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AUTOMATIC FOOD INTAKE DETECTION FOR SWALLOW SOUNDS

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ABSTRACT

The main aim is to improve our understanding about the eating behavior associated with obesity and overweight. People who want to lose weight and monitor their intake would love to have a mechanism whose can objectively check their consume behavior over time and the mechanism also used for modification program of behavioral. Our long period aim is that to make such a device that can affordable wearable to non-invasively who can determine instances of swallowing (deglutition) in free living individuals in such a way to objectively measure how and when often food intake is taking place. Degulation is a scientific term is used for swallowing. Swallowing is the process in the human or animal body which makes something pass from the mouth. For checking of ingestive behavior, a very significant work is to recognize bouts of swallowing food-related so as to calculate the length of eating periods and number per day. The study has shown that the frequency of swallowing which can serve as a predicting factor for correct food intake detection, difference between solid and liquid foods with higher swallowing frequency being representative of ingestion.

KEYWORDS: Monitoring of ingestive behavior, Food intake detection, Obesity, Eating disorders.

INTRODUCTION

The potential decline in US life expectancy is obesity which has been introduced as a first origin for this [Olshansky et al. 2005]. In 2005, 40 % Americans were with Body Mass Index (BMI) of more than 30 and more than 73% were obese with BMI of more than 25 [WHO 2006]. Overweight may be a reason to [1]generate a number of health problems like hypertension, diabetes, heart disease, [Carmelli et al. 1997, James 1998] and some cancers and is now also acknowledge as a factor of risk for [1]cardiovascular disease[Eckel and Krauss 1998]. Americans more than millions in number are desire to reduce weight at any time, but the gaining rate the result at controlling weight regain is only 5-20%[Wyatt and Hill 2002]. .Todays modernized lifestyle is the most preferable reason of overweight epidemic. We are enclosed by highly palatable and food with high calorie which get at a very cheap rate. And also the physical activity level is reduced as compare to certain decades ago. The latest study shows that first factor for manage a healthy weight in such an environment is control of food intake [Flatt 1996].The frequency of swallowing which can serve as a predicting factor for correct food intake detection, difference between solid and liquid foods and calculation of digest mass, with higher swallowing frequency being representative of ingestion. So, to develop the proper device, a methodology for an automatic swallowing detection is necessary that would be suited for obese subjects and would be able to different sounds of swallowing from sound artifacts that derive in, food ingestion, head movements, respiration, talking etc.Characterization of food intake behavior includes: detection of periods of food intake, differentiation of solid foods from liquids, recognition of food type.

Various methods has been introduced to measure intake food includes estimated records, observation, diet history, weighed food records, food recall methods, food-frequency questionnaires, and others. Measurement of food intake indirectly from the use of doubly-labeled water [Schoeller 1988] [1]has been used as a gold standard to determine other methods for measuring energy intake [Livingstone and Black 2003]. In a review of studies with comparing these methods to doubly-labeled water, from underestimation of energy intake on the basis of 0.84(ratio of estimate to actual intake) the majority suffers [Livingstone and Black 2003]. Observation provides the best agreement, but is costly and may not be representative of the behavior of the subjects. All the methods which are based on self-reporting have important under-estimation [Mertz et al. 1991, Subar et al.2003, Prentice et al. 1989, Weber et al.

2001, Champagne et al. 2002] due to various factors, consisting under-eating, under-reporting, psychological, recording burden and behavioral aspects.In this work the system that is developed includes a number of things like piezoelectric sensor, personal computer and MATLAB software. With the help of piezoelectric sensor we recorded the signal of the subjects from hardware and that signal is fed to the sound port of the computer where that signal get amplified and converted to digital signal. To read the signal from the sound port of the computer we used Signal processing and Data acquisition toolboxes of MATLAB software and then filter it subsequently.

