MOTOR ACTIVITY TELEMONITORING USING DSPIC MICROPROCESSORS

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INTRODUCTION

The present work is part to the inside of a national research project: the SIR-LOOK project, result of the collaboration between three Italian universities (Politecnico di Torino, Università di Roma Tre, Università di Genova). The aim of the present thesis it has been to build a start-up base for the realization of a wearable prototype, for monitoring the physical activity and elaborating in real time signals captured by accelerometer sensors, exploiting an innovative microcalculator: the dsPIC. The innovation of the proposed system resides, beyond the use of an innovative microcalculator, in the development of a new algorithm of identification of motor activies that takes into account the variability in the speed of execution of the gesture and in the elaboration of accelerometer signal in real time directly on the wearable unit, with subsequent wireless Bluetooth transmission of the resulting information. The possibility of elaborating data directly on wearable unit gives the great advantage of reducing the data that must be transmitted or stored on board.

MATERIALS AND METHODS

The signal is captured by a biaxial accelerometer (the ADXL203 product gives Analog Device) and elaborated by the dsPIC microcalculator, which converts the signal in digital form, to the sampling frequency of 100 samples/s, and directly elaborates it on the wearable unit. The results are sent to a PC for the visualization through a Bluetooth module (Stollmann BlueRS+E). The identification algorithm compares in real time a portion of accelerometer signal with the template of the motor activity through the calculation of the cross-correlation coefficients, if the value of the coefficient exceeds a threshold the motor activity is considered recognized. To recognize the motor activity, even if executed at different speeds, the signal was compared to three templates associated to different execution speeds. This technique uses of a number of duplications of the same template with different durations. Such duplications have been obtained warping through time the original template The application program for the dsPIC has been written using the MikroBasic for dsPIC compiler produced by MikroElektronika. It is worthwhile to emphasize the fact that the entire system can be reduced to very small dimensions (3x7 cm) using SMD technology.

RESULTS

The collection of results had as primary object the verification of the effectiveness of the developed identification algorithm and the abilities to elaboration of the dsPIC. The activity taken in consideration has been gait, because important from the quality of life point of view. Three templates have been used with a threshold of 0,8 on correlation coefficient for the gait recognition in the entire interval of variability (from 0,7s to 1,3s). The tests were conducted testing the device on two different participants using a standard template, Data (i.e: the trend of the cross-correlation coefficient) was transmitted with wireless Bluetooth technology. The result collected (see Figure) put in evidence the effectiveness and the robustness of the algorithm (95,8% considering also the transitions between different activities and 100% not considering such transitions) with respect to the identification of motor activities in real time considering variations in the speed of execution of the gesture. The dsPIC device demonstrated fast algorithm execution times: 6 ms (equal to the 60% of available time for the real time elaboration), and the memory occupation was 11% for the data memory (RAM) and 28% for the program memory (ROM). These results demonstrate that lowering the sampling frequency to 50 samples/s it is possible to use up to ten template for recognizing and distinguishing more daily motor activity.

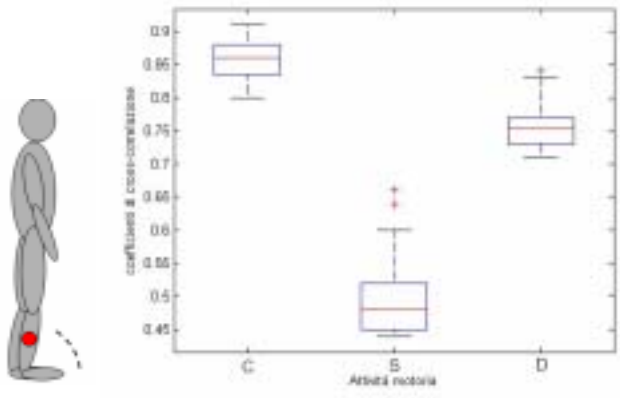

Figure: Signal positioning and distribution of the maximums of the cross-correlation coefficients in the three motor activities considered (C: walking, S: climb stairs, D: descending stairs).

CONCLUSION

The results demonstrated that the use of dsPIC microcontrollers in the motor activity telemonitoring is feasible. Thanks to their potentialities and the development of a new algorithm it was possible to obtain a wearable, low cost and not invasive prototype for the motor telemonitoring able to supply, in real time, information relative to the motor abilities useful for the diagnostic and therapeutic-rehabilitative field. In future it is worthwhile to explore the possibility of the introduction of a solid state memory (such like Secure Digital Cards) for storing data directly on the device obtaining thus a "motor holter".