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Research Proposal for Master’s Thesis Project / Research Project / Survey for Doctoral Research Plan

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| **Intended Degree** | | **Master of Science** | | | | |
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| Type of Major Research | | ✓ Master’s Thesis Project  □ Research Project  □ Survey for Doctoral Research Plan (Qualifying Examination) | | | | |
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| **Student Name** | NGUYỄN VĂN QUANG | | | **Program** | ✓ ICT  □ QCF | |
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| Supervisor | QUAN THANH THO | | **Signature** | **Second Supervisor** |  | **Signature** |
| □ Advisor for Minor Research Project  □ Advisor for Internship | | | | |  | **Signature** |
|  | | | | | | |
| Title | | | | | | |
| ONLINE CAPACITY ESTIMATION OF LITHIUM-ION USING DATA-DRIVEN METHODS | | | | | | |
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| Background | | | | | | |
| *Refer to the preceding works and specify their significance as well as their problems.*  Lithium Ion Battery (LIB) is a type of rechargeable battery commonly manufactured in the market. During the charging process, the positive ions (Li+) move from cathode to anode and vice versa in the discharging process (using time) to create the current. LIB is mostly used for mobile devices, especially lightweight wearables. However, it has sometimes been used for big moving objects such as cars, drones, unmanned aerial vehicles, etc.  LIB research topics are classified into these two kinds: electrochemical and equivalent circuit model. The electrochemical class use finite element analysis or derivative equations and usually have problem of computation complexity [6]. On the other hand, the equivalent circuit models are parameterised, alternated and can be used during a long time. Besides, the 2000-2012 era have recorded many researches lead acid battery to the advanced finite element of LIBs [7]. The finite element software uses physical models to analyze the deep understanding of physical-chemistry of cell level of LIBs have also been found. Those of intelligent methods, Neural Network, genetic algorithm … have been used to solve the capacity estimation for LIBs. | | | | | | |
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| Objectives | | | | | | |
| *State your research goal to be achieved.*  The main obstacle is the accuracy of measurement devices, and the cost to be spent in controlling different options. Besides, the system also asked for deep knowledge of physical and mechanical competence. Therefore, models based on AI-DL have more attention recently because:   * The deep knowledge of LIB hardware related is not required * Sensors, high bandwidth, big data technologies enable the data collection efficiently; creating good inputs for the models. Some of big-data sources are Nasa [1], Oxford [2], Center for Advanced Life Cycle Engineering (CALCE) [3] or Sandia National Labs [4] and 124-cells of [5]. * In these methods, the [8] had proposed a method with high quality result. However, the shortcoming of the methods includes the contribution of full capability to analyze dependency of large volume of data and poorly extract characteristic features). We will introduce the approach and create the solution proposal in the following sections. | | | | | | |
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| Originality/Significance | | | | | | |
| *Master’s Thesis and Survey for Doctoral Research Plan*  *State the followings clearly:*  *1. What do you intend to add on the previous works?*  *2. How this research will have broader societal benefits?*  *Research Project*  *State the uniqueness of your proposal.*  The mentioned traditional DL methods created quite accurate results. Still, limitation and still be seen based on the following observation. Firstly, the big source of data had not been utilized fully. Secondly, the feature extraction manually relied on people and the LIBs understanding. It should be very challenging to define the features carrying correct information of the specific problems, i.e capacity information in our case. Finally, the extraction are different because of the application variety [9]. | | | | | | |
| Methodology and Evaluation | | | | | | |
| *State the followings clearly:*  *1. Mention your intended machine environment, programming language, algorithm, proof method, and so on.*  *2. How do you evaluate/verify/justify your results?*  The studies of AI-DL on LIBs information have been highly considered from us by either academic and industrial perspective. Moreover, we will inherit the foundation of data-driven and big-data on deep learning of the existing research, aiming to create difference and more powerful results. Our input could be some of these sources:   * NASA [1], * Oxford [2], * (CALCE) [3] or Sandia National Labs [4] and 124-cells of [5]   We process the big data and train the model based on these sources. Later on, we estimate multivariate output of capacity, temperature, fading capacity … from them. Data of outputs will be analyzed to optimize the model and verify our methods, comparing with the existing studies. | | | | | | |
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| Research Plan | | | | | | |
| *State your research plan with the supposed milestones.*   |  |  |  | | --- | --- | --- | | Time | Description | Output | | March-April 2020 | Literature review | Proposal document | | May- August 2020 | Experiment and writing thesis | Thesis papers | | | | | | | |
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| Submission Requirements for Research Proposal | | | | | | |
| ① Successfully accumulate all **required** courses. | | | | | | |
| ② The research plan should have sufficient contents | | | | | | |

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| Reference: |
| [1] B. Bole, Chetan S. Kulkarni, Matthew Daigle, Adaptation of an Electrochemistry- based Li-ion Battery Model to Account for Deterioration Observed Under Randomized Use, SGT, Inc. Moffett Field United States, 2014.  [2] R. R. Richardson, Christoph R. Birkl, Michael A. Osborne, David A. Howey, Gaussian process regression for in situ capacity estimation of lithium-ion batteries, IEEE Trans. Ind. Inform. 15 (1) (2018) 127–138.  [3] CALCE Battery Research Group. (2017). Retrieved June 18, 2019, from https:// web.calce.umd.edu/batteries/data.htm.  [4] H. M. Barkholtz, Armando Fresquez, Babu R. Chalamala, Summer R. Ferreira, A database for comparative electrochemical performance of commercial 18650- format lithium-ion cells, J. Electrochem. Soc. 164 (12) (2017) A2697–A2706.  [5] K. A. Severson, Peter M. Attia, Norman Jin, Nicholas Perkins, Benben Jiang, Zi Yang, Michael H. Chen, et al., Data-driven prediction of battery cycle life before capacity degradation, Nat. Energy (2019).  [6] H Al-Sheikh et. al. A sensor fault diagnosis scheme for a DC/DC converter used in hybrid electric vehicles. IFAC-PapersOnLine. 713–719, 2015.  [7] L Ungurean et. al. Battery state of health estimation: a structured review of models, methods and commercial devices. Int J Energy Res. 2017;41(2):151–181.  [8] S. Sheng et. al. A deep learning method for online capacity estimation of lithium-ion batteries, Journal of Energy Storage, 100817, 2019.  [9] B. Bole, Chetan S. Kulkarni, Matthew Daigle, Adaptation of an Electrochemistry- based Li-ion Battery Model to Account for Deterioration Observed Under Randomized Use, SGT, Inc. Moffett Field United States, 2014. |