MATERIALS AND METHODS

For the signal acquisition purpose hardware is used. In this, hardware a flex sensor is used for hand movement. An electronic hardware amplifies swallow sounds by electronically amplifying the signal. A piezo sensor is used for detection of swallow. Electronic piezo sensor converts sound waves to electric signals which can be amplified and processed. The simplest method is by placing piezo sensor over the laryngopharynx. An electronic hardware can transmit signals, and can record signals as well. The signals can be interfaced with a computer to analyze the signal waveforms.The signal processing approach is used to perform the swallow signal analysis and acquisition. Hardware is designed to acquire swallow signals in real time. The hardware is interfaced with computer through a 3.5 mm stereo plug. The stereo plug is used to transfer the signals to the sound port from where they are transferred to the sound card. The MATLAB software used is compatible with sound port and the signals are acquired directly from the sound port to the software.

Block diagram

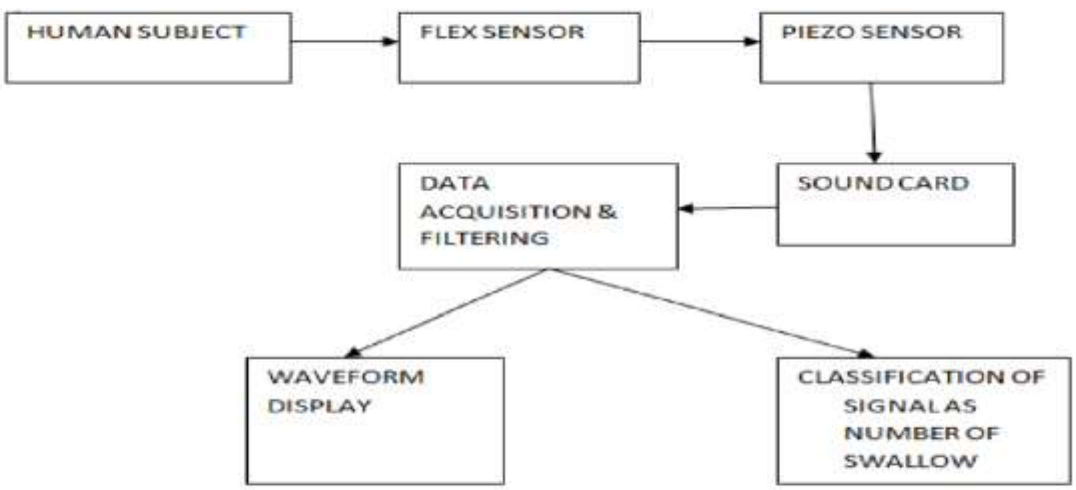

Fig 1: Block diagram of data collection system

A system for data collection was designed for non-invasive checking of swallowing. Monitoring is established on swallowing detection from a piezo sensor situated over the laryngopharynx. A Flex sensor is used for hand movement. A noise is a wanted random signal which lost the quality of the original signal. Therefore, it must be removed without losing the original characteristics of the signal. The easiest method for removing the noise is filtered based Fourier transform but these filtering methods are not successful. They successful only when removing high frequency noise from low frequency signals. This method also develops the original signal characteristics and fails to give suitable results under real scenarios i.e. for non-stationary signals. The Short Time Fourier Transform (STFT) reduces this limitation by using the windowing technique in considering the frequency behavior of signal with time. But due to fixed window length STFT does not give improved time and frequency resolution of the signal. This gives progress to wavelet transforms that provide better time, localization of frequency and multi-resolution analysis of the signal. Wavelet transforms reduce the STFT drawback by using wide windows for lower frequencies and short windows for higher frequencies, forming them as a useful tool in ejecting noise from signals.

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In wavelet study high frequency coefficients represent the noise & low frequency coefficients represent signal. Audio signals are non-stationary in nature, so the analysis of non-stationary signals using STFT and Fourier Transform does not give better results. Coiflets5 wavelet is used for removal of noise.

Fig 2 shows hardware.

Fig 3 Experimental setup

RESULTS

Signal Waveform

The study is conducted on different people. In this we take 3 example subject 1, subject 2 and subject 3.Fig 4.1 shows the recorded signal of subject 1.This signal is recorded from hardware.

