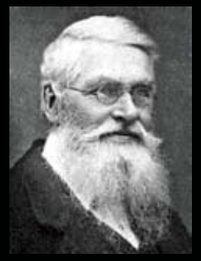

# Alfred Russell Wallace & Malay Archipelago

*"Truth is born into this world only with pangs and tribulations, and every fresh truth is received unwillingly. To expect the world to receive a new truth, or even an old truth, without challenging it, is to look for one of those miracles which do not occur." ARW*

Alfred Russel Wallace did not get his equal share in fame in the context of science. He was a man who had done extensive exploration and observation on par with another, and was one of the 19th century's most remarkable intellectuals. His link as the co-discoverer in 1858 of natural selection would alone have secured his place in history, but he went on to make very many other significant contributions, not just to biology, but to subjects as far-ranging as glaciology, land reform, anthropology, ethnography, epidemiology, and even astrobiology.


His pioneering work on continually-adapting biogeography led to him becoming recognized as that subject's 'father'. Beyond this, Wallace is regarded as the pre-eminent collector and field biologist of tropical regions of the 19th century, and his book The Malay Archipelago is one of the most celebrated travel writings of that century and has never been out of print [1]. The Malay Archipelago had been the nursery nurturing his theories and discoveries. The archipelago's association itself gives a sense of pride and a moment to be cherished with all its inhabitants, especially we Malaysians.

He was born in the village of Usk in Monmouthshire, England. His father died when Alfred was young. Not long after, formal schooling ended for Alfred. He joined his brother, William, in surveying a number of English counties over the next four years. This experience was to teach him how to make accurate observations and detailed recordings, skills which would be of immense importance in later life. Shortly after this, Wallace was appointed to the position of drawing-master at the Collegiate School in Leicester. It was here that he met Henry Walter Bates, a fellow teacher who introduced him to the methods and delights of botany [2].

Wallace had had his fair share of trials and tribulations on his road of scientific achievements. He set on an expedition with Bates to explore the Amazon and Rio Negro rivers. Wallace and Bates had to split up to cover the vast basin. He spent four years of extensive exploration and collection. In 1852 the ship which he set sail caught fire and was abandoned. He lost his entire collection and most of his notes in this event. Such a calamity would have defeated a lesser person but Wallace turned his energies to writing an account of his time in Brazil, Travels on the Amazon and Rio Negro (1853). Within twelve months he again left England and sailed eastwards towards Singapore. It was here, over the next eight years, that A.R. Wallace was to make the great voyage which led to his formulation of the theory of Natural Selection [2]. Wallace, continued his travels and focused his study on the importance of biogeography [2]

*"The smell of the ripe fruit is certainly at first disagreeable, though less so when it has newly fallen from the tree; for the moment it is ripe it falls of itself, and the only way to eat* ***Durians*** *in perfection is to get them as they fall. It would perhaps not be correct to say that the* ***Durian*** *is the best of all fruits, because it cannot supply the place of subacid juicy fruits such as the orange, grape, mango, and* ***mangosteen****, whose refreshing and cooling qualities are so grateful; but as producing a food of the most exquisite flavour it is unsurpassed. If I had to fix on two only as representing the perfection of the two classes, I should certainly choose the* ***Durian*** *and the Orange as the king and queen of fruits." - ARW*

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Explore | Deputy Vice Chancellor (Research & Innovation) Office, Universiti Malaysia Perlis (UniMAP)
KWSP Building, 10th Floor, Jalan Bukit Lagi, 01000 Kangar, Perlis MALAYSIA.
Tel : +604-979 8297 Fax : +604-979 8039 www.unimap.edu.my


# Explore


UniMAP RESEARCH & INNOVATION • ISSUE 07


## E-nose For Basal Stem Rot Detection

## FMEA Generation : Model & Reasoning

## Particle Swarm Optimization & Facial Emotion


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# Greetings From Vice Chancellor

Assalamualaikum Warahmatullahi Taala Wabarakatuh and Salam Sejahtera.

With the completion of seven years of UniMAP's operation, this 7th edition of Explore marks an occasion to be celebrated. The number seven has always been the favourite of the University. UniMAP's 'seven pillar' programmes have been instrumental in developing its students' soft skills, and more so, UniMAP's seven research clusters have generated outputs that are the University's and Perlis' pride and joy.

As I was browsing through the compilation of materials put together in this issue of Explore, I am reminded of an article about the seven scientific 'must have' attitudes of scientists and researchers I read some time back, and hence it is most apt that I share it in this greeting. The seven attitudes are: a scientist/researcher must be curious about the world, logical and systematic, open-minded, intellectually honest, hard worker and persistent, must not jump to conclusions, and finally, must be a creative and critical thinker.

Each of the 'must have' attitudes above can be evidenced in the lives of great scientists and researchers who have changed our world to be what it is today. I believe these same attitudes – to a lesser or greater extent - can be found in the dwellers of the labs of UniMAP – for they have worked extremely hard to bring back the golds, silvers and bronzes that we have come to cherish. I wish to congratulate all of them, as well others who work as hard not in the labs but in the classrooms and offices of the University. As a team, we have come a long way.

Thank you.

**Brigadier General Dato' Prof. Dr. Kamarudin Hussin**
**Vice Chancellor**

A five country collaboration between Vietnam, Canada, Malaysia, Thailand, and China. From left : Dr. Hoang Hung, Deputy-General Director, Petro Vietnam University; Dr. Gary Boire, Vice President, University of Regina; Prof. Dr. Zul Azhar Zahid Jamal, Deputy Vice Chancellor, University Malaysia Perlis; Asst. Prof. Dr. Bundit Thipakorn, Vice President, King Mongkut's University of Technology Thonburi; Prof. Dr. Huang Hongwu, President, Xiamen University of Technology; Prof. Zhang Jing, Vice President, Hunan University.

# Foreword From Deputy Vice Chancellor

**As fina**l preparations are made for this issue of Explore, there has been a whirlwind of excitement in the labs and offices of the University. The Ranking Web of World Universities, or more popularly known as 'Webometrics', has announced that UniMAP is at no. 745 out of more than 16 000 universities in the world. In South East Asia, it is at the very impressive position of no. 14 - only a few places behind UTM (no. 10) and USM (no. 12). That makes UniMAP at no. 3 in Malaysia. Quite an accomplishment for a 7 year old university.

