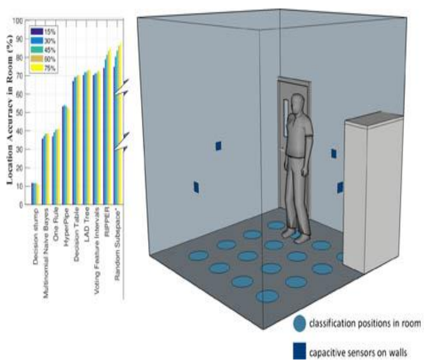

Fig.2 Indoor human localization in a 3 m x 3 m room using long-range capacitive sensors

Capacitive sensors for localization purpose is installed in predefined places on the walls near the light switches in the room and also on the ground beneath the carpets This enables to determine the exact position of the person inside the room and to arrest his or her movement by giving a shock to the person at that place. We keep the sampling rate low to limit the overall energy consumption of sensor while it still measures without any problem. These can be used to classify different modes of walking like running, jogging, sneaking, walking with weight and so on.

Electromagnetic noise and other similar objects with different permittivity values might intervene with sensor’s measurements. To overcome these kind of effects, the plate of the sensor is guarded by auxiliary fields to depreciate unwanted couplings of the plate of the sensor with surrounding objects. By post-processing the data from the sensor we can actually improve the reliability and accuracy of long range measurements.

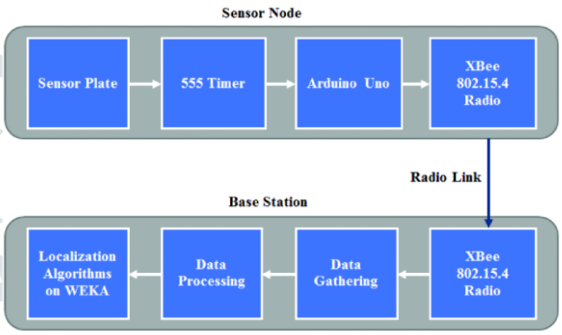

Fig.3 Main building blocks of Sensor Node and Base Station.

The base frequency of the sensors may vary each time they are turned on when there is no person nearby for a very long time. The orientation of the human body can affect the measurements of sensor, as for different angleof rotation, the distance from the closest body part to sensor may change for a given position inside the room.

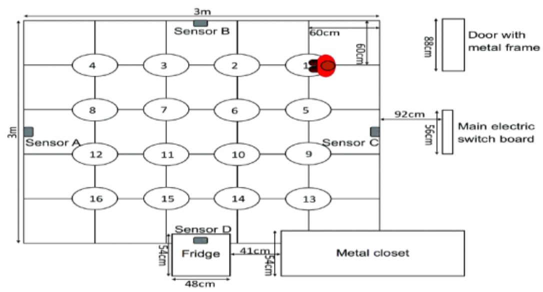

Fig.4 Setup of the capacitors

Each of the sensors has an 8 cm×8 cm copper clad plate attached as the external capacitor to a 555 integrated circuit in a stable multivibrator configuration. The oscillation frequency can be obtained by using the formula:

$$\text{Frequency} = \frac{1}{0.7(R1+2R2)C}$$

The overall capacitance of the plate approximately depends on the distance d from the person as d−2.5 We measure the frequency using an Arduino Uno board and we use an XBee 802.15.4 modem to transmit the measurements to a central node for post-processing purposes.

CONCLUSION

Thus, we can detect the unauthorized intrusion and the theft by detecting his exact position by using capacitive sensors and ML Classifiers and an alarming system and shock generator is further used to stop further movements of the person.

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