Enabling Population-Scale Physical Activity Measurement on Common Mobile Phones

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The primary aim of this U01 project is the technical development, deployment, and evaluation of hardware and software technology that will enable population-scale, longitudinal measurement of physical activity using common mobile phones. Mobile phones available in Asia and soon in the U.S. already include internal accelerometers and low-power wireless communication capabilities. This study will investigate how to use these computing devices for accurate measurement of physical activity intensity and type. By exploiting consumer expenditures on phones that many Americans will purchase, maintain, and carry, it may be possible to run large-scale studies where the physical activity of several hundred thousand participants is measured and remotely monitored for months or years at an affordable cost. Wireless accelerometers designed at MIT will be redesigned so that they can send data to common mobile phones available in 2010. Laboratory testing using the current version of the sensors will be used to compare the relative information gain that can be obtained by combining the phone accelerometer data and data obtained by wearing one or more wireless sensors on different convenient body locations (e.g., in a watch, shoe, pocket, necklace, etc.). Optimal but practical configurations of accelerometers will be determined so that software running on the mobile phone can automatically detect specific physical activities such as brisk walking, running, cycling, climbing stairs, etc. Technical challenges that will be addressed by the sensor and software design include: 1) obtaining practical battery life; 2) acquiring physical activity data at high temporal resolution; 3) enabling person-specific customization of the detection algorithms; 4) addressing practical end-user concerns about ergonomics, comfort, and social acceptability; 5) permitting real-time and low-cost remote monitoring and maintenance for studies with hundreds of thousands of phone users; and 4) enabling use of other off-the-shelf sensor devices such as heart rate monitors as they become available. A participatory design process will be employed to develop strategies for obtaining longitudinal compliance from typical phone users. After two rounds of iterative technical development, each with laboratory validation of the sensors conducted at Stanford, the technology will be deployed with fifty typical phone users for 10 months. Validity relative to self report, acceptability, and longitudinal compliance will be measured. In the first year of this project, we are also working on the technical development and pilot testing of a flexible and extensible software platform that permits researchers to conduct ecological momentary assessment (EMA) studies using mobile phones. We are creating open-source, phone-based EMA software that will be tested by creating instruments for momentary assessment of psychosocial stress and substance exposure.