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Emory Sleep Patient Monitoring

Introduction

In the modern medical world, there are endless non-fatal conditions in which research is being underfunded or overlooked. Restless Leg Syndrome (RLS), also known as Willis-Ekbom Disease is a disease which affects sensorimotor characteristics of the patient's neurons. RLS inflicts the urge to repeatedly move or even kick one's legs even while the body is at rest. [1] With approximately ten percent of adult Americans suffering from RLS, there have been studies that show that RLS can be, many times, the symptom of another serious condition (ie. Iron deficiency, Parkinson's disease, pregnancy, kidney failure, etc). [2] With the high rate of occurrence, and ranging levels of severity, a sleep monitoring device is in design process. This paper will review the current technologies being used to monitor a patient's sleep patterns as well as current technologies to adopt in the implementation of a streamline, accurate monitoring device.

Analysis of Low Power Controls and Battery Management

FitBit is one of the most popular wearable sleep monitoring systems. With the typical bracelet battery lasting up to five days, the company has managed to allow the device to effectively "turn off" while there are no measurements being recorded. [3] However, whilst asleep, the sleep monitor must be able to wake up quickly enough to record a sudden kick or movement by a patient in order to prolong the battery life of the device. When investigating how to allow for a low power mode, the battery within the device should be considered as a single resistor between the power source and the end terminal. The obvious solution would be to add a large capacitor across the drop, however, capacitors will have a continuous leakage even throughout a low power "sleep" mode. Power and clocking speed do not follow a linear relationship. By adjusting the clocking speed, a balance between speed and power savings can be determined and utilized. [4] With only a periodic export of data required, the lack of constant Bluetooth interactions also allows for a slower clock speed and less power consumption.

Implementation of Low Power Controls and Battery Management

The power dissipation associated with the device, is directly related to the switching frequency as well as the capacitance rating. [5] If a multi-cell battery design is utilized, the batteries should be connected in series as well as in parallel in order to ensure that all battery cells will reach their maximum charge at relatively the same time. A bypass FET with paired with a resistor (current limiting) will slow the charging of the closest cells. [6] Since the temperature of the pack will not be changing drastically (attached to the patient's ankle), external temperature concerns causing capacitance leakage can be effectively ignored. By reducing the voltage running through the system, the current in turn will reduce. However, since power (and thus voltage and current) and the clocking cycle do not follow a linear relation, if the clocking cycle is not adjusted accordingly, the microcontroller within the ankle monitoring box may begin to behave undesirably. Reduction of the clock speed can help to reduce the current required by the device by several milliamps. [7] That being said, there is a threshold that needs to be met in order to keep the system alive. Analog to digital converters can be disabled in order to allow for a minimized power consumption as long as the threshold is previously established. Once this threshold is established, the capability of the device to awaken and go back to sleep almost instantly becomes a reality.