Gastric assessment by images processing of ultrasound in LabVIEW platform: preliminary results

Avaliação gástrica pelo processamento de imagens de ultrassom na plataforma LabVIEW: resultados preliminares

T. Córdova[1,2], M. Sosa[1], J. J. Bernal[1], A. Hernandez[1], G. D. Gutiérrez[1], D. Rodriguez[1], S. Solorio[3], M. A. Hernandez[3], M. Vargas[1], I. Delgadillo[1], G. Moreno[1], J. G. Villalpando[2] and C. R. Contreras[2]

[1]Departamento de Ingeniería Física, Universidad de Guanajuato, Campus León – México.
[2]Facultad de Ingeniería en Computación y Electrónica, Universidad De La Salle Bajío – México.
[3]Unidad Médica de Alta Especialidad, Clínica T1-León, Instituto Mexicano del Seguro Social – México.

Abstract

Nowadays, the gold technique in gastric evaluations still is scintigraphy in spite of ionization radiation dose per patient undergoing this procedure. Gastro images with ultrasound technique are controversial, because the stomach is a hollow cavity filled with gas in basal conditions or in fast state. Fortunately, a stomach with food is recommended in gastric motility and gastric emptying assessment. So, a lack of air in stomach contributes in this kind of study and in recordings of excellent images by ultrasound. In this study, a digital image processing of gastric ultrasound is presented. Whole automated routine and implemented filters are described in order to use this procedure in gastric peristalsis and gastric emptying evaluations. Ten volunteers were recruited and required to attend the measurements about dominant frequency, with values of at least 3 cpm. Although the behavior stomach activity is observed in dynamic graph, an analysis in frequency space is performed.

Keywords: gastric, peristalsis, ultrasound, emptying, LabVIEW.

Resumo

Hoje em dia, a técnica de ouro nas avaliações gástricas ainda é a cintilografia apesar da dose de radiação de ionização por paciente submetido a esse procedimento. As imagens gástricas com a técnica do ultrassom são controversas, pois o estômago é uma cavidade oca preenchida com gás em condições basais ou em estado rápido. Felizmente, um estômago com comida é recomendado em motilidade gástrica, como também na avaliação do esvaziamento gástrico. Portanto, falta de ar no estômago contribui para este tipo de estudo e para gravações de excelentes imagens por ultrassom. Neste estudo, o processamento da imagem digital do ultrassom gástrico é apresentado. Uma rotina totalmente automatizada e filtros implementados estão descritos para usar este procedimento no peristaltismo gástrico e nas avaliações de esvaziamento gástrico. Dez voluntários foram avaliados em relação à frequência dominante, com valores de no mínimo 3 cpm. Embora a atividade estomacal comportamental seja observada em gráfico de dinâmica, uma análise de frequência espacial é realizada.

Palavras-chave: gástrico, peristaltismo, ultrassonografia, esvaziamento, LabVIEW.

Introduction

The gastrointestinal system evaluation is, currently, as important as other clinical procedures, like heart monitoring. If patients are not adequately treated, they may die. This is especially important for some kinds of patients, for instance, diabetes patients with problems of gastroparesis. The scintigraphy technique is now the gold standard in this evaluation, despite ionizing radiations that undergo the persons[1]. There are other imaging techniques for this study, like the ultrasound, that has been an alternative for assessment and monitoring of the gastric activity in the last years[2-6], although it has still not taken off, which could be due to a lack of conclusive results and proper procedure, leading to results highly correlated with the gold standard technique, scintigraphy.

A routine for processing ultrasound images of stomach, implemented in LabVIEW platform, is presented. This has been used to perform evaluations of

Corresponding author: Teodoro Córdova – Departamento de Ingeniería Física – DCI, Universidad de Guanajuato, campus León – Loma del Bosque, 103 – Lomas del Campestre – León, GTO, Mexico – E-mail: theo@fisica.ugto.mx

the peristaltic activity and gastric emptying in prepandial and postprandial conditions in healthy subjects and patients.

Procedure

An ultrasound equipment model Medison SONOACE 8000 SE was used in this study. A group of ten healthy volunteers with no history of gastrointestinal diseases and two patients were recruited and required to attend the measurements after a night of fast. Each subject swallowed 300 mL of water previous to first measurement; then, a solid test meal was ingested in order to estimate the gastric area. Each subject was in supine position during the auscultation and along the data acquisition time, that lasted one minute. It is important to point out that this work was carried out according to the Helsinki agreement for studies in human.

Protocol

Once the gastric area was identified, a video of 1740 frames was recorded in B Mode and in M modes (Figure 1). Then, the M mode video was split in each one of its frames and the image processing was performed.

From the M mode video, a representative frame is selected and the region of interest (RI) is studied (Figure 2); the superior and inferior bands are identified. In the RI of the frame, the points x1,y1, x2 and y2 are determined and the same action is automatically executed in each of the 1740 frames. Simultaneously, a new file (Figures 2 and 3) of this new outage image is created in order to perform the imaging processing over all of it.

Imaging processing

The upper and lower bands, in the image of the Figure 4, correspond to the upper and lower walls of the stomach, respectively.

Here, a series of filters were implemented during image processing in order to reduce the area of each band to a single line (IMAQ MathLookup + IMAQ GrayMorphology + IMAQ MathLookup + IMAQ BCGLookup + IMAQ LowPass + IMAQ Convolute + IMAQ RejectBorder). When the filtering process is over, one distance from inferior to superior band is measured through a subroutine of *find Vertical Edge* of the IMAQ sofware; this leads to determine only one couple of coordinates, selected from each one of the edge points of the band. With that couple of coordinates, the distance from one to other side of the stomach is measured (Figure 5).

It is important to point out that only one distance is measured from each couple of coordinates. If we have 29 frames in one second, then, this corresponds to have a rate frequency of 29 samples per second. These points are simultaneously plotted (Figure 6).

Results and discussion

The above description is appropriated for gastro evaluations. The peristaltic information is seen from first measurement (Figure 7) in time domain, in which about three contractions are shown. Nevertheless, physicians are interested in the exact value of the dominant frequency,
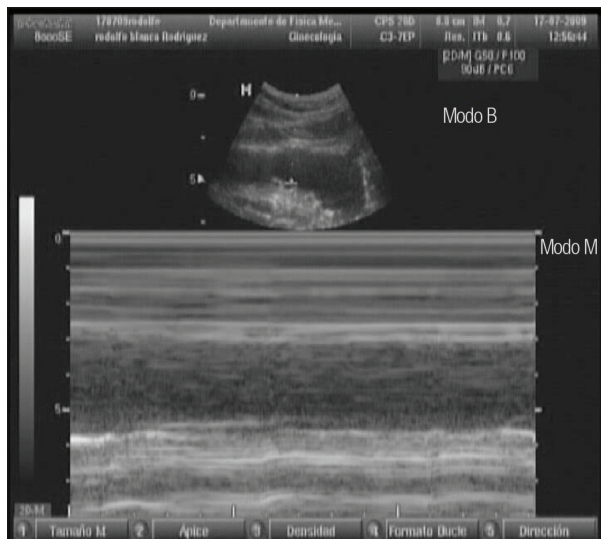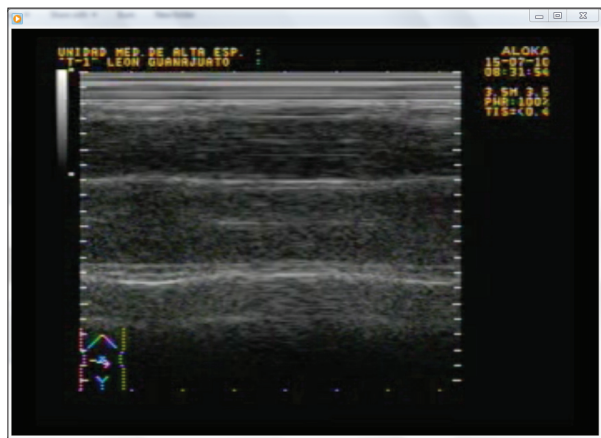

Figure 1. A frame showing the B and M mode.
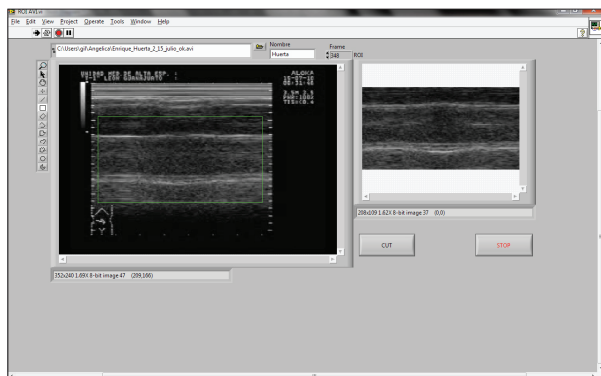

Figure 2. Representative frame.

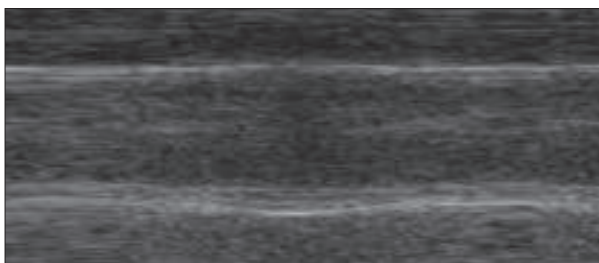**Figure 3.** LabVIEW Screen for the RI.

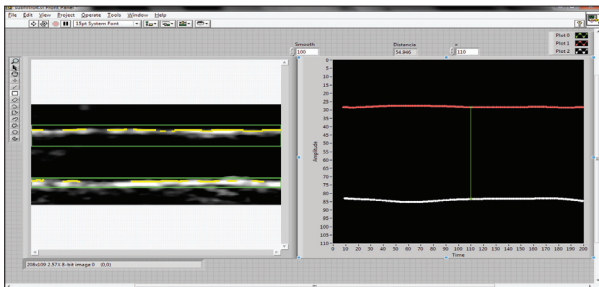**Figure 4.** Outage image of the represented frame.

Figure 5. The measurement of the stomach wall can be obtained from de filtering of the left image.
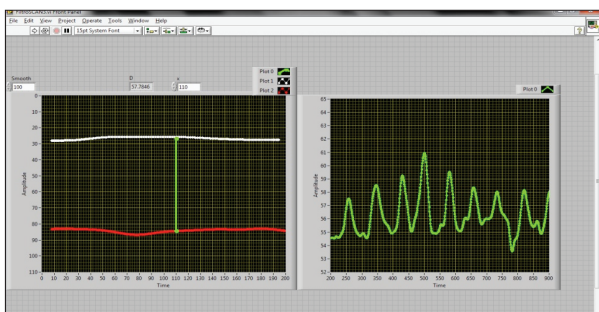

Figure 6. The left figure shows the superior and inferior band; the right figure presents the square and gastric activity along the time.
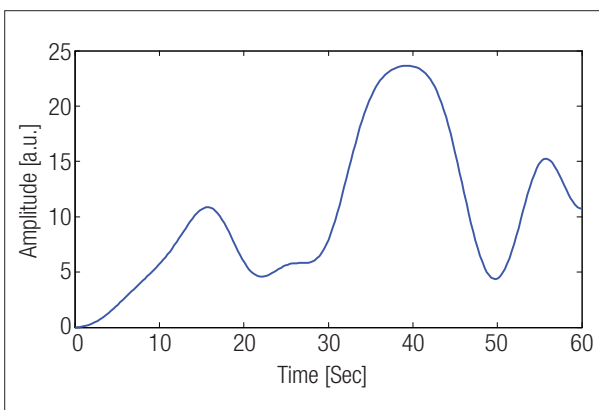

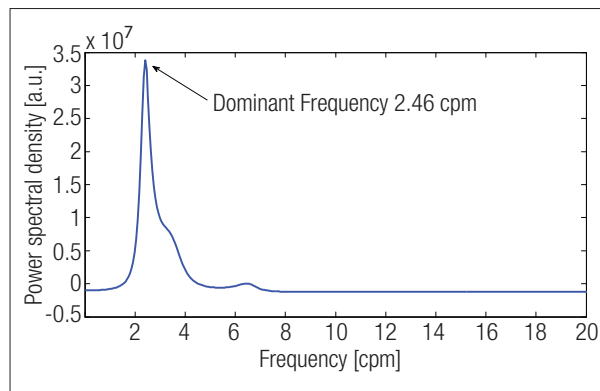**Figure 7.** Gastric mechanical activity.

Figure 8. PSD of the gastric mechanical activity.

so a FFT (fast Fourier transform) is obtained from above signal in order to present this value (Figure 8).

Conclusions

This new ultrasound gastric imaging processing is presented as a powerful technique, with relatively easy implementation, because the ultrasound equipments are very common in hospitals and the LabVIEW routine can be executed in any personal computer.

Acknowledgment

References

1. Odunsi ST, Camilleri M. Selected interventions in nuclear medicine: gastrointestinal motor functions. Semin Nucl Med. 1999;39(3):186-94.
2. Kusunoki H, Haruma K, Hata J, Ishii M, Kamada T, Yamashita N, et al. Efficacy of Rikkunshito, a traditional japanese medicine (Kampo), in treating functional dyspepsia. Inter Med. 2010;49(20):2195-202.
3. Newell SJ, Chapman S, Booth IW. Ultrasonic assessment of gastric emptying in preterm infant. Arch Dis Child. 1993;69(1):32-6.
4. Gilja OH, Hausken T, Degaard S, Berstad A. Gastric emptying measured by ultrasonography. World J Gastroenterol. 1999;5(2):93-4.
5. Bateman DN, Whittingham TA. Measurements of gastric empting by real-time ultrasound. Gut. 1982;23:524-7.
6. Holt S, McDicken WN, Anderson T, Stewart IC, Heading RC. Dynamic imaging of the stomach by real-time ultrasound–a method for study of gastric motility. Gut. 1980;21(7):597-601.