One might ask, so what have we got to celebrate? To answer, a look at the criteria used in Webometrics is eminent. The target being *"…..electronic access to scientific publications and other academic material"*, the ranking thus looks at *"global performance and visibility of the universities"*, which *"…reflects better the global quality of the scholar and research institutions worldwide"*.

*(http://www.webometrics.info/top100_continent.asp?cont=SE_Asia).*

As such, I must congratulate UniMAP's ICT and research community for contributing to this success. Obviously, the culture of knowledge and experience sharing is thriving in this University. Just a few minutes of browsing through our website will show that it is indeed an intellectual treasure trove worthy of visits and revisits. It is a digital repository of numerous academic and research experiences of UniMAP scholars, who get together not just physically but virtually as well to share what they have to offer.

Still, a high ranking in Webometrics should not lead us to rest on our laurels. Maintaining our position is a challenge. Hence, in the usual *'UniMAP Boleh'* spirit, I dare each and every UniMAP denizen to rise to this challenge.

**Prof. Dr Zul Azhar Zahid Jamal**
**Deputy Vice Chancellor**

# Editorial Comment

**A full round trip** has been made. We are where we were a year ago… graduation ceremonies and celebrations. UniMAP's fourth. To our graduates congratulations! Our warmest wishes to the class of 2008/09. It must be noted that even in these trying times, a good number of UniMAP's 'products' have been employed. All said, it has been a fruitful and productive year. Congratulations UniMAP. In fact, every graduation of her students is a graduation for UniMAp herself.

Congratulations!

Praba





# Contents






*The cover picture shows multiple ultrasound transducers for a mobile autonomous vehicle.*

# E-nose for Basal Stem Rot Detection

**A.Y. Md Shakaff, M.N. Ahmad, M.A. Markom, A.H. Adom, Wahyu Hidayat, A.H. Abdullah, and N. Ahmad Fikri**

School of Mechatronic Engineering, UniMAP

E-mail : aliyeon@unimap.edu.my

## INTRODUCTION

An electronic nose is an intelligent device, able to mimic human olfaction functions and may be used for detection, recognition and classification of volatile compounds and odours. An e-nose consists of an array of sensors, signal collecting unit(s) and suitable pattern recognition algorithm. The possible implementations of these devices are wide ranging, from agricultural applications to solving environmental issues. In terms of agricultural applications, e-nose systems have been used successfully to assist product quality monitoring, fruit ripeness determination as well as inspection of fish. The e-nose has also been used to detect the causal agent or element of plant disease such as fungi and bacteria. Fungi produce mycotoxins on agricultural commodities during plant growth or after harvest during storage and shipment, which could be detrimental to living organisms when ingested. Also, the growth of the moulds in grains reduces their nutritional quality and subsequent decrease in germination results in economic loss. The disease is a threat to the oil palm industry causing an estimated annual lost of RM80 million. Hence a novel feasibility study to use an e-nose to detect plant disease, specifically the basal stem rot (BSR) disease, is executed, with a commercial e-nose, Cyranose 320 incorporated artificial neural networks.

### Basal stem rot disease

The oil palm tree is a leading source of edible vegetable oil production in the world and in Malaysia, palm oil as a cash crop has superceded natural rubber, and its importance has been further boosted with the introduction of bio-diesel. Its cultivation, in much of South-East Asia, is threatened by BSR caused by G. boninense, where losses can reach 80% after repeated planting cycles. BSR has been causing serious damage to oil palm plantations in Malaysia for more than 50 years and is currently the most important disease of economical importance causing large amount of losses in revenue. In severe infestation situations, more than 50% of oil palm stands can be lost to the disease. The Federal Land Development Authority (FELDA) recorded a high incidence of the disease in Peninsular Malaysia, about 50%, from 1994 to 2005. The disease does not indicate early infection when it progresses from the base. Visible symptoms appear at a very late stage of infection, when more than half of the root tissues have decayed, thus eliminating cure. The causal agent, G. boninense, a white-rot basidiomycete, is a saprophyte or weak parasite that infects living palms if there are massive inoculums as shown in Fig.1. G. boninense produces enzymes that degrade the palm tissue. As the fungus destroys internal palm tissues, it affects the palm xylem, causing serious problems to the distribution of water and other nutrients to the palm tree top, eventually leading to its death. The incidence increases rapidly by the time the palms are 15 years old, the disease levels can reach between 40 and 50 percent of the palm. In severe cases, up to 85 percent of the standing palms succumb to BSR by the time the palms are 25 years old. There are two biochemistry processes used to detect ganoderma infection. The first is culture, such as Ganoderma Selective Medium (GSM).

*Fig. 1.* Ganoderma boninense fruiting body.

The second category is molecular DNA, such as a polymerase chain reaction (PCR). However, both require stem collection for further tests in the laboratories. There has yet to be a method able to provide real time or in-situ results.

### Cyranose 320

The Cyranose 320 (C-320) is a handheld e-nose instrument widely used in quality control, process measurement, hazardous material identification and biomedical sample discrimination. The sensing component consists of an array of 32 conduction-based polymer sensor elements. Each sensor has a different response specificity to a broad range of compounds, and is able to produce limitless numbers of output signals, referred to as the signal pattern or fingerprint.





### Pattern recognition

Artificial neural networks (ANNs), an interconnected group of artificial neurons that use a mathematical or computational model for data processing, have been widely used as a pattern recognition tool. It produces a good performance with promising results in chemical vapour recognition. A Levenberg–Marquardt algorithm is chosen because it offers the best performance in terms of speed and efficiency. It has a faster convergence leading to faster optimisation.

### Data and sample collection

The ganoderma odour data collection, is performed at FELDA Besout 7 oil palm plantation, Sungkai, Perak, Malaysia. The area of interest is divided into two sections; the first is of normal or healthy plants while the second is the infected area. Three types of odour samples are selected - odour of the air surrounding the tree, odour of bored tree trunk and odour of soil surrounding the base of the tree trunks, which represent different parameters of the tree odour. Three trees are chosen randomly from each section and, three points for each odour parameter are marked as shown in Fig. 2. The tree odours are collected, as are samples, for laboratory analysis. The C-320 readings of these samples are also performed in the laboratory for comparison purposes. The comparison between on-site and laboratory readings enable verification of any physiological change of the samples that may alter its odour profile. Also, the results of this test will dictate whether the odour readings taken on site and in the laboratory are interchangeable.

