107 學年度大四工工專題摘要

第七組	基於深度學習及極限梯度提升演算法開發可解釋人工智慧模型以萃取關鍵製造因子 Develop Explainable Artificial Intelligence Model to Extract Key Manufacturing Factors based on Deep Learning and eXtreme Gradient Boosting Algorithm
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摘　要

隨著德國於 2011 年提出工業 4.0 的概念後，全球工業界即如火如荼展開智慧工廠的建置，企圖趕上這波革命性的風潮。從最早的工業革命，為人類帶來機械化的革新，不必再依靠人力及獸力，以大規模生產取代個體生產，而有了工廠的概念；而工業 2.0 為人類的生活帶來了「電」，不僅日常生活電器被廣泛運用，工廠也由傳統蒸汽機或水力機械轉而使用內燃機與發電機；工業 3.0 進入自動化的階段，隨著資訊科技的發展、精密儀器的發明和工業機器人的出現，讓生產效率與品質大幅提升，高科技產業也應運而生；而工業 4.0 和以往不同，並非只是創造新的工業技術，而是透過整合工廠內的技術、銷售與產品設計等方面，建立出一個以智慧型整合感控系統及物聯網為基礎，具有適應性的智慧工廠，在整個產業鏈中整合上下游，提供完整的售後服務。

本研究主要為合作公司——台灣晶技股份有限公司建立一套智慧化生產的流程及回饋模型，前期透過對公司早期大量批量資料的分析，對製程及產品有初步的了解，並進一步跟討論關於公司資料的收集及清洗方式；中期以線上開放資料作為智慧化產線建立前的模擬研究對象，由相似的產業類型中的大量逐筆數據之中，以深度學習技術（Deep Learning）及極限梯度提升演算法（eXtreme Gradient Boosting，Xgboost）等演算法，建立不良品預測模型，並利用 Local Interpretable Model-Agnostic Explanations（LIME）試圖找出不良品的成因，用以快速接軌示範線建立完成後的數據分析；後期以合作公司之 OCXO 智慧化示範線為基礎，加以整合並調整先前的經驗及模型，建立出石英晶片電性與補償站 IC 三個設定值之間的預測模型，並從模型中歸納出電性特徵中影響 IC 設定值的關鍵因素及影響範圍大小，達到控制產品良率及製程研發速度及準確度改善的目的。

此模型成果及建立過程在未來可以用於合作公司之其餘製程及產品線的智慧化過程中。因目前全廠對於工業 4.0 的相關基礎建設尚未完全，因此只針對擁有逐筆資料的相關產線及產品做預測及改善，再待將來硬體設備建立完成時，能快速利用本研究對於大數據分析的過程，從資料收集的方式、資料清洗及建立資料庫到利用深度學習等演算法，在雲端運算出即時的生產回饋資訊，進而降低重工及不良品的發生，本研究的運用的範圍也不僅止於此，在其他方面如：機台的預測維修保養、製程的設計及產品的開發上也都能進一步去探討，並完成工業 4.0 的產業升級。

Abstract

With the introduced of the industry 4.0 by the German government, a substantial amount of A.I related facilities are set up by different countries around the world in order to follow this revolutionary trend. Ever since the very beginning of the industrialization, it has already brought revolutionary impact to man-kind. Thanks to industrialization, we do not have to generate electricity through man power. At the same time, replacing multiple manufacture lines with a single one, which brings out the idea of industry 2.0. Industry 2.0 provides us with electricity which generalizes the use of the electronic appliances. Furthermore, it brings the traditional steam and hydro generator era to the next level: the electricity generator. When it comes to Industry 3.0, automation is introduced. With the progress of the technology, more advance facilities and industrial robot have greatly improved the quality and the efficiency of the manufacturing process. For industry 4.0, what makes it so different from the previous era is that, we are not just creating a new industrial skill but to use Cyber-physical system(CPS) and Internet of things (IoT) as a foundation to create an adaptable smart factory base on integrating industrial skill, marketing and product design skill within the whole system, so as to join the overall production lines together and provide after sale service.

Our research is based on the intellectual production line model created by TXC Corporation which includes the flow and feedback according to the manufacturing process. During phase one of our research, we analyze and make an effort to understand the unofficial data provided by the company. Next, we proceed to the next level of discussion on how to gather and filter the information obtained. During phase two of our research, we browse through the existing information online and create a subject based on the intellectual production line model mentioned. Next, we abstract information from big data according the similar industrial type, and make use of deep learning and eXtreme Gradient Boosting, Xgboost to create model which can be used to detect defective item. At the same time, we make use of LIME(Local Interpretable Model-Agnostic Explanations) to find out the cause of defect and create a high speed production line so as to set as an example which can be used as a reference for the other production lines in the future. During the final phase of our research, we make use of the OCXO intellectual production line as a foundation to integrate and adjust the previous experience and model. At same time, we create a predicting model that is able to predict the setting value among quartz chip, property of electricity and TCV. Furthermore, conclude on how property of electricity will affect the setting value of TCV and the range of influence so as to control the yield of product, the speed of development and precision of the result.

The result of the experiment and the building process are able to be used in the rest of the production lines involved in intellectual process in TXC Corporation. Due to the incomplete industry 4.0 fundamental facilities, we can only focus on the prediction and adjustment on the data of related production line. Furthermore, we will be able to use this current research to analyze the process in big data: From ways to gather information, data

filtering and creating data base to deep learning algorithm. This is able to calculate the information gathered from feedback on cloud storage, so as to reduce the probability of defect and redoing. Our research can be used on other fields too. For example, prediction and maintaining of machines, production line and product design and even fulfill the aim of industry 4.0 to upgrade the industry to its optimum level.