Particle-Filtering-Based Prognostics for the State of Maximum Power Available in Lithium-Ion Batteries at Electromobility Applications

Por: Diaz, C (Diaz, Cesar)[1]; Quintero, V (Quintero, Vanessa)[2]; Perez, A (Perez, Aratnis)[3]; Jaramillo, F (Jaramillo, Francisco)[1]; Burgos-Mellado, C (Burgos-Mellado, Claudio)[4]; Rozas, H (Rozas, Heraldo)[1]; Orchard, ME (Orchard, Marcos E.)[1]; Saez, D (Saez, Doris)[1,5]; Cardenas, R (Cardenas, Roberto)[1]

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Abstract

Nowadays, electric vehicles such as cars and bicycles are increasing their popularity due to the rising environmental consciousness. The autonomy required by these means of transport has marked a significant and steady growth in the development of battery technologies. In this sense, it is crucial to estimate and prognosticate critical parameters of battery packs such as the State of Charge (SOC), the State of Maximum Power Available (SoMPA), and the Failure Time. All these indicators are relevant to determine if both the energy stored in the battery of electric vehicles and power specifications are sufficient to successfully complete a required route, avoiding battery preventive disconnection before arrival. In this regard, this paper presents a novel approach to estimate and prognosticate the SOC and SoMPA of Lithium-Ion batteries in the context of electromobility applications. The proposed method uses the formulation of an optimization problem to find an analytical relationship between the SOC and the SoMPA; whereas the battery pack is modeled in terms of both the polarization resistance and the SOC. Particle filtering algorithms are used to compute online estimates and prognostic results, while the characterization of the usage profile of the battery bank is achieved using probability-based models (Markov chains). The problem of battery monitoring for an electric bicycle is used as a case study to validate the proposed scheme, when driven in flat and sloped routes to generate different usage profiles. It is demonstrated that the proposed methodology allows to successfully prognosticate both SOC and SoMPA when the future discharge current profile is characterized in terms of probability-based models.

Palabras clave

Palabras clave de autor: Batteries; State of charge; Estimation; Integrated circuit modeling; Prognostics and health management; Adaptation models; Bicycles; SOC prognostics; SoMPA prognostics; Lithium-Ion batteries; Particle filtering; Markov chains; Electromobility

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Información del autor

Dirección para petición de copias:
Universidad de Chile Univ Chile, Dept Elect Engn, Santiago 8370451, Chile.
Dirección correspondiente: Orchard, ME (corresponding author)

+ Univ Chile, Dept Elect Engn, Santiago 8370451, Chile.

Direcciones:

+ [1] Univ Chile, Dept Elect Engn, Santiago 8370451, Chile
+ [2] Univ Tecnol Panama, Fac Elect Engn, Panama City 081907289, Panama
+ [3] Univ Costa Rica, Sch Elect Engn, San Jose 115012060, Costa Rica
+ [4] Univ Nottingham, PEMC Grp, Nottingham NG7 2RD, England
  [5] Inst Sistemas Complejos Ingn ISCI, Santiago 8370397, Chile

Direcciones de correo electrónico:cesardiaz@ug.uchile.cl; vanessa.quintero1@utp.ac.pa; aramis.perez@ucr.ac.cr; francisco.jaramillo@ing.uchile.cl; claudio.burgosmellado1@nottingham.ac.uk; heraldo.rozas@ing.uchile.cl; morchard@u.uchile.cl; dsaez@ing.uchile.cl; rcardenas@ing.uchile.cl

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