

Internet of Things

Developing an optimal wireless power transfer
system for a real-world low power LED wristband
application

MUHAMMAD WASIF

IMARA SPEEK

Delft University of Technology

October 28, 2013

Abstract

Keywords: Wireless power transfer, low power, real-world application

1 Introduction

introduction

2 Related work

related

3 Prior knowledge

prior

4 Description of the proposed idea

decription idea

4.1 Working towards a realization

Our major goal is to provide with an efficient solution that meets the challenges in battery charging systems using wireless power transfer the best. Those challenges include:

1. Charging the battery as quickly as possible. Though batteries can store a large amount of charge, there is a limit to how fast a battery can be charged. This limit gets smaller with the size, or capacity of the battery. If the battery is smaller, the charging current limit will also be smaller. Exceeding this limit will deteriorate the battery's life. To overcome this difficulty we propose adding a super capacitor in parallel with the battery. Super capacitors are known to hold a less amount of charge than same sized batteries, but they are capable of charging much faster[3].
2. Providing a longer battery life with a large charge-to-discharge ratio. In our scenario we want to make the charging interval as small as possible which requires a need to store as much charging current as possible in a short interval. That makes the addition of a super capacitor an ideal solution to overcome the battery charging limitation. During the charging interval, a super capacitor can store a large amount of charging current. This current can be used to charge the battery with a slow pace. This provides a long battery life in terms of a large charge-to-discharge ratio.
3. Working out an efficient protocol for sharing the available charge.

4.2 Protocols concerning environmental impact features

The major goal of this report is to be able to develop a real-world application. In order to do this, all real-world implications need to be taken into consideration. Scenario's were developed to develop a charging protocol that accounts for all possible states. For these scenarios a user wearing a tranceiver wristband is considered. Other viewpoints for a scenario can be the user wearing a receiving wristband or the transmitting bar. However, these viewpoints are considerably easier to address and will implements parts of the protocol designed for a tranceiving system.

There are certain states in which the system can reside depending on its own battery state, the battery state of neighbour nodes and the availability of a charging bar. These states and their transmissions are displayer in figure 1. It can either be sufficiently full defined as V_{full} , starving defined as V_{starve} or dead which is defined by V_{dead} . These parameters are further specified in section 5.

A charging protocol has to be designed to account for these combinations. We considered three possibilities: an infinite network like design, a hop-to-hop

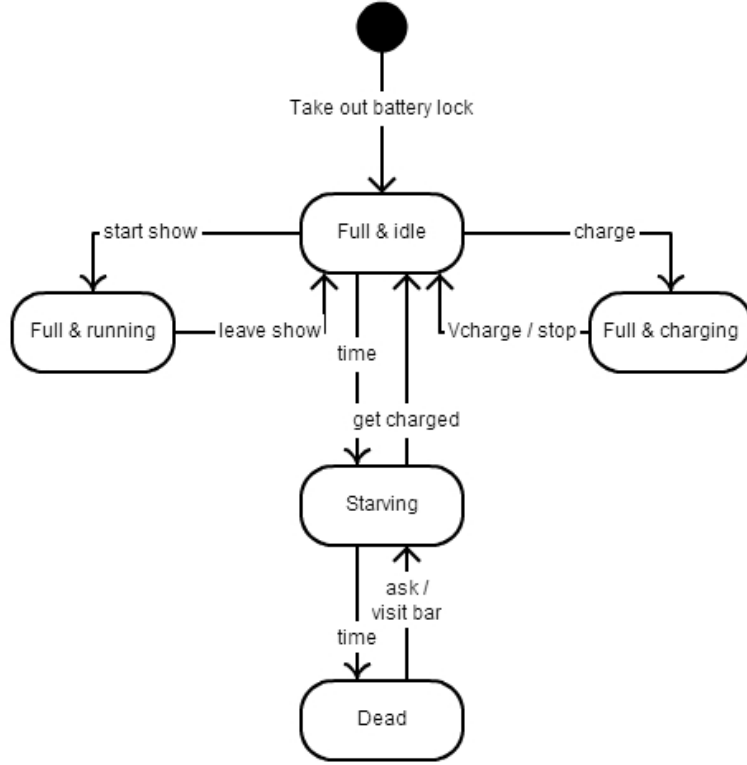


Figure 1: State diagram of a transceiving wireless power transfer system

spread of energy or an interactive behavior to selectively share energy. To stimulate interaction through this application we choose to apply a scenario where a user can choose to act upon energy requests and share with friends, or strangers.

To handle these protocols, an IC has to be added. This way whenever the battery reached V_{starve} it will send out a request for energy visually by lighting a red LED embedded in the wristband. Neighbouring nodes can then choose to react on this or save their own energy. Whenever the battery dies, the user either has to verbally ask for energy or visit an energy bar.

5 The proposed system design

The Figure The transmitter is powered up by a voltage source V_i of 12 Volts capable of delivering 400 milli-Amps of i_{in} current. i_c is the constant current that is consumed by the transmitter circuitry and i_s is the induction current which flows through the transmitter coil such that $i_{in} = i_c + i_s$. i_c is constant and depends on the transmitter inner circuitry power consumption, in our case $i_c = 100\text{milli} - \text{Amps}$. i_s depends on the distance between the

two magnetically coupled coils, greater the distance smaller the i_s will be. Another factor that i_s could depend is on adding an iron core between the two coils, adding a core makes the magnetic coupling stronger and increases the i_s which enhances an overall efficiency of the system. The receiver circuit receives an induction voltage V_r , rectifies it through a rectifier containing a shotkey diode D_r and a capacitor C_r . A shotkey diode is used in order to have a good frequency response at the range of $300 - 400Khz$ the transmitter working frequency also shotkey has lower forward voltage drop. The rectified voltage is then fed to the voltage regulator that produces constant voltage $V_{reg} = 5Volts$.

