WIRELESS SELF-ACQUISITION OF 12-LEAD ECG VIA ANDROID SMART PHONE

A collaboration involving *1*) NASA Johnson Space Center, Houston, TX;
2) Orbital Research, Inc, Cleveland, OH; *3*) TopCoder, Inc, Glastonbury, CT; and *4*) the NASA Tournament Lab, Cambridge, MA

Researchers at NASA's Johnson Space Center and at Orbital Research, Inc. (a NASA SBIR grant recipient) have recently developed a dry-electrode harness that allows for self-acquisition of resting 12-lead ECGs by minimally trained laypersons.[1] When used in conjunction with commercial wireless (e.g., Bluetooth™ or 802.11-enabled) 12-lead ECG devices and custom smart phone-based software, the collected 12-lead ECG data can also immediately be forwarded from any geographic location within cellular range to the user's physician(s) of choice. The system can also be used to immediately forward to central receiving stations 12-lead ECG data collected during space flight or during activities in any remote terrestrial location supported by an internet or cellular phone infrastructure. The main novel aspects of the system are first, the dry-electrode 12-lead ECG harness itself, and second, an accompanying Android™ smart phone-based wireless 12-lead ECG capability.

The ECG harness nominally employs dry electrodes manufactured by Orbital Research, Inc (see Figure, next page), recently cleared through the Food and Drug Administration (FDA). However, other dry electrodes that are not yet FDA cleared, for example those recently developed by Nanosonic, Inc as part of another NASA SBIR grant, can also be used. The various advantageous features of the harness include: *1*) laypersons can be quickly instructed on its correct use, remotely if necessary; *2*) all tangled "leadwire spaghetti" is eliminated, as is the common clinical problem of "leadwire reversal"[2]; *3*) all adhesives and disposables are also eliminated, the harness being fully reusable; if multiple individuals intend to use use the same harness, then standard antimicrobial wipes can be employed to sterilize the dry electrodes (and harness surface if needed) between users; *5*) padded cushions at the lateral sides of the torso function to press the left arm (LA) and right arm (RA) dry electrodes mounted on the cushions against sideward (as shown in the Figure) or downward-rested arms of the subject; *6*) sufficient distal placement of the arm electrodes achieves good electrode abutment to the arms without the need for adhesives, straps, bands, bracelets, or gloves; *7*) padding over the sternum avoids "tenting" in the V1 through V3 (and, when present, the V3R) electrode positions; *8*) easy-to-don, one-piece design with an adjustable, front-side single point of connection and an adjustable shoulder strap; and *9*) Lund or "modified Lund" placement of the dry electrodes, the results of which more effectively reproduce results from "standard" 12-lead ECG placements than do results from Mason-Likar placements.[3] The main limitation of the harness is that "one size does not fit all", meaning that an appropriately sized harness (small, medium, large, etc) must be chosen on the basis of an individual's size.

To facilitate the use of the harness with inexpensive, commodity-grade cell phones and tablet devices, 12-lead ECG software is also being developed to accompany the harness for wireless use with Android. For this part of the project, NASA has teamed with TopCoder, Inc and the Harvard-affiliated NASA Tournament Lab in sponsoring java-based software programming contests through TopCoder. While ECG signals from the harness can already be wirelessly received and thoroughly processed (locally or remotely) by commercial-grade conventional (as well as advanced[4]) 12-lead ECG software running on Microsoft Windows™, the Android-based software, once completed, will "cast a wider net" by allowing for a greater percentage of cell phone owners to participate in inexpensive, store-and-forward recordings of 12-lead ECGs worldwide, including for example Android cell phone users in many remote, third-world locations. At the time of writing (March, 2012), the Android 12-lead ECG software platform consists of a basic but expanding graphical user interface and accompanying software that: *1*) wirelessly receives the 12-lead ECG data stream from a Bluetooth-based, FDA-cleared 12-lead ECG device attached to the harness; *2*) locally stores the same data in binary format to the SD card on the Android cell phone; and *3*) makes the data stream in available in real time, for now to TopCoder's java programming contestants.