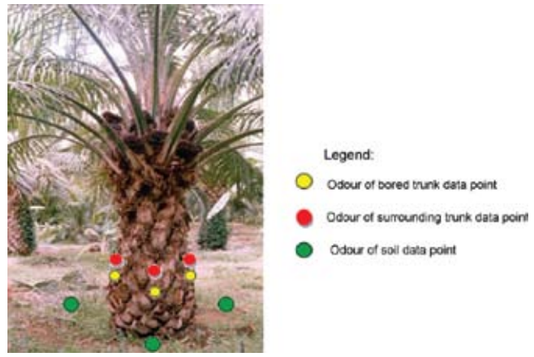


*Fig. 2 :* Ganoderma boninense fruiting body.

### Dimension reduction

Dimension reduction is a process of identifying the most effective subset of the original features to use in the classification process that should lead to a higher classification accuracy. In this study, Principle Component Analysis (PCA) is chosen as it is commonly used in e-nose signal processing. A reduced number of sensors input to the ANN improves the system performance, increases accuracy and efficiency. Only eight significant sensor responses of the 32 will be considered to be ANN's inputs.

### Normalisation and ANN analysis

The collected data, normalized to ensure no dominance of any specific sensor to the ANN output, are divided for training and testing. Different network sizes are tested, with the number of inputs and outputs set to eight and one, respectively, since these are determined by implementation. Since eight sensors are input to the ANN after feature selection, the network has the same number of inputs. Since sample implementation only determines healthy or infected sample, a single output is sufficient, with a 1 indicating positive recognition and 0 for negative.

### Network testing

Network testing is performed using the test data set, which tests the accuracy of the trained ANN model in discriminating and hence classifying the samples.

## Results and discussions

### Comparison on in-situ and laboratory data

Graphs are plotted for the mean sensors response against the number of sensors for both data taken in the laboratory as well as on-site, as seen in Fig. 3. The graphs do not show any similarity whereby there must be some physiological changes during transit which caused different odour profiles to be recorded by the sensors of C-320. Hence, only in-situ data samples are used.

### The data profile

All tested trees have the same sensor responses. This means that regardless of the tree where the odour was captured, the odour profile of the same parameter remains consistent. This indicates that the data collected are reliable to be used for the ANN training. The best graphical method to present the profile or fingerprint, instead of a bar chart, is a radar plot as shown in Fig. 4 (a–c) which shows that healthy and infected samples have their own odour profile.

### Dimension reduction

PCA method expresses the response vectors in terms of a linear combination of orthogonal vectors that account for a certain amount of variance in the data. As a result of applying PCA to an array of 32 sensors when applied to three types of BSR disease environment parameters, two principle components are kept, which account for 99.32% of the variance in the data set (PC1 and PC2 accounted for 74.67% and 24.65% of the variance, respectively).

### Sensors selection

The selection of sensors is taken from the eight high valued PCA coefficients. Sensors are chosen based on the presented high responses to the samples for all parameters. Only the data from these sensors will be used as the input to the ANN.

### Results from the ANN training and testing

The training of the ANN showed that the e-nose was able to discriminate healthy and infected tree trunk samples. After the completion of the network training phase, a hundred data of each sample is tested using the resulting ANN model, with a 100% accuracy.

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## Conclusions

A successful application of an electronic nose, Cyranose 320, as a frontend sensor with artificial neural networks for the discrimination of oil palm trees infected by G. boninense has been shown. This is the first step in proving the feasibility of using an e-nose for plant disease detection. The next phase of the research will study the ability of the proposed e-nose setup to differentiate the different levels of infection stages of the fungus. This will lead to the implementation of the system for early infection detection application.

The odour profiles recorded are consistent for each tree, and the 32 different sensors in Cyranose 320 are able to give individual odour fingerprints of healthy and infected trees. The PCA used as feature selection, has successfully to reduced the execution time of ANN training as well as to improve the accuracy of classification. These results are valuable as they proved the feasibility of using an electronic nose with artificial intelligence to discriminate healthy and infected plants, hence the detection of plant diseases. The system can be easily adopted for different diseases, and this approach holds promise for a better plant disease detection and monitoring.

**Acknowledgements**

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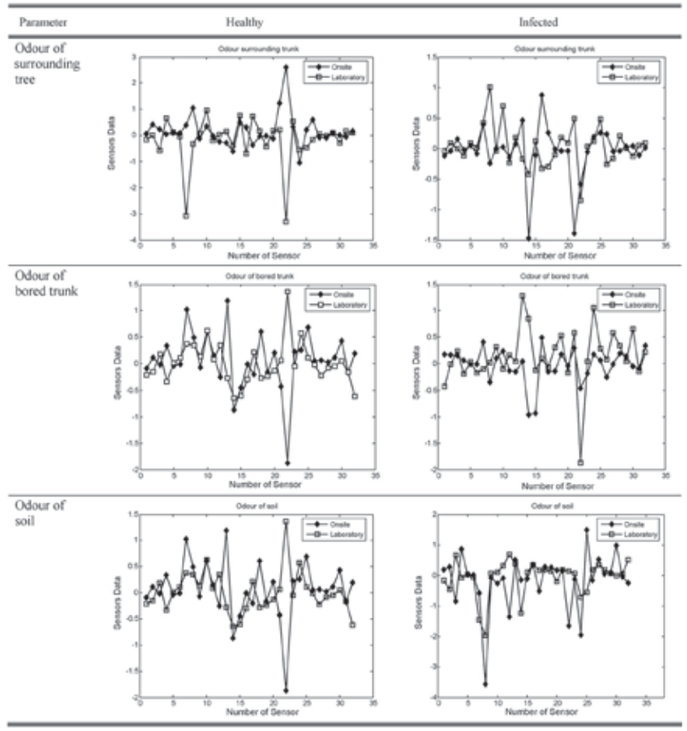


*Fig. 3* : Onsite and laboratory data comparison.