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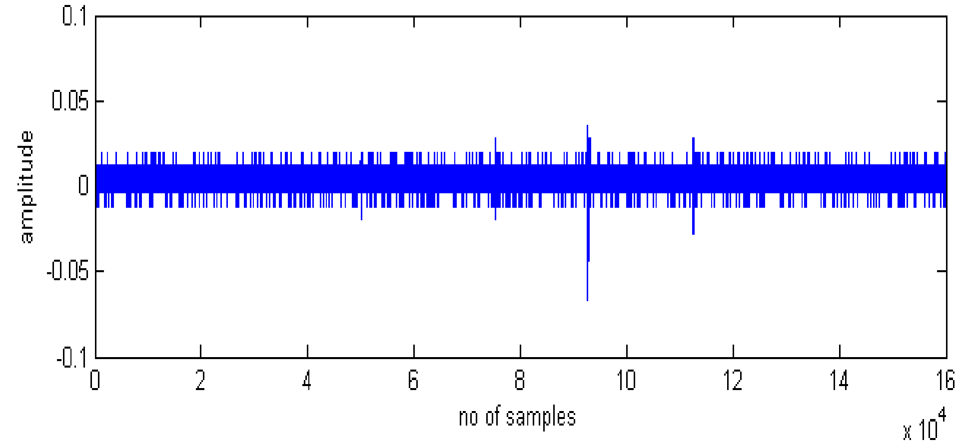


Fig 4.1shows the recorded signal of sub1

The fig 4.2 shows the signal after wavelet filtering. Wavelet filtering is used for removal of noise present during recording of signal from hardware. From wavelet filtering transform denoise the signal.

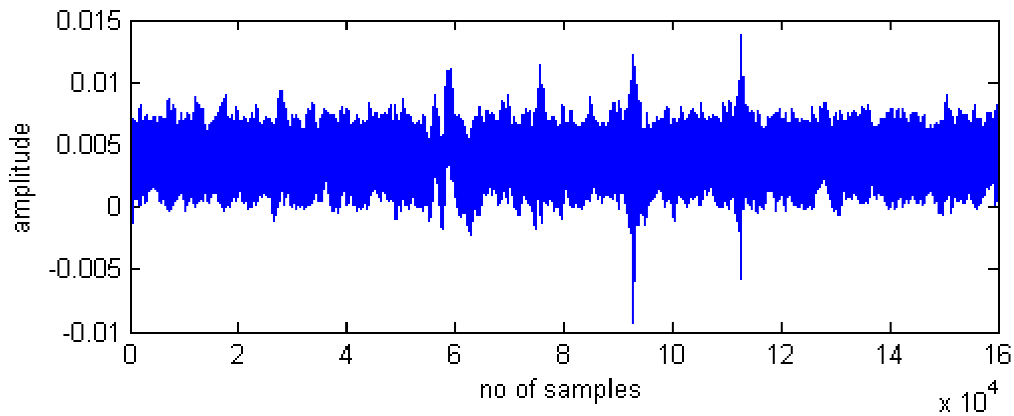


Fig 4.2 shows signal after wavelet filtering of sub1

Fig 4.3 shows the signal achieved by applying threshold. Denoising process involves thresholding which uses in filtering of noise as well as retaining the real characteristics of the signal. In wavelet thresholding, signal is decomposed into wavelet coefficients and this signal compares the detailed coefficients with the threshold value.

