Dobrea Dan Marius, 2nd place at Innovact 2005
The European Forum For Innovative Growth Companies

A Laser Non-Contact Bio-Instrumental System

The system's goals are:

- to emerge a natural form of subject interaction with computers – this system offers the possibility **to use a new kind of information regarding the subject's emotional state, unexploited yet on the human computer interface systems**, namely, the emotional state of the subject expressed through his/her body language
- to assure the reproducibility of the evaluation and assessment of the severity in Parkinson disease – a way of helping the physicians to improve the quality of the medical act (up to this moment no kind of standard method exists in order to quantitatively/objectively evaluate the Parkinson symptoms),
- to offer support for the vocally impaired subjects (offering a new non-contact way of communication – through hand gesture).

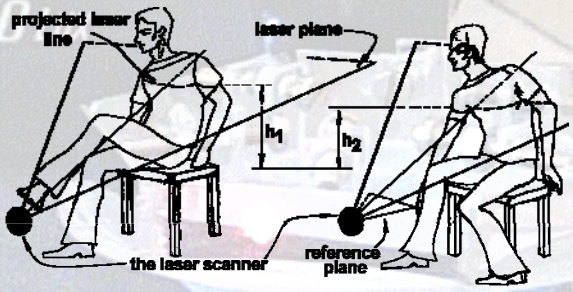

Fig. 1 Two different positions of a subject

The laser sensor

The implementation of the sensor system is given by a laser scanner (LS), a video camera and a software program that controls the scanner and extracts the distance/position information. The working principle of the whole system relays on a LS that generates a laser plane (LP) at a constant angle from the horizontal plane (consider this plane the floor). When the LP hits a target in the imaged area, a line of laser light appears on the target – Fig. 1.

The system uses a single conventional video camera that is capable to acquire images from the area where the LP can hit the target. With this camera the software gets two consecutive images: first, with the laser diode on, with a line of laser light that appears on the target, and the second, with the laser diode off – Fig. 2. Making the difference between these two images we get, as a result, only the laser line projected on the people's torso, Fig. 2. If the object is far away the extracted laser line will be close to the top part of the image. In the opposite situation it will be more appropriate to the bottom part of the resulting image – h_1 versus h_2 in Fig. 1 or the depth information reflected in Fig. 2 (c).

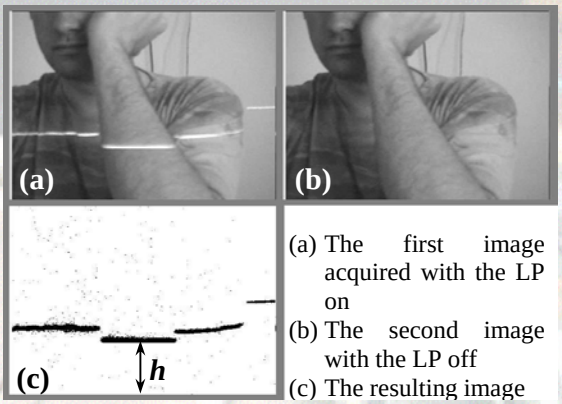

Fig. 2 The output for the video display subsystem

Further the information is processed and recognised by a system that can be a DSP (TMS320C6711) or a personal computer.

The main advantages of the system are:

- **the system is cheap**, due to the its simplicity, the working principle and the mature technology involved;
- **the system works in real time;**
- **the body movements and postures are determined without any physical contact** with the subject's body;
- the system **uses a new kind of information regarding the subject's emotional state, unexploited yet on HCI** (the emotional state of the subject is expressed through his/her body language);
- **the system flexibility** (without any major modification the bio-instrumental complex can be used in applications such as: subject emotional state identification, medicine, hand sign recognition, etc.)

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Make It Speak To Everybody 'Round You

After the extraction of the laser line a procedure is used to extract the time series.