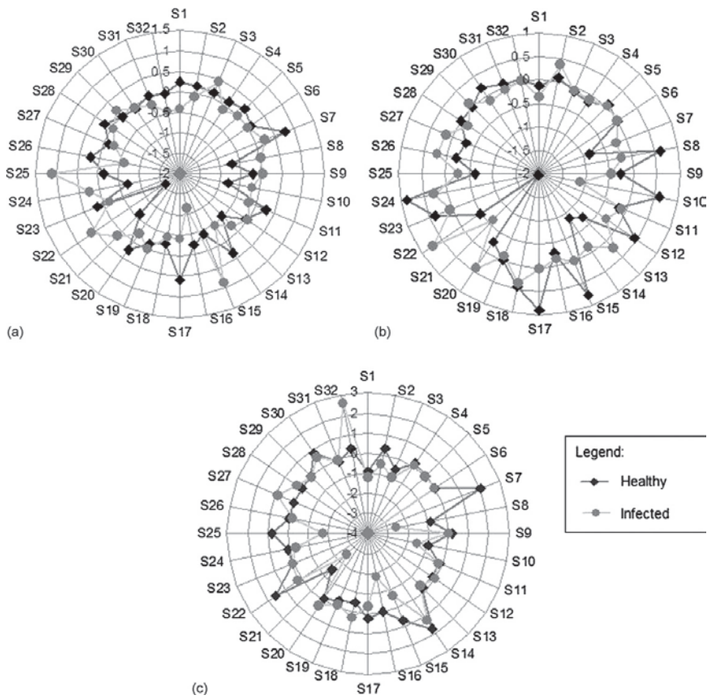


*Fig. 4* : (a) Profile of healthy and infected data for odour surrounding the trunk.
(b) Profile of healthy and infected data for odour of bored trunk.
(c) Profile of healthy and infected for odour of soil.





# FMEA Generation : Model & Reasoning

**P.C. Teoh[1], K. Case[2]**

1. Motorola Technology Malaysia
2. Mechanical and Manufacturing Engineering, Loughborough University

E-mail : cpt005@motorola.com

**INTRODUCTION**

Concurrent engineering improves competitiveness of the manufacturing industry,by improving quality, reducing cost and cycle times of the products. In line with this initiative the International Standards Organization has adopted a "failure modes and effects analysis" (FMEA) tool. FMEA is used to identify potential failure modes of a product or process, effects of the failures, and assess the criticality of these effects on the product functionality, providing basic information for risk assessment and quality improvement of product and process design. The potential failure modes and causes for each component or process step are identified, followed by assessment of the failure effects to the end users. The risk of each failure is prioritized with a risk priority number (RPN) between 1 and 10, a decision factor based on the product of three ratings: occurrence, severity and detection. Failure modes with high RPN values are selected and corresponding solutions implemented.

**MOTIVATION**

Traditionally, FMEA uses manual hard copies or spreadsheets which, becomes increasingly diffcult to find and reuse, since it is not user friendly, hard to understand and of limited flexibility. As a result, FMEA merely satisfies the contractual requirements of customers. FMEA is often executed late in the design cycle after the design prototype has been built, and changes made at later stages become very costly. Most methods to improve FMEA usage earlier in the design process, require a considerable amount of modelling effort. To this effect, artificial intelligence (AI) techniques such as modelling and reasoning are used. A specific analysis on modelling and reasoning approach that provides the basis for FMEA automation for more generic product and process design applications is made here.

**MODELLING AND REASONING**

Modelling and reasoning are two important and widely used concepts in FMEA research. A model is an abstracted picture of a concept and an approximation of a system or an object or a problem, constructed for the purpose of analysis. Modelling is a process of transferring the concept into a type of representation that is comprehensible, communicable and worked upon. Reasoning is a decision-making process based on the understanding of the available information. In artificial intelligence (AI) terms, reasoning represents the capability of the computer to make decisions based on given information.

**Modelling in FMEA**

FMEA models can be divided to functional and structural models, with both needed to automate the FMEA process. A functional model describes the intended function / purpose of a system and is made up of function and behaviour. Function provides the design intent, whereas behaviour describes how the structure of an artifact achieves its function. A structural model is a set of components making up an artifact and their relationships, referring to the configuration of the product or system. It contains the information of all the components, entities, subprocesses or subsystems, and the interactions between them that make up a useful structure for an intended purpose. It may refer to a physical assembly of a product or a software configuration. In design, each artifact is created to achieve one or more functions while one or more artifacts can achieve a function. The relationships between functions and artifacts are represented by the mapping between a functional and a structural model, Fig. 1.

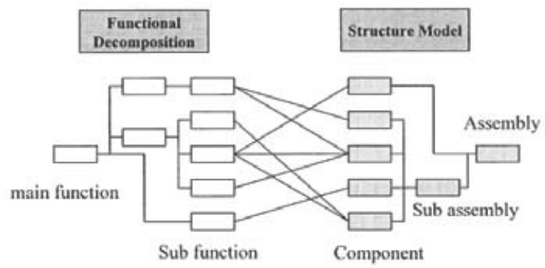


*Fig. 1* : Function-structure mapping

**Modelling in conceptual design**

There is a systematic design approach for the design process whereby, the design process can be divided into:

1. Design specification - establishes requirement specifications.
2. Conceptual design - finds possible design concepts based on requirements.
3. Embodiment design - layout design, schematic, draft or configuration drawing.
4. Detail design - establish details.

Conceptual design is a phase where ideas are generated, evaluated and selected, and serve as the basis for the embodiment and detail design. The overall process involved in function decomposition and searching for working principles is known as functional analysis.

**FUNCTIONAL ANALYSIS**

Function decomposition can be achieved via flow-based approach, integrated definition (IDEF) method and functional diagram approach.

**Flow-based black-box approach**

The black box represents the function of a design / process, which converts an input into an output of a different state. The issue in using flow-based approach in conceptual design is the need for a basic form operand. The flexibility in modelling implicit concepts allows concentration on solutions. However, flow-based approach imposes restrictions that hinders the formation of implicit relationships in a model.

**IDEF methods**

IDEF methods are standard methodologies that are widely used in concurrent engineering. IDEF family of modelling methods include IDEF0 for function models, IDEF3 for process models, etc. A function box can be decomposed into more detailed subfunctions, similar to the flow-based 'black-box' approach. The downside of using IDEF methods is that the method is not suitable for static model functions, since there is no sequence or direction involved that can be used to construct an IDEF diagram.

**Functional diagram**

The functional diagram provides one of the simplest models to represent function and structure interaction. The basic unit of the diagram consists of two objects linked by a function. Functional models are simple and user-friendly which, is very important for conceptual design with frequent design changes but its simplicity lacks other features in modelling.

**REASONING IN FMEA**

Reasoning is carried out to establish cause-and-effect relationships based on the functional and structural models, and to generate the FMEA report.