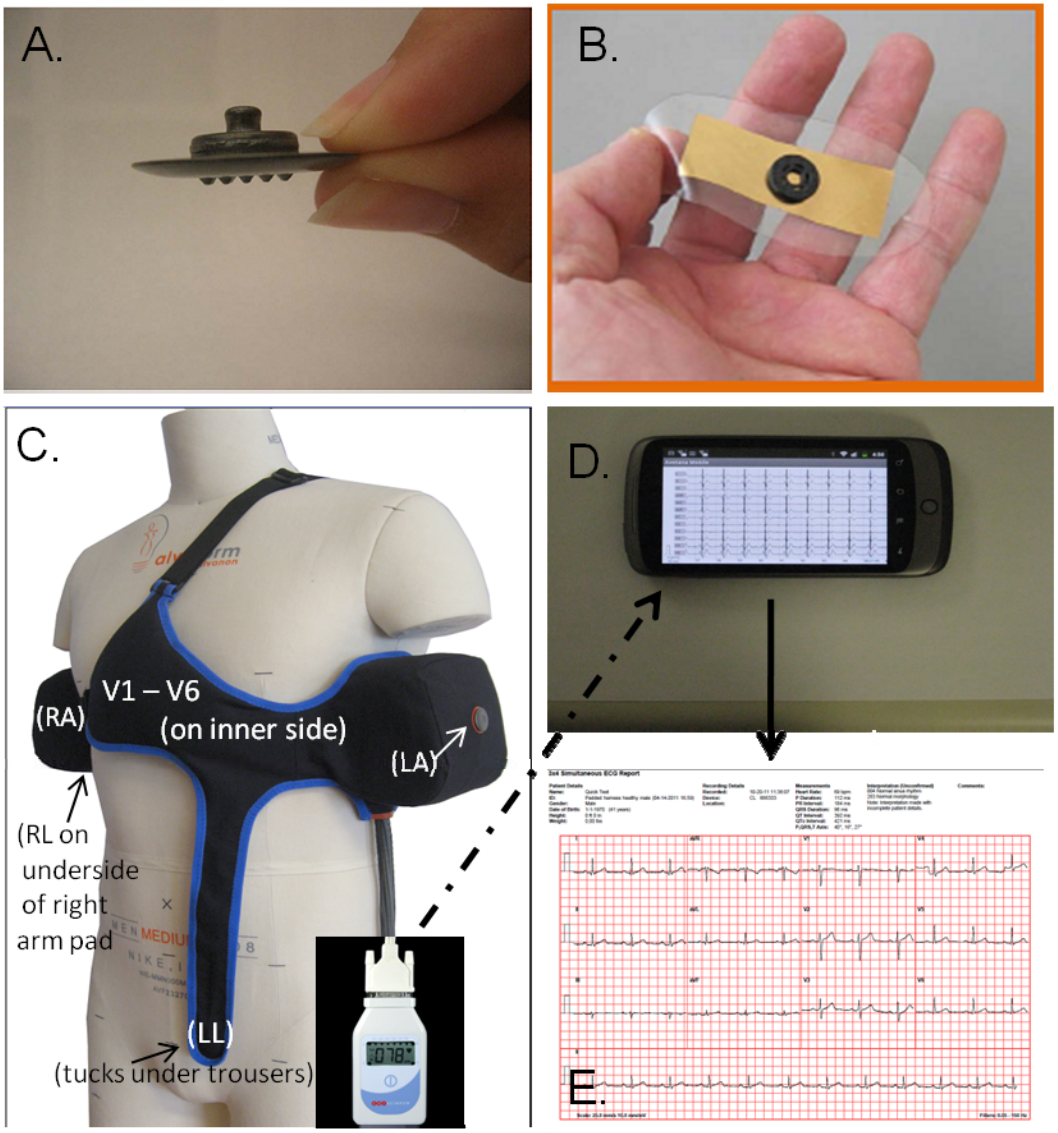

Figure. (A) Orbital's and (B) NanoSonics' dry electrodes as individual sensors, and (C) Orbital's electrodes as implemented in the harness, with wireless 12-lead ECG transmission (dotted arrow) to (D) Android phone and (E) final printout of 12-lead ECG obtained from harness. RA, RL, LA, LL: right arm, right leg, left arm, left leg.

REFERENCES

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