Postgraduates Studies

As a young university, KUKUM has strived very hard to be a highly regarded repository of knowledge. Testament to this vision is the number of postgraduates who have gained from this university. Four M.Sc candidatures' dissertation abstracts, edited for this bulletin, are featured here, showing the diversity of research as well as depth of knowledge.

A Surface Roughness based Visual and Analysis System for Surface Quality Improvement in Fused Deposition Modeling Rapid Prototype Machine

Khairul Fauzi Karim
Master of Science (Mechatronic Engineering)

In rapid prototyping (RP), part deposition orientation and surface finish are two significant concerns, which contradict each other. In RP model building, a compromise is usually made between these two features to get good quality surface roughness at a short build time. The compromise balances between adaptive slicing method and selection of an appropriate part deposition orientation. In this dissertation, an effort towards determining the best balance between the two for Fused Deposition Modeling (FDM) process for enhancing part surface finish, and hence, reducing build time (repeating process in RP cycle) is proposed. The quality of the surface roughness is determined visually and analytically. This Surface Roughness Based Visual and Analysis (SRVA) system is obtained based on the calculation of surface roughness (Ra). Region Based Adaptive Slicing method is applied in building the model in FDM. The proposed methodology allows the RP user to observe and analyze the prototype model before fabricating the prototype model in the FDM. A program based on fuzzy logic is also used to verify the input and output parameters obtained from the proposed method.

The developed SRVA system has successfully improved the surface finish and minimized the build time in fabricating the prototype model in FDM. The result showed that increasing part deposition orientation would decrease the Ra value of the model. For 0˚ and 90˚ part deposition orientation, the Ra from measurement are closed to the Ra output from fuzzy logic with percentage differences 1.78% and 1.52% respectively. Therefore, the Ra values calculated from the SRVA system are acceptable for these orientations. However, for 45˚ part deposition orientation, it is 2.26% higher than the Ra output from fuzzy logic since during the fabrication process, the surrounding support model affects the surface finish of the prototype model. This value is acceptable because the effect of surrounding support model to the surface finish has not been the focus of the present work. The result also shows that the adaptive slicing method has improved the surface roughness of the prototype model. The inspected Ra obtained by this method is 1.22% lower than that obtained without adaptive slicing method, but 0.56% higher than that obtained by fuzzy logic. This result is obtained without the necessity to repeatedly fabricate the model or piecework in FDM for good quality surface roughness as the proposed method has successfully managed to optimize the RP cycle; hence the build time in RP is reduced.

Design, Simulation and Process Development for SOI Single Electron Transistor (SET) Fabrication

Amiza Rasmi
Master of Science (Microeletronic Engineering)

Single – Electron Transistors (SET) are one of the promising technologies, distinguished by very small device dimensions and low power dissipation. This project works on the SET mask design, fabrication process flow development and device simulation. The SET mask design consists of four masks namely source and drain mask, polysilicon gate mask, contact mask and metal mask. These masks were designed for nanometer (10 -9 m) sizes using ELPHY Quantum GDS II Editor Software. A nanowire is placed between the source and drain region. The nanowire is approximately 100 nm long and 10 nm wide.

The process flow includes detailed parameters developed for SET process and device simulation. This process flow consists of ten process modules, as follows: wafer cleaning process, material deposition, polysilicon gate formation, source/drain implantation, contact formation, metal deposition and formation and finally annealing and alloying process. Synopsys TCAD is then used to simulate the SET process and device design of a 100 nm length and 10 nm width operating at room temperature (300 K), with a capacitance 0.4297 x 10 -18 F and a charging enegry of 186.4 meV.

A Study on Clinker Microstructure during Cement Production

Mohd Sobri Idris
Master of Science (Material Engineering)

Some samples of clinker from commercial cement production process was studied. The objective of this research was to study the microstructural characteristics and physical properties of cement clinker with light and scanning electron microscope. Acquisition of a good image of the clinker microstructure needs proper sample preparation and a suitable imaging technique. Microstructure analysis of clinker via light microscope requires etching with a reagent to differentiate the mineral phases that exist in the clinker. Nital, a safe etching reagent, enables the various mineral phases like alite (C3S), belit (C2S), aluminate (C3A) and ferrite (C4AF) in the clinker to be identified based on grain shape and colour.

Study of clinker microstructure using scanning electron microscope (SEM) as a alternative technique had advantages due to the higher magnification, which is an advantage especially when analyzing interstitial mineral phases like aluminate (C3A), compared to light microscopes. Image acquisition using backscattered electron (BSE) is more suitable than secondary electron (SE). Secondary electron images show the essential morphological nature of the surface of brittle materials compared to backscattered electron images, which show images of electron scattering due to atomic numbers of sample atoms. Suitable accelerating potentials, between 12kV and 15kV, are critical in order to acquire high quality images. Accelerating potentials below or above that range reduce image quality. However, a balance between the need for high spatial resolution, low X-ray absorption of the lighter elements, and provide a satisfactory over-voltage for excitation of heavier elements must be made. Clinker categorized as problematic was studied and their microstructure analyzed. Results show the effect of incomplete burning to the clinker microstructure and clinker quality generally. This is correlated to the process of cement clinker production. Clinkering temperatures must reach 14500C to produce quality clinker with a high constituent of alite and low belite. Clinkering temperature below that reverses the contents..

Classification of Binary Insect Images using Fuzzy and Gaussian Artmap Neural Network

Shahrul Nizam Yaakob
Master of Science (Computer Engineering)

Object recognition and classification is an essential routine in our daily lives. Our eyes act as a camera, capturing the image of particular object and sending it to the brain to be recognized. Thus, the human vision system has inspired researchers to create machine vision systems. A significant part of the machine vision system of this research focused on two (2) important phases; feature extraction and classification. As for the feature extraction six (6) different types of moment invariant techniques namely Geometric moment invariant (GMI), United moment invariant (UMI), Zernike moment invariant (ZMI), Legendre moment invariant (LMI), Tchebichef moment invariant (TMI) and Krawtchouk moment invariant (KMI) are used to extract the global shape features of the binary insect images.

These features are then channeled to the Fuzzy ARTMAP (FAM) and Gaussian ARTMAP(GAM)neural network to be classified and recognized. In the GAM neural network, a gamma threshold is proposed to find the optimal value for gamma parameter acting as the initial value for a Gaussian distribution in the training phase. KMI is the best technique for feature extraction of the global shape information of insect images as compared to GMI, UMI, ZMI, LMI and TMI. The finding is based on the lowest value of Total Min Absolute Error (TPMAE) (0.03%-1.01). The training and testing method for both neural networks is based on a 4-fold cross validation technique. It is also found that the performance of FAM neural network is influenced by the types of normalization technique utilized. The Improved Linear Scaling (ILS) normalization technique generated the highest classification rate by the FAM neural network when compared to Unit Range (UR) and Improved Unit Range (IUR). It is further found that GAM neural network is a better insect classification technique when compared to FAM neural network producing classification accuracy of up to 99.58% whereby the classification accuracy of FAM neural network is 82%.