**Common approaches**

In AI, rule-based, model-based and case-based reasoning are common. Rule-based reasoning uses IF–THEN rules to capture knowledge. Model-based reasoning aims at formulating knowledge of general principles for a wider range of problems. Case-based reasoning is experience-based relating prior problems to current ones. Rules are built within functional blocks to reason about failure modes, causes and effects.

Shallow knowledge reasoning benables generic rule usage for all function blocks thereby avoiding complexities of custom-rules for different functions, a disadvantage since it relies on the data input to the system. A model-based approach can provide an accurate simulation of failure conditions,however, with a comprehensive structural model created before the reasoning process. A component library for the predefined models needs to be created to eliminate modelling activities during FMEA generation.

**'Knowledge fragment' reasoning approach**

Previous failure reports are knowledge fragments of deliberation, reasoning and experience of experts, and is highly reusable. Initially, a model is constructed using function and component ontologies. Assuming there were previous failure reports, a failure mode to one of the components in the functional model enables compoutation of all possible paths based on the functional links among the components in the model.

The voltage of the secondary battery in Fig. 2 is affected by low temperatures. Hence, the cause function 'temperature dependence' has affected the function 'power supply'. In a d.c.–d.c. converter, the function 'power supply' from the secondary battery has become the cause function to the d.c.–d.c. converter. Hence the failure has propagated to the d.c.–d.c. converter. This leads to the frequency-modulated receiver, affecting the function 'command reception'. The advantage of this approach is that reasoning can be carried out on the basis of a relatively small amount of information. Models are driven by information assigned to ontologies rather than basic principles and can be easily composed from simple heuristic rules using shallow knowledge reasoning. Hence, it is a suitable method for reasoning in conceptual design.

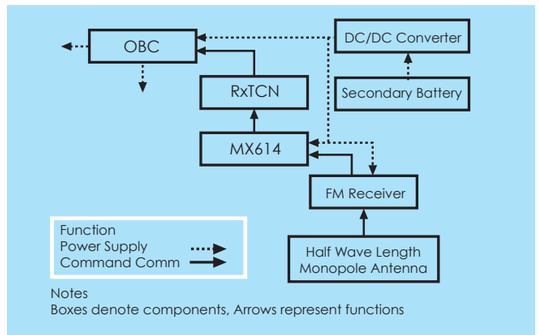


*Fig. 2* : (Part of the functional model (OBC, RxTCN, MX614, FM, frequency modulated)

*Table 1* : Failure case example

| Label | Temperature dependence of secondary battery | Inability of d.c.–d.c. converter to boost up voltage | Inability of receiver to receive commands |
|---|---|---|---|
| Affected component | Secondary battery | D.c.–d.c. converter | Frequency-modulated receiver |
| Affected function | Power supply | Power supply | Command reception |
| Cause function | Temperature dependency | Power supply | Power supply |
| Detail | When the temperature of a battery becomes low, the voltage provided by the battery becomes low | When the input voltage becomes low, the d.c.–d.c. converter cannot provide enough boost up to the output voltage | There were some cases where commands could not be received when the input voltage to the frequency-modulated receiver becomes low |





**FMAG PROPOSAL**

FMEA generation or FMAG is a new method to automate generic FMEA report generation. In a process such as PCB going through a conveyor, an IDEF3 diagram contains information of the functions and operands that can be mapped to relevant structures through functional units, which can be combined to form a functional diagram.

**Cause-and-effect propagation**

In order to facilitate cause-and-effect propagation, a functional diagram must respond to stimulation in its components. Causal reasoning with 'knowledge fragment' reasoning approach is employed. However, FMAG divides the fragment to 'pre-condition' and 'post-condition', in the forms of 'operator failure state-failure behaviour' and 'failure behaviour–operand failure state'.

Causal reasoning in FMAG is based on a)existence of a state of an operator where, if there is a change to that state, it will cause its functional behaviour to change accordingly, and b)existence of a functional behaviour where, if there is a change to that behaviour, it causes the corresponding operand to change state accordingly.

The semantics of the knowledge fragments for the pre-condition are based on assumption a), whereas that for the post-condition is based on assumption b). Both pre- and postcondition gain knowledge through historical data extracted from failure reports and FMEA. For a particular function unit, operator state and behaviour of a failure form a set of pre-conditions while behaviour and state of the operand form the post-condition. Hence, with the accumulated events being recorded, pre- and postcondition tables will be formed. During reasoning, only the failure cause and effect is required from the pre- and post-condition tables. The other properties of the operator and operand that remain in normal conditions are assumed and will not be required in the model. In a functional model, a state change in one entity will affect the status of the interrelated entities, a cause-and-effect propagation through the behaviour of a generic function via the pre- and post-condition. The operator state determines the behaviour of the generic function within a function unit. The behaviour, in turn, decides the operand state within the function unit. The knowledge is referred to entities and their functions, but not to the function units.

During reasoning, it is possible to create new knowledge by matching the pre- and post-condition knowledge with the same failure behaviour. This approach provides modularity for the creation of new knowledge. When a new function unit is used in a functional diagram, the operator, operand and the generic function involved can be used as keys to search for matching states and behaviours in the pre- and post-condition tables. Hence, an entity is able to act or respond to the system through its historical knowledge. Generating the same result with an identical function unit is straightforward. However, there is a possibility that new knowledge can be generated using a new function unit with similar pre- and post-conditions. If the function unit has never been captured from failures, under normal circumstances, it will not be available for reasoning. However, FMAG provides a means to create new knowledge based on possible matching between information in the pre- and post-condition tables. The system searches for the operator name and retrieves the likely pre-condition. The same process is carried out on another operand and function whereby the system retrieves a likely post-condition. The combination of this information results in a new case. Hence, the knowledge to respond to a new case even though the case has never existed is possible.

**FMEA generation**

FMEA generation is achieved when causal reasoning is applied throughout the functional diagram. When a new functional diagram is created for a particular design, FMEA report is generated on the basis of historical data saved in the database.

**Hierarchical functional modelling**

Currently FMAG is limited to provide cause-and-effect propagation within a single level of abstraction; i.e. within one functional diagram. An abstract model can be decomposed into more detailed submodels so that analysis can be carried out, at many levels of abstraction. Under the current FMAG structure, function units are connected to form a functional diagram with each representing a scenario of a design operation or process. A model is described by different scenarios of the design or process and is part of the entity class, serving as an operator or an operand of yet another functional diagram.