5.1 Analysis of the system design

The Figure shows a low level schematic of the receiver and charging circuit which will be the main focus of our project. The induction current i_r induced by the transmitter through magnetic coupling will be the main source of charging current. The current i_c charges the super capacitor, i_b charges the battery and i_L is consumed by the load including resistor R_L and a light source. During the charge cycle $i_r = i_c + i_b + i_L$. Now in analysis lets first consider the efficiency η of the circuit. If P_o is the power consumed by the receiver and P_i is the power provided by the transmitter, ignoring small power drops across D_r and C_r then:

$$\eta = \frac{P_o}{P_i} \quad (1)$$

where $P_o = V_{reg} \times i_r$ and $P_i = V_i \times i_s$

5.2 The internet of things

The assignment of this report conveyed critizing and accessing system-level Internet of Things components in scientific literature. Because the assigned paper [4] did not include anything IoT related, we will present our own idea. In this section we will provide a short introduction to the Internet of Things and its key features, we will also present our idea and focus on the practicality and entrepreneurial aspect of the idea.

The Internet of Things refers to uniquely identitfiable objects, or things, and their virtual representations in an Internet-like structure. [5]. The intelligent application is the key feature here. Important aspects to be taken into consideration when designing such systems are security, privacy and scalability.

The anatomy of Internet of Things is initiated by a certain event, that is detected and logged by devices that include self-properties [5]. This data is then uploaded by a ubiquitous and interoperable network. The unique feature of the internet of things is that this system is smart and can generate

knowledge and by analyzing this data and understands the system. Certain events are then triggered and reported as response. The intelligence of these systems lie in the adapting mechanisms that analyse and understand the environment in order to deal with the complex dynamics of a real-world environment.

Internet of Things has already been employed at multiple festivals and initially used as a ticketing solution in 2004 at the SXSW festival in Austin. It emerged in the form of wristbands and cut down significantly on gate crashing and lost tickets [7]. SXSW announced that each tag contained a unique ID code, correlated with personal information available by SXSW [6]. It has further been introduced at Coachella and Bonnaroo. [1] [2] RFID now even support cashless payments and integration with social networks, allowing people to upload pictures to facebook via the so-called "Live Click Stations"[7]. We can conclude that it safe to say that the Internet of Things hasn't reached its peak yet concerning festival and concerts.

Because our scenario already portrays users wearing a wristband throughout the festival containing the discussed electronics, we can add some small features to play into current trends concerning Internet of Things and music festivals. By adding a RFID tag into each wristband, users are assigned unique IDs. These tags can be applied fairly easy and can obviously contain functionality such as a unique entrance ID or even cashless payments. In this report however, we want to focus on the fun factor of connecting with friends and strangers. Users can prior to arriving at the festival use their unique ID and optionally link it to all the accounts of their friends are the accompanying social media. When the users enter the festival site and receive their wristbands, these are connected to their unique id priorly received. Whenever they charge their wristband, either at the bar or at check in points near every site of interest, their friends that are not near them will receive a message containing their location and if made, an image at the check-in location. Based on certain check-in's at time in the schedule of the festival, the system can recognize their interests (if not already mentioned in their id page online) and even give them recommendations to go next to. The sequence of this Internet of things can be seen in figure 2.

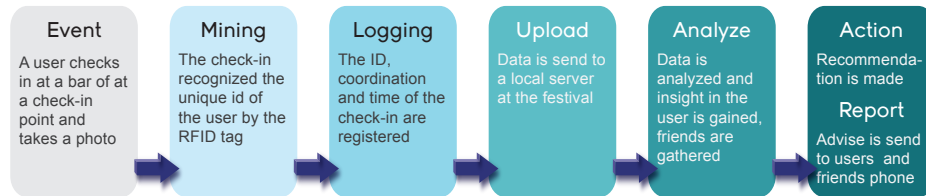


Figure 2: Internet of things chain of actions

Our system goes beyond simply assigning a unique id to a user, it also adds functionality and connects ids to exchange information. In this manner, it mines the data when users check in at charging points where they can even choose to make a picture. These check-ins are logged and sent to a server, where the user's ID is processed and connected IDs of friends are notified. The system can then analyze the data and generate knowledge by searching for common factors of interest. Based on this intelligence, the system can in turn return some recommendations back to the user. This doesn't just improve the experience of the user, but it gives the organization a better insight into the behavior of their visitors.

6 Results

results

7 Conclusion

conclusion

References

- [1]
- [2]
- [3] ref still.
- [4] J. Pineda de Gyvez A. Kapoor. Architectural analysis for wirelessly powered computing platforms. *IEEE Transactions on very large scale integration (VLSI) systems*.
- [5] Ringo Doe. This is a test entry of type @ONLINE, June 2009.
- [6] SXSW. SXSW RFID Policy. <http://sxsw.com/rfid-policy>.
- [7] A. Zauner. On Tour With RFID. <http://rfid.thingmagic.com/rfid-blog/?Tag=RFID%20Wristbands>, August 2012.