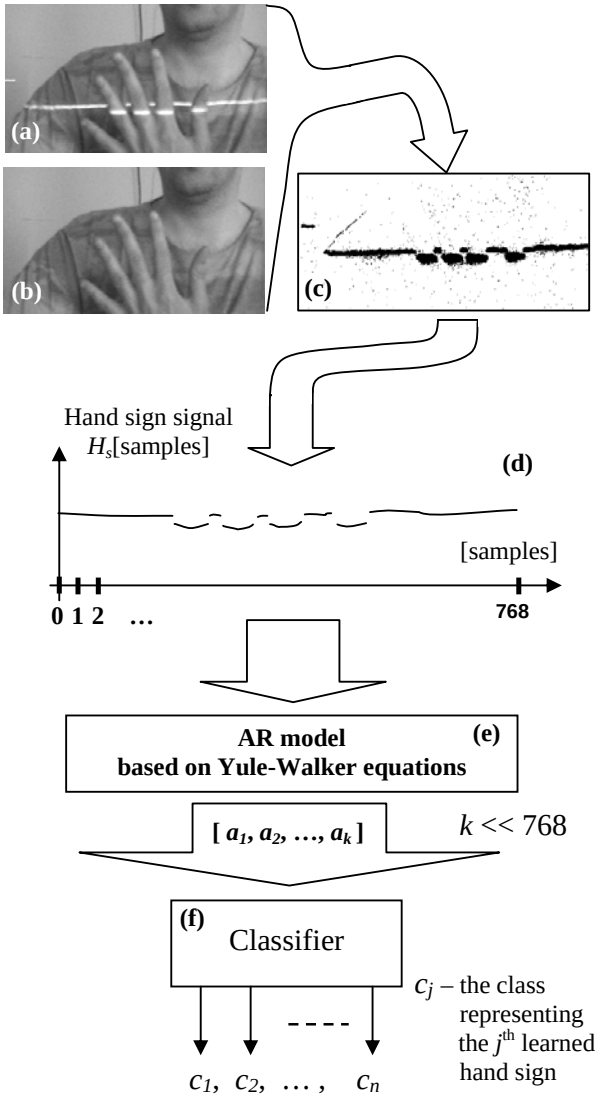

Fig. 3 The output for the video display subsystem

The laser trace signal ($H_s(t)$ resulted from the laser extraction algorithm) is modeled using the coefficients of an auto-regressive (AR) filter. The AR filter's coefficients (that can be determined with the Yule-Walker equations) are used to reduce the redundant input information passed to the classifier algorithm implemented on DSP. This Levinson-Durbin recursive algorithm is used to obtain the AR coefficients.

Finally, a MLP network was trained using backpropagation algorithm in order to classify the hand signs.

From the subject's body language to emotional state identification

The identification of some particular postures like the arm position in front of the torso, as in **Fig. 2**, or the torso position, as in **Fig. 4**, can be done based on the geometric extracted curve dimension, curvature and the final position of these laser segments in the final image. Each of these postures or body positions can be related with different internal subject states that can guide a system in order to improve the human computer interaction. For example, in **Fig. 2**, the subject posture can express boring if the subject keeps this posture for a long time.

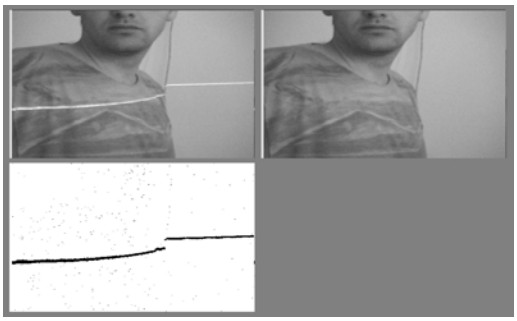

Fig. 4 A particular body posture

Evaluation/analysis of Parkinson patients

Nowadays the physicians use, in order to evaluate and assess the severity of the Parkinson disease, different rating scales. The most commonly used scale is the ***Unified Parkinson's Disease Rating Scale***. The most important disadvantage of the rating scales are generated by the lack of results reproducibility.

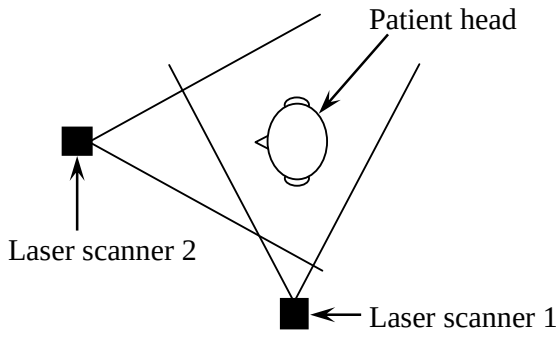

Fig. 5 The output for the video display subsystem

Up to this moment there is no kind of standard method (either qualitative or quantitative) to evaluate the Parkinson symptoms. Using two different laser scanner systems the trajectory or the head trajectory of the subject (like in Figure 8) can be recorded and easily quantified in order to assess the patient rehabilitation. In this mode, the proposed system is able to quantitatively evaluate the severity and the progress of the Parkinson's disease and to offer a reproducibility of the obtained results. Thus, all the above presented drawbacks are eliminated.