At the lowest level, generic functions in the functional basis are used in the functional models. However, at higher levels, non-standard terms are used. Many function units in the second level functional diagram use the function 'produces', which is not a generic function. The objects and functions in the functional diagram at lower levels are aggregations of higher-level model. Hence, the hierarchical functional diagrams represent the decomposition of structural and functional models, and the relationships of the entities in both models.

**CONCLUSION**

The need to improve knowledge reuse at an early stage in design and improve the effectiveness of the FMEA is to automate the FMEA authoring process. The combination of IDEF3 and functional diagram provide the basic model for the process. A 'knowledge fragment' reasoning approach is used to create cause-and-effect relationships. The reasoning is controlled by precondition and postcondition relationships based on two basic assumptions, leading to the formation of FMEA knowledge. The content of the FMEA is naturally domain dependent, but it is believed that the methodology is generic and could be used for many applications. However, it is true that, as knowledge increases, the computational load will be more demanding and there is a need to study methods of addressing this aspect before contemplating large-scale practical implementations

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# Particle Swarm Optimization & Facial Emotion

**H. Desa, R. Nagarajan and B. M. Ghandi**

School of Mechatronic Engineering, Universiti Malaysia Perlis UniMAP

E-mail : hazry@unimap.edu.my

## INTRODUCTION

There are several applications that can be derived from efforts in improving human-computer interaction so that computers can have the intelligence to perceive the emotional state of a human user and react accordingly. Such as an intelligent welfare robot to provide support and comfort to bed-ridden / highly disabled people. This is important given the modern life style of declining children population and busier middle-age which leaves the senior citizens and the disabled to fend for themselves.

Particle Swarm Optimization (PSO) is an algorithm that has been found to be very efficient and effective in solving a variety of optimization or searching problems. PSO is a population-based search algorithm that was first developed to simulate the social behavior of birds as they fly in a group searching for food. It has since been used for the classical travelling salesman problem, electrical power systems, neural networks training, image clustering, data clustering, gene clustering, underwater acoustics, task assignment and combinational logic circuits design. However a modified PSO, renamed as Guided Particle Swarm Optimization (GPSO), is here successfully applied in detecting facial emotions.

## EMOTION

Six basic emotions are identified as universal and independent of cultural background, both in terms of how they are expressed and how they are perceived. These are happiness, anger, sadness, surprise, disgust and fear. One approach to facial expressions classification is to recognize the underlying facial muscle activities and interpret these in terms of categories such as emotions, attitudes or moods. Facial Action Coding System (FACS), the most commonly used system developed for human observers to describe facial activity, allots Action Units (AU) to visually observable facial muscle actions. FACS allows unique decomposition of facial expression to 44 AUs.

The methodology used is based on studying the underlying AUs involved in expressing the different types of emotions. Then the specific AUs movements can be observed using luminous markers, placed on the subject's face. A video record of the subject is taken as the different types of emotions are expressed. Fig. 1 shows some digital stills extracted from such a video. The aim here is to identify the expressed emotion for each frame in the video by simply observing the changes in the positions of the AUs. Upon obtaining the video clip, the first step is to digitize the clip and obtain the AU positions in 2D over time.

The second step is a training session for a particular subject, where the program is manually taught the approximate positions of the AUs for each of the emotions we wish to detect. Finally, the program, a direct implementation of GPSO, is executed for the full length video clip where a visual display of the emotion expressed at each frame is obtained continuously.

## PSO and GPSO

### *A. Particle Swarm Optimization (PSO)*

A PSO algorithm maintains a swarm of particles, where each particle represents a potential solution. Particles are "flown" through a multi-dimensional search space, where the position of a particle is adjusted according to two factors:

- Its own successful experience
- The successful experiences of its neighbours.

The velocity vector drives the optimization process, and reflects both the experiences of the particle and that of its neighbours. The experiential knowledge of the Particle is referred to as the cognitive component, and is proportional to the distance of the particle from its own best position. The socially exchanged information is referred to as the social component of the velocity equation and is represented by two PSO algorithms, gbest and lbest,. The social networking employed by gbest PSO reflects a star topology, where the social component of the velocity reflects the information obtained from the entire swarm. The lbest, is similar to gbest, except that it uses a ring social network topology, where smaller neighborhoods are defined for each particle. The social component reflects information exchanged within the neighborhood of the particle. The two versions of PSO algorithms are similar because the social component of the velocity updates causes both to move towards the global best, with two main differences:

- the larger particle interconnectivity in gbest converges faster but at the cost of less diversity.
- larger diversity in lbest, results in more coverage of the search space, and less prone to being trapped in local minima.





### *B. Guided Particle Swarm Optimization (GPSO)*

Emotion detection is a search problem, to identify which of the possible emotion does the current facial expression represent. In order to apply PSO for emotion detection, definable parameters of the algorithm are:

- search space and its dimension
- representing a particle in the emotion-detection setting
- representing position and velocity of a particle
- objective function to be minimized by the PSO

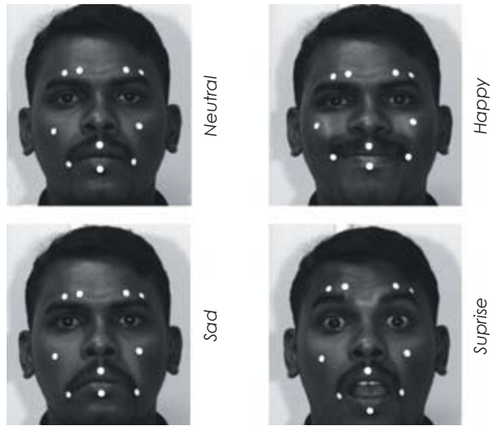


*Fig. 1 :* Positions of AUs in different emotions

The approach to emotion detection, is to monitor the changes in the positions of the action units, placed on the face of a subject over a period of time, from which we can then determine the emotion expressed at each point in time.

***Definition:*** **Search space and its dimension:**
If Action Units (AUs) are denoted by, q1, q2, ..., qn then D1, D2, ..., Dn represents the domains of the AUs, where Dj represents a 2-dimensional rectangular neighborhood window consisting of the possible points that qj can be assigned to. Then the search space is a n-tuple, Rn where the dimension of the search space is n, which represents the number of action units being observed.

