Technology Optimized Scavenging of Energy from Exercise Machines

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This paper seeks to guide scavenging of green energy from exercise machines by redesigning current exercise machines and deploying in populous environments. The machines incorporate Exercise Feedback Systems and Mobile Fitness Applications. The harnessed energy can be used directly e.g. to pump water for use in nearby communities or be transmitted to the national grid.

Keywords: Green Energy, Energy Scavenging, Exercise Machine,

Introduction

Innovative integration of Information and Communication Technologies (ICTs) holds the key to sustainable adoption and adherence to a lifestyle of exercise (Zickuhr, 2013). A lifestyle of exercise is not only beneficial through burning calories and building of muscles, but also has the potential of generating free and green energy. Heavy use of exercise machines in highly populated areas can empower the local community economically (Gibson 2011). The energy can be used to meet needs of the community such as lighting of markets and pumping water closer to the people among others. Institutions with large populations such as universities can tap into this opportunity of energy scavenging given the populations they hold (Gibson 2011). They are capable of drawing thousands of students, staff and locals onto exercise machines to generate heavy movement that translates to kinetic energy for scavenging. At home, the scavenged green energy from exercise machines can run pumps, irrigate gardens, and provide lighting among other uses. The green energy scavenged consequently reduces carbon emission if alternative energy were environment-unfriendly.

This paper aims to optimize energy scavenging from exercise machines by redesigning current exercise machines to incorporate Exercise Feedback Systems and Mobile Fitness Applications.

Methodology

Desktop review and survey designs were adopted. Primary data was also collected around universities that lie in the headquarters of the six counties in the larger Nyanza region in Kenya namely; Kisumu County, Siaya County, Homabay County, Migori County, Kisii County and Nyamira County. Physical exercise facilities were purposively picked in those counties and characteristics of the exercise equipment assessed. Suppliers of gym equipment were followed up for information on the state of the art with respect to exercise equipment in the context of energy scavenging. Users of exercise equipment were drawn from across different segments of society (age, level of expertise, socioeconomic status). Mobile technologies and other Information and Communication Technologies relevant to the proposed multi-equipment exercise unit, Exercise Feedback System and corresponding Fitness Mobile Application were interrogated. The data collection exercise was done throughout a period of six months given the iterative nature of the model chosen for system design and development (spiral model) of the specialized ICT compliant exercise machines, exercise feedback system and self-tracking mobile application. A feasibility study was undertaken to ascertain technical practicability of the special multi-equipment exercise unit, Exercise Feedback System and Fitness Mobile Application by determining the technology and skills necessary. Economic practicability was ascertained too by assessing performance, information and outputs from the system as justified by cost and benefit. Social practicability and operational practicability too was ascertained. Functional and nonfunctional requirements were defined, analyzed and specified for the multi-equipment exercise unit, Exercise Feedback System and Fitness Mobile Application. The functional requirements include: separation, integration, event management, user management, hardware abstraction, device management. Administrator module (create, update, manage, and delete users), User module (login, update profile, manage account, create an exercise plan). Nonfunctional requirements include usability (graphical user interface with uniform look, using icons and tools bars), accessibility, reliability and availability, performance, and security. The spiral model used in the design and development combines the idea of iterative development with the systematic, controlled aspects of the waterfall model. It allowed incremental releases of the product or incremental refinement through each iteration around the spiral.

Literature Review

Literature was reviewed and compiled as below.

Optimization of Exercise Machines for Green Energy Scavenging

Currently, a number of exercise machines have already been integrated with a small generator that provides power to the machine's monitoring console, and to increase the resistance the user feels when exercising (Gibson 2011). There is however extra energy that would be wasted, which, can be converted to AC. All the exercise machines can be hooked up to a central unit that can then provide the energy for other use or connect to the grid. When a user pedals, the batteries charge and when the charge is full, the inverter sends power to the grid, converting 24V DC to 110V AC (Gibson 2011). Aerobic gym machines, elliptical trainers, steppers, and stationary bikes can all be converted so that when used, electrical energy is generated (Gibson 2011). Some companies are creating their own exercise machines that are specially designed to optimize energy scavenging, and some of the machines can be linked together so that the scavenged energy comes out as one collective source. An example is a typical stationary bike piece that also combines an arm workout portion to increase the amount of energy and workout (Gibson 2011). Averagely, a professional cyclist can produce more than 400 watts, more than half a horsepower, for an hour or more at a stretch (Gibson 2011). An average person is capable of generating 50 watts to 150 watts during an hour of strenuous exercise (Gibson 2011). Half an hour workout on an elliptical cross-trainer generates around 50 Watts of power, which is enough to power a bulb for two and a half hours, to charge a cell phone about six times, to support a laptop for one hour, or a desktop computer for half an hour (Meinhold 2010).

Economic Impact of Green Energy Scavenged from Special Exercise Machines

While not a significant amount, this is capturing energy potential that already exists every day in gyms around the world. With thousands of movement on exercise machines, the amount of energy is not insignificant (Gibson 2011). For one gym facility only, say an average piece of exercise equipment is in use 5 hours a day, 365 days a year. If each person generates 100 watts while using it, the machine creates around 183 kilowatt-hours of electricity a year. Commercial power costs about 13 shillings per kilowatt-hour on average in Kenya, so the electricity produced in a year from one machine is worth about 2,379 shillings (Gibson 2011). Certainly, the cost-savings and kilowatt-hours of electricity generated depends on the hours the gym equipment is in use and how the machine has been designed to optimize on energy scavenging. If one piece of equipment was in use, say, even only 10 hours a day on average, it would generate 366 kilowatt-hours of electricity. Multiply this times the number of pieces of equipment, and the amounts of energy and cost-savings increase.

Environmental Impact of Green Energy Scavenged from Special Exercise Machines

In another perspective, 183 kilowatt-hours of electricity for the whole year is the equivalent of several carbon dioxide emissions. That's the fuel tank capacity of a 2013 Volkswagen Jetta sedan (Gibson 2011). Again, isolating one machine doesn't create a huge environmental incentive, but on a larger scale and with an educational component qualitatively added, the power of the transition to energy generating equipment increases. The "green gym facility" aspect is in itself a way of marketing or way of appealing to the global community on the call to be environment friendly. The same could be said in terms of drawing in more students to attend an institution or university where efforts to stay healthy and fit also reduce the carbon emissions of the campus, even if it's a small amount. Many people who hear about energy generating equipment have no idea how much energy is actually created, so for the purposes of marketing a "green gym facility" there is some possibility of this being viable in some way. Harnessing the energy generated by gym equipment that will be used either way can provide a significant amount of watts that can offset the amount of fossil-fuel-sourced energy used. The same kind of concerns over economic incentives occurred with the introduction of compact fluorescent light bulbs and wind and solar energy (Gibson 2011). Over time as energy-generated gym machines become more widespread, the technology will likely become less expensive and perhaps will become the expectation in gyms everywhere. The potential also exists to be generating electricity; it just needs a little more money to change the equipment, and then the scavenged energy can be added to the grid. For educational reasons it is the best way to inculcate people on the value of energy conservation and the use of green energy. Placing alternative energy generation at the front of people's minds each time they hop on a machine inevitably will lead them to consider these issues and could potentially lead to some innovative ideas about environmental conservation. The educational experience for people using their energy generating gym is more important than the cost savings or actual energy generated (Barnard 2009). Simply understanding that unit of measurement and the energy required to produce it encourages people to engage in broader issues of conservation and renewable energy production" (Lewiston 2010). With these proposed innovative steps of redesigning exercise machines and integrating ICTs to grow adoption and adherence to exercise for energy scavenging, funding is needed. And this concept note serves the purpose of articulating the importance of the funding.

ICT integration for Better Adoption and Adherence to Exercise

Results comparing technologies showed that self-tracking with a mobile devices led to improved adherence than traditional methods (Burke, Conroy, et al., 2011). Also, using a software system to for self-tracking led to more adherence in weight self-tracking than use of memory (Gokee-Larose et al., 2009). Technology therefore improves self-tracking in exercise adherence (Burke, Conroy, et al., 2011; Khaylis, Yiaslas, Bergstrom, & GoreFelton, 2010). With advancement of mobile technologies, self-tracking is bound to improve even more. The worldwide use of mobile phones stands at more than 90% (Zickuhr, 2013), this offers more advantages for tracking exercise lifestyle. Computational capabilities (Anderson & Raine, 2014), sensors i.e. context awareness features (Klasnja & Pratt, 2012), and attachment to mobile phones by people (Klasnja & Pratt, 2012; Ventä, Isomursu, Ahtinen, & Ramiah, 2008) now make mobile devices better in self-tracking than computers. Also, mobile devices can capture information in real time that can be contextually and ecologically focused, creating rich data based on an individual's natural environment and experiences (Gasser et al., 2006; Klasnja & Pratt, 2012; Patrick, Griswold, Raab, & Intille, 2008). Lastly, mobile devices are better at reporting behaviors and measures, leading to decreasing recall bias in self-reporting as well as participant burden (Tsai et al., 2007). Although data is limited (for a review, see Buhi et al., 2013), various uses of mobile devices for self-tracking have shown positive results. A mobile application prototype before smartphones was found to lead to better and regular self-tracking than a diary (Tsai et al., 2007). Also, mobile applications were found to lead to more frequent self-monitoring and higher intention to exercise (Hurling et al., 2007; Turner-McGrievy et al., 2013). Findings about tracking mode don't seem to be exhaustive (Turner-McGrievy et al., 2013), except for the case of mobile tracking (Buhi et al., 2013). Much of the research comparing different tracking modes had other components in the study that were easily confounded with tracking mode, such as external rewards (Gokee-Larose et al., 2009) or social support (Hurling et al., 2007), making it difficult to know whether the effect was due to mobile tracking mode per se or due to other factors.

Outputs of the Study

The output of the research include;

1. An Exercise Feedback System for adherence to exercise by users of exercise machines
2. A Self-tracking Mobile Fitness Application for adherence to exercise by users of exercise machines
3. A special multi-equipment exercise unit optimized for green energy scavenging that integrates an Exercise Feedback System and a Mobile Fitness Application
4. A comprehensive review report of the energy needs of the local communities around the areas of study that can be fulfilled by the scavenged energy
5. An energy conversion and transmission system to interface special multi-equipment exercise machine and energy outlet.
6. A framework for the optimization of scavenging and use of energy from the special multi-equipment exercise unit

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