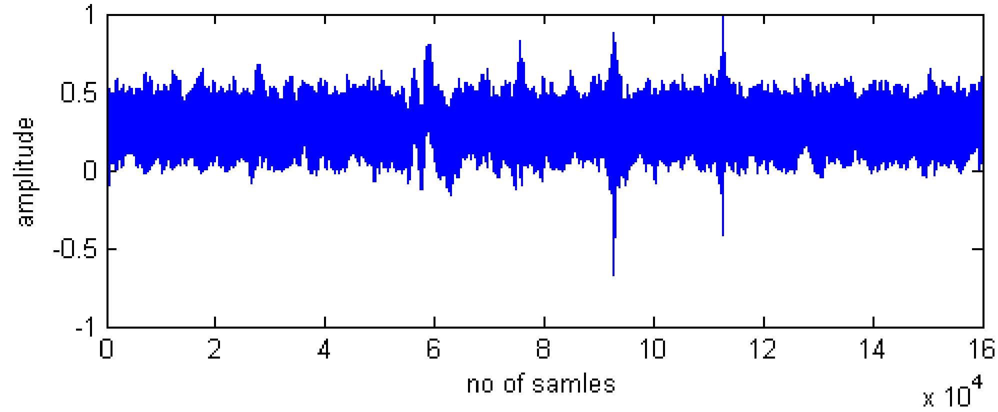


Fig4.3 shows signal after threshold

The fig 4.4 shows the number of swallow from subject 1 in 20 sec.

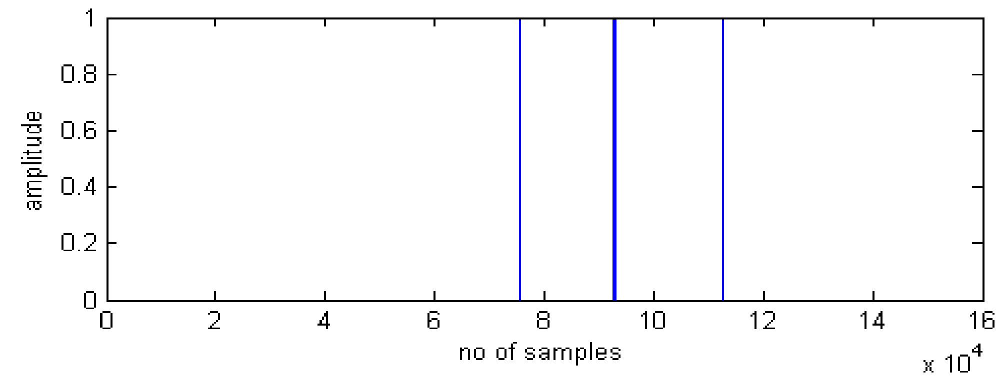


Fig4.4 shows number of swallow

Now, we take another example of testing subject 2. In this fig 4.5 shows the recorded signal of subject 2.

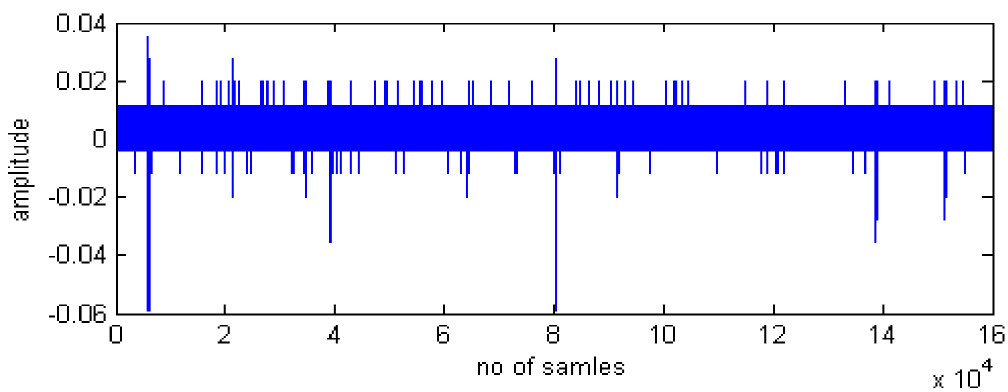


Fig 4.5 shows the recorded signal of subject 2.

The fig 4.6 shows the signal after applying wavelet transform. Wavelet transform is to reduce noise present in original signal.

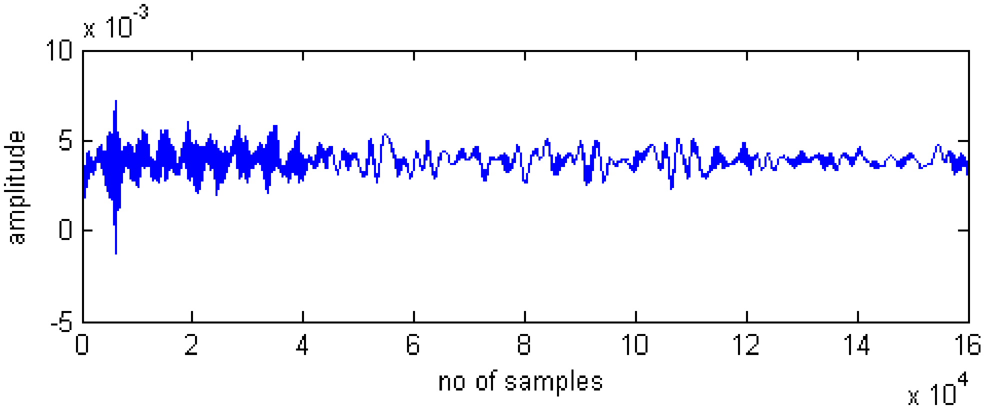


Fig 4.6 shows the signal after wavelet transform

Fig 4.7 shows the signal of subject 2 after applying threshold.

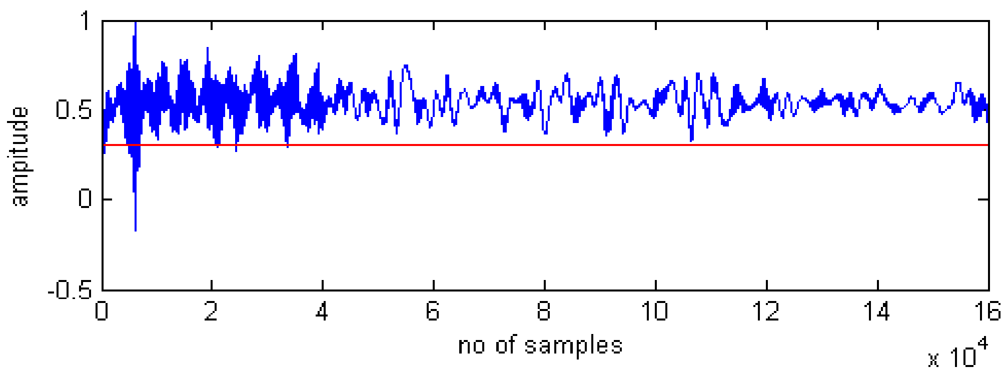


Fig 4.7 shows the signal after threshold.

Fig 4.8 shows the final result. In this we find out number of swallow of subject 2 in 20 sec.

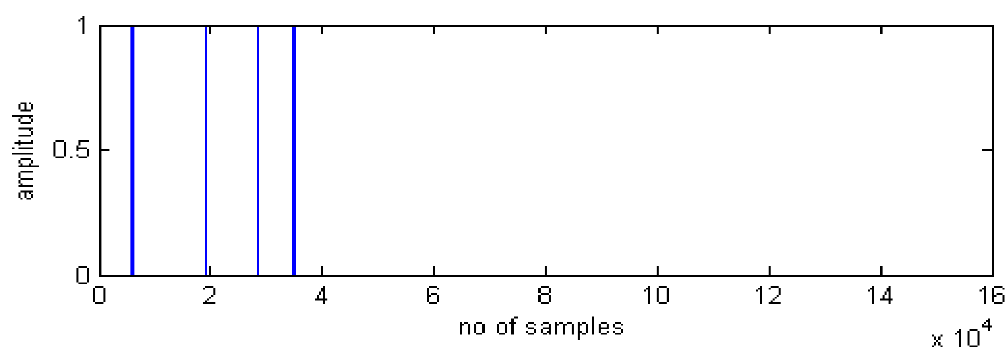


Fig 4.8 shows the number of swallow.

Fig 4.9 shows the recorded signal of subject 3. This is the recorded signal. In this signal there is noise present in it.

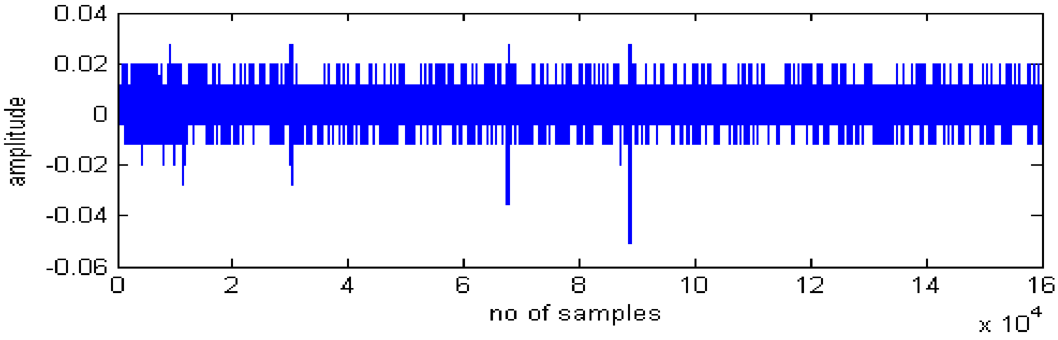


Fig 4.9 shows the recorded signal of subject 3.

Now the second fig 4.10 shows the signal after applying wavelet transform. We used wavelet transform for removal of noise.

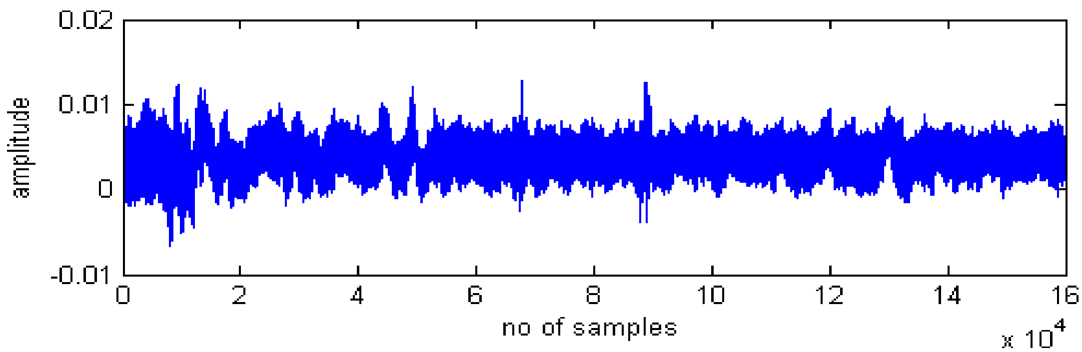


Fig 4.10 shows the signal after wavelet.

The fig 4.11 shows the signal after applying threshold. We applying wavelet transform on original signal and after that we apply threshold on the signal getting after wavelet transform.