***Definition:*** **Particle position and velocity:**
A particle is an abstract object in the Rn search space with a position and a velocity and represents a possible solution. In emotion detection there are a number of possible emotions which can be encountered at any time. In order to solve a multi-target problem, multiple swarms, one for each possible emotion is used. Since each swarm has a different target to reach, the objective function of each swarm, the Euclidean distance between its current position and its target, is defined differently.

***Definition:*** **Objective function for a swarm:**
In each iteration of the PSO algorithm, each swarm will update the positions of its particles as usual. These positions are then compared to find the swarm that is closest to its target, which is considered to have found a solution.

This gives data about the positions of the action units and if the particles can take advantage of this knowledge, then they are likely to reach their target sooner than if they rely solely on their cognitive and experiential knowledge. Changing the algorithm such that the position of the AUs should always be represented as one of the particles in each swarm. Incorporating these changes, the particles are effectively guided to converge towards the path of the action units. hence the term Guided Particle Swarm Optimization (GPSO).

## EXPERIMENTAL RESULTS

The GPSO algorithm, implemented in C# language under the .NET framework, has two modes: learning and detection. In the learning mode, a video clip is run to capture the approximate positions of the AUs corresponding to each of the basic emotions. Once a particular emotion is observed, the video is paused and the identified positions of the AUs are saved into a file as the coordinate values for the particular emotion. The learning session is over as soon as the data for each of the relevant emotions is obtained. In detection mode, the system will take as input a video clip, the digitized data for the video clip and the positions of the AUs corresponding to the various emotions as captured in the training session. The system initializes a swarm by creating random particles within the domain of each of the AUs. The GPSO algorithm is then executed to detect the emotions expressed in each frame of the video clip and the detected emotion is visually displayed on the screen.

The algorithm modifications introduced, enabled particles to converge very quickly towards the AUs and identify the emotion being expressed. Three of the six universal basic emotions, namely happy, surprise and sad are considered. These three, plus the neutral state gives four possible states that the GPSO system can detect presently. The system is tested with 6 different video clips of different subjects with each video clip about 30 seconds long or of 200 frames, displayed at about 7 frames per second. In order to test the performance of the detection algorithm, the system is made to pause at each frame, where a manual identification is also made and for each frame, the emotion detected by the system as well as manually is recorded in a file. The average success rates - where the auto-detection and the manual detection coincide - recorded after taking the data 10 times for each video clip, is quite good, ranging from 85% to 95%.

## Conclusions

A modification of the Particle Swam Optimization (PSO) algorithm for the purpose of emotion detection has been shown, appropriately named , Guided Particle Swarm Optimization (GPSO). It has been implemented and tested, with promising success rates. The algorithm is very efficient in terms of the speed with which particles converge to identify the emotion being expressed in each video frame. This is in part due to the concurrent nature of the PSO algorithm where multiple particles are involved in searching different portions of the search space in parallel, thus increasing the chances of finding a solution sooner. Another equally important factor contributing to the efficiency of the GPSO algorithm is the fact that it made particles to be guided by the actual positions of the AUs as the video clip is played.

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# Prof. Dr. Ali Yeon Md Shakaff

## *Academia is the only career that allows you to 'do things tomorrow, whatever that you dream tonight'…*

*Please elaborate on your educational background.*
I had my early education in Kulim and later at the Kolej Sultan Abdul Hamid in Alor Setar, before continuing my A-Levels at Grimsby College of Technology, England. I completed my degree in Electrical &Electronic Engineering at Newcastle University in 1982 and returned to serve as an electronic engineer at RTM for a year. I went back to Newcastle in 1983 to pursue a Ph.D in digital signal processing, via the USM's staff training program and started teaching at USM in early 1988, at the School of Electrical & Electronic Engineering.

*As UniMAP's iconic legend, please explain UniMAP's setting, her past and her future.*
UniMAP (or KUKUM at that time) was set up as one of the 4, new generation technical universities in the country. It was conceived by the government during the aftermath of the '97 financial crisis, with the aim of providing the industry with a new breed of 'highly skilled' engineers (skill in this sense, is both theoretical & practical), to help rejuvenate the economy. In the northern region, UniMAP was assigned the task of supporting the electronic industries in Penang, Kulim Hi-Tech Park and Sg.Petani, which explains why microelectronics became the initial focus of this university. Given that mandate, a number of engineering programs that was necessary to support such industries was put together. UniMAP was also instructed ('unwritten' though) to offer unique boutique programs that are useful to the industry. This explains the offering of programs such as mechatronics, metallurgy, photonics and several others.

About 3 years after our establishment, there seemed to be a growing shift in the focus of the economy towards bio-based industries, albeit the 'high-tech' bio-industry, and there was also a growing concern about the co-existence of the industry with the environment. Hence, the Bioprocess and Environmental Engineering programs were introduced. More recently, with the availability of the various core-engineering programs and the sudden upsurge in the interest in agriculture, Biosystem Engineering, a modern and high-tech form of agriculture engineering has been introduced.

Entrepreneurship for the engineering students has always been an important agenda for the university, in fact, well before it was made compulsory by the Ministry. It was also realized that with a purely 'engineering' environment within the university, it was somewhat difficult to conduct proper and effective programs in business and entrepreneurship. Hence, came the decision to offer several programs in this area, although it was a 'tough' battle to convince the Ministry on the need for such programs, and many other programs for that matter!

Therefore, essentially the university has been very dynamic and will have to continue to be dynamic to ensure that it remains relevant and competitive. I have no doubt that under the leadership of the present Vice-Chancellor, this university will continue to strengthen its current programs whilst at the same time explore the need for more and more emerging programs.

*As second in command, what are your aspirations for the university? Has it been achieved?*
My hope has always been to see this university command a 'respectable' status in the eyes of the stakeholders and other universities, at the soonest possible timeframe. In this respect, although there's always much to be done, we're almost there.

The overall curriculum, particularly the engineering programs are 'structurally' in place. In a way they are quite unique and designed to accommodate the original aspirations of the government, although inadvertently we faced some problems with people like the Board of Engineers, when things seem somewhat 'unconventional' to them (e.g the 'practical-intensive' issues, prolonged industrial training, which although are good for the students and their would-be industry employer, the BEM thinks otherwise!).

In terms of physical build-up, the 'signature' facilities are there….. the 'one-of-a-kind' semiconductor facilities, the Engineering Centre, Teaching Factory, the Dragon & Phoenix complex, the R&D Clusters, the Agro-Tech station and numerous others sprawled throughout Perlis; and not to mention the upcoming completion of part of the Pauh Campus soon.

*Where do you see the university heading in the next 20 years? Will UniMAP's niche programmes still be niche? Or will have to change over the course of time?*
As can be seen over the past decade, the world economy has become increasingly unpredictable. This directly affects the way we educate our masses. Hence, the University has to continually re-invent itself and it will be helpful for everyone involved to keep on open mind and not be constrained by 'pre-conceived' notions of what the university should be doing. For instance, it has been quite a struggle for the University to introduce non-EE programs, especially the bio-based and business programs, simply because of the so-called original unwritten 'mandate' that we should only be doing electronics. In short, the way I see it, our niche will continue (and should be preserved) to be engineering, particularly micro/nano electronics, but we have to re-examine our position from time to time, depending on the industry trends.

*After being at the helm for these past years, do you miss 'being there'?*
I have 'mixed-feelings' on this. 'Being there' one is obviously in a better position to somewhat 'influence' the University on how you want things to develop, especially since you've been there from day-1. On the other hand, 7 years has been long enough and perhaps it is time to contribute to the university in a different way.

*As for research, how much has UniMAP progressed? Is it up to your mark?*
It has progressed beyond my expectation. Considering the fact that only about 25% of our lecturers are PhD holders, a considerable number of the the younger staff , despite lacking experience have done extremely well in getting research grants and producing good results out of their research. Other than the numerous research medals that have been won over the years, the quality of refereed publications are also on the increase.

*How much more progress should be there? What else remains to be achieved?*
We are now in a situation whereby a considerable number of staff have gone or are going for their study leaves (not to mention the significant number of expatriates and locals who are on a short term contract basis). Hence, the need for the schools and research clusters to ensure research continuity is very important.

There is also the need to encourage a more cross-disciplinary research within the university and to promote general awareness among the lecturers regarding the availability of numerous research facilities within the university. This will ensure better utilization of resources and further enhance our research output.

Lastly, although much has been achieved, obviously it is still only a drop in the ocean. We'll need to strive harder to ensure even greater successes in the future.

*Having worked at different places, how much does UniMAP differ from other places?*
It is obviously very, very different. Seven years ago, we started off in a row of buildings beside paddy fields, 30mins from the Thai border, and trying to do some 'high-tech' stuff. Now, we have proven that it can be done, despite the numerous odds that had been stacked against us.

So, I guess UniMAP is different in terms of the 'never say NO spirit'

*On a personal note, do you miss making decisions for the university as a whole?*
Decision making often comes with responsibilities and I do not mind having less of that for now. On the hand, it has been quite an eye-opener over the past 2 months wandering across the university looking at things from the other perspective!!

*How are you spending time these days?*
I am now on a 9-month sabbatical. For the past 2 months I have been going through a period of adjustments (and trying to improve my health as well)… for the first time in 14 years that I am now without a secretary!!

I normally start my day with a 3km brisk walk, before going to the office, now at Jejawi (courtesy of the Dean of Mechatronics). I spend most afternoons either at the Muhibbah Lab or the Sensors Technology Lab at Pengkalan Assam, trying to catch up on some research work with the Sensors group.

*What about research and lectures?*
I've been somewhat fortunate that all these while I have managed to somehow maintain my involvement with the Sensors Group. So, I am taking the present opportunity to enhance my contribution to the ongoing research work. With regard to lectures, yes it has been a while since I last conducted proper classes. So, again I am trying to make a gradual preparation for whatever class that I will be handling next year.

*As for UniMAP's young staff, what would you say to them? Why?*
Academia is the only career that allows you to 'do things tomorrow, whatever that you dream tonight'. It gives you a lot of flexibilities and basically you can 'control' your destiny (God willing, of course). The 'publish or perish syndrome' still persists and will continue to persist due to the very nature of the job. You must participate in research, better still be part of a research group, enhance your teaching and technical skills, produce papers and try to find consultancy opportunities wherever possible (for some added income!) and lastly, always be prepared to assist your School in whatever way possible. Here at UniMAP, it is always teamwork (as reminded by the VC almost every week!!).

*Is there a benefit of having a large population of young staff? Academically and research wise?*
Yes, definitely. Being young obviously means more energetic, enthusiasm, inquisitive etc,etc… But they must be prepared to be the 'Gurkha' during the first few years of their career, especially in research. I have very often seen young lecturers 'sub-con' their 'research' work to their students. This will not be good for them, more so if you have yet to do your PhD. Remember, this is, after all, a technical university and we must all be competent technically. It saddens me to see a lecturer in electronics who has never once build a hardware throughout his/her life. To them… it has always been Matlab, Matlab and more Matlab and…!!!

# International Postgraduates @ UniMAP

**The first international student** to register at UniMAP (formerly KUKUM) was Muhammad Iqbal s/o Muhammad Hussain from Pakistan who registered for the PhD programme in Manufacturing Engineering in February 2005. The number then increased to 5 by the end of that year. Undoubtedly, it was not easy for a relatively new university located way up north to satisfy students who came from different cultural and socio-economic backgrounds. A lot of constraints had to be overcome in the initial stage of the students' arrival, especially in assimilating them into the Malaysian way of life.

Up till June 2009 the number of international students in UniMAP has increased to 53 where 30 are enrolled in the PhD and 23 are doing their master's degree. The year 2008 saw one international student awarded the Doctor of Philosophy in Manufacturing Engineering and another awarded the Masters Degree in Mechatronic Engineering.

Most international students in UniMAP hail from Asian countries such as India, Bangladesh, Indonesia, Thailand and Myanmar. Some are from countries in the Middle East and Africa like Iraq, Jordan, Syria, Algeria and Nigeria. With such a large presence, these students have formed their own community in UniMAP and try their very best to adjust their cultural lifestyle to the new environment in Perlis. Even though they come from different cultural and socio-linguistic backgrounds they are very much interested in learning the custom and tradition of the local communities, especially Bahasa Melayu. For example, Zainab Khalil from Iraq and Maung Maung Soe from Myanmar are interested to learn Malay language for better communication with the local people. This should help them accommodate themselves with the local students.

Life for international students in UniMAP is not much different from that of international students studying in other universities in Malaysia except that they are not exposