A Flexible, Wireless, Skin-wearable Device for Real-time Ambulatory ECG Monitoring

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Cardiovascular diseases being the leading cause of mortality in the US, create a prominent need for prolonged ambulatory electrocardiogram (ECG) monitoring. Therefore, this study has focused on developing a compact ambulatory ECG monitoring device that would be wireless, lightweight, flexible, low-profile, and user-comfort along with the high quality of ECG signals. To develop such a device, firstly, compact electrode positions on the chest were investigated for optimal readings of ECG lead I and II. Secondly, stretchable dry electrodes and a flexible circuit were microfabricated using ultrathin copper foils. Thirdly, the fabricated circuit and electrodes were integrated on a thin elastomeric membrane via materials transfer printing. Finally, human subject tests were performed using the developed ECG device. Our experiments showed the distance between two electrodes in a bipolar lead configuration can be reduced up to 3 cm for ECG lead I and lead II, respectively, to achieve the compact design of the device. In addition, the flexibility of the device was presented using cylinders with different radii of curvatures. Also, the assembled fabricated device was laminated and delaminated with the skin without the use of adhesives and gels to ensure user comfort. The accuracy and quality of ECG signals acquired from human subjects during different activities like resting, walking and jogging showed potential of the device for ambulatory monitoring. The collected data were also able to provide HRV analysis. Overall, the key aspects of this device being soft, flexible, and conformal allow user comfortable ambulatory ECG monitoring in real-time effortlessly.