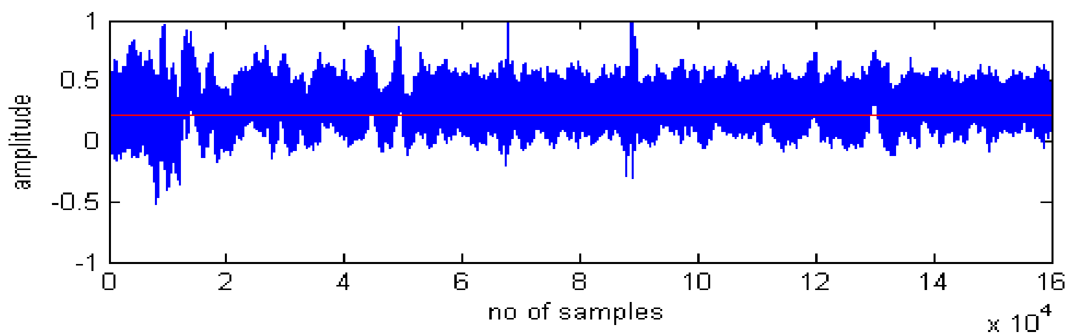
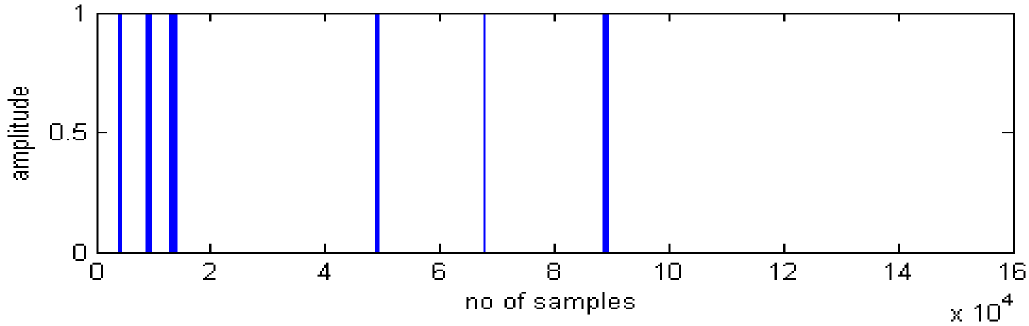


Fig 4.11 shows the signal after threshold

Fig 4.12 shows the number of swallow of subject 3. Final result shows in the figure. We find out the number of swallow in 20 sec for subject 3.



DISCUSSION
This study indicates that the swallowing events can be used for detection of food Intake periods. The study has shown that the frequency of swallowing which can serve as a predicting factor for correct food intake detection, difference between solid and liquid foods and calculation of digest mass, with higher swallowing frequency being representative of ingestion. So, to develop the proper device, a methodology for an automatic swallowing detection is necessary that would be suited for obese subjects. In the present work we recorded the swallow signal of the different subjects from the piezoelectric sensor over the laryngopharynx. The swallow signal from the human s acquired in real time using the hardware. The recorded swallow signals are directly fed to the sound card. From the sound card, the signals are transferred to MATLAB software. The software has the provision to acquire signals from sound card. After the signal acquisition in the software; the noise is present. For removal of noise we use wavelet. Swallow signal is recorded from hardware. Then find out time domain analysis after that we apply averaging. From averaging we find out mean value. After getting the mean value we apply wavelet on this. After this we calculate local maxima. Now, apply threshold on the signal. To set the threshold limit, more time is consumed on the basis of case-by-case. The limit is selected in such a way that satisfactory removal of noise is achieved. After the threshold we get the number of swallow. This model can be implemented directly in a wearable device which is automatically monitors ingestive behavior of humans. Such type of device can be used in free-living conditions improving our understanding about of eating behaviors related with obesity and gives the real-time feedback to individuals and other eating disorders.

CONCLUSION
The human research described in this was performed to data collection required to validate the swallowing detection proposed and methodologies for food intake detection. A process of research of ingestive behavior through non-invasive checking of swallowing (deglutition) has been proposed established on data through sensors that may be achieved in a wearable monitoring device, thus enabling ingestive behavior monitoring in free living individuals. The hardware/software system designed in this project captures multi-modal sensor data which may be used for manual scoring of food intake periods and swallowing. These manual scores will further be used for assessment of food intake detection accuracies and swallowing. This presented work can be implemented in various medical applications to analyze the swallow sounds. Human easily determine how and when food consumption is taking place.

REFERENCES
[1] Oleksandr Makeyev'' Automatic method of acoustical swallowing detection for monitoring of ingestive behavior'' April 13, 2010
[2] Makeyeva O, Lopez-Meyerb P, Schuckersc S, Besioa W, Edward Sazonovb E "Automatic food intake detection based on swallowing sounds", 2012 Elsevier Ltd.
[3] A.J. Alberg, J.W. Park, B.W. Hager, M.V. Brock, M. Diener- West, The use of overall accuracy to evaluate the validity of screening or diagnostic tests, J. Gen. Intern. Med. 19 (2004) 460–465.
[4] Alpaydin E. Introduction to Machine Learning. Cambridge: MIT press, 2004.
[5] AmftO. ,G. Tröster. Recognition of dietary activity events using on-bodysensors. Artif. Intell. Med. 42(2):121-136. 2008.
[6] Caballero B. The global epidemic of obesity: an overview. Epidemiol.Rev.29(1):1-5. 2007.

[7] Makeyev O, Sazonov E, Schuckers S, Melanson E and Neuman M (2007a)“Limited receptiveare neural classifier for recognition of swallowing sound using short-time Fourier transform” Proc. Int. Joint Conf. Neural Network IJCNN’2007 (Orlando, USA)1417.1-6.
[8] Makeyev O, Sazonov E, Schuckers S, Lopez-Meyer P, Melanson EandNeumanM(2007b)“Limited receptive area neural classifier for recognition of swallowing sounds using continuous wavelet transform”Proc. of 29th Annual Int. Conf. of the IEEE Engineering in Medicine and Biology Society EMBC’2007 (Lyon France) 3128-31.
[9] Makeyev O, Sazonov E, Schuckers S, Lopez-Meyer P, Baidyk T, Melanson E and Neuman M (2008b) “Recognition of swallowing soundsusingtime-frequency decomposition and limited receptive area neural classifier” Proc. of 28th SGAIInt.Conf. on Innovative Techniques and Applications of Artificial Intelligence (Cambridge, UK) 33-46.
[10] Sazonov E, Schuckers S, Lopez-Meyer P, Makeyev O, Sazonova N,MelansonE, Neuman M (2008) “Non invasive monitoring of chewing ands wallowing for objective quantification of ingestive behaviour ”Physiologica lMeasurement,29:525-541.
[11] Sazonov E, Schuckers S, Lopez-Meyer P, Makeyev O, Sazonova N,MelansonE,NeumanM(2009a)“Reply to 'Comment on Non-invasive monitoring of chewing and swallowing for objective quantification of ingestive behavior'” Physiologica Measurement, 30:L5-L7.
[12] Sazonov E, Makeyev O, Schuckers S, Lopez-Meyer P, Melanson E,Neuman (2010)“Automatic detection of swallowing events by acoustica lmeans for applications of monitoring of ingestive behavior” IEEE Transactions on Biomedical Engineering,57:626–633.
[13] Makeyev O, Lopez-Meyer P, Schuckers S and Sazonov E (2010) “Automatic food intake detection based on swallowing sounds” Physiological Measuremen (In review).
[14] Aboofazeli M and Moussavi Z (2004)Automated classification of swallowing and breath sounds” In: Proceedings of 26th Annual InternationaL Conferenceof the Engineering in Medicine and Biology Society, San Francisco, 3816-3819.
[15] Aboofazeli M and Moussavi Z (2005) “Analysis and Classification of Swallowing Sounds Using Reconstructed Phase SpaceFeatures”,Proc.IEEE ICASSP, pp.V421-V424.
[16] Aboofazeli M and Moussavi Z (2006) “Automated Extraction of Swallowing Sound Using a Wavelet-Based Filter,” in Proc. 28th Annual International Conference of the Engineering in Medicine and BiologySociety,NewYork,New YorkUSA,pp 5607- 5610.
[17] Amft O, Tröster G. (2008) “Recognition of dietary activity eventsusingon-body sensors. Artificial Intelligence in Medicine.’’ 42(2):121–136.
[18]]MakeyevO,LopezMeyerP,SchuckersSandSazonovE(2010)“Automatic food intake Detection based on swallowing sounds” Physiological Measurement (In review).
[19] Poppitt SD, Swann D, Black AE and Prentice AM (1998) “Assessmentofselective under-reporting of food intake by both obese annon-obesewomeninmetabolicfacility.” Int. J. Obes. 22:303-311.

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