ULTRASOUND BASED AUTOMATIC HOME OBSERVATION

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ABSTRACT

In 2060 the total EU's population will rise only by 2% while the number of over 65 year olds will increase by 85%. This causes significant budgetary implications on today's care system. To cope with these facts transferring elderly to expensive nursing and retirement homes should be delayed as long as possible. A possible solution is automatic home observation where a) acute (e.g. fall detection) and gradual events (e.g. change of sleep rhythm) can be detected and b) person specific reports with information related to clinical and care status can be generated.

During the last decade many modalities have been examined in order to achieve these objectives. However, the usage of low-cost compact ultrasonic sensors in the intended application has to our knowledge not yet been investigated. In this work, it is explored if domestic events can be recognized based on ultrasonic signals. This is done by recording events with a 40kHz ultrasound receiver which can be tuned in the frequency range between 28-44kHz. Next, the recorded signals will be shifted towards the audio spectrum with a bandwidth of 10kHz. This makes the captured signals audible for the human hearing and easy to record with standard audio hardware. To get an idea of the potential that ultrasonic signals might have for classifying domestic events, Gaussian Mixture Models based on Mel-Frequency Cepstral Coefficients were used. The latter are a classical method for speaker recognition [1] which seems to be related to the problem at hand.

In total 14 different events (including coughing, shuffling, running water, watching television, opening and closing doors, speech) were recorded multiple times in a simulated setup, both when the receiver was tuned to the 25-35kHz band and to the 35-45kHz band. The capturing distance between receiver and source (event) varies between 0.1m and 1m. Promising results were obtained in this configuration. An average accuracy of 98.4% and 91,0% with a standard deviation of 3 and 5 was reached, respectively when the receiver was tuned into the 25-35kHz and 35-45kHz band. As a result, this preliminary study indicates that ultrasound contains useful information related to domestic events. In future research this result is studied in more detail and on real-life data.

REFERENCES

[1] D.A. Reynolds and R.C. Rose, "Robust Text-Independent Speaker Identification Using Gaussian Mixture Speaker Models", IEEE Transactions on Speech and Audio Processing, Vol. 3, No. 1, pp. 72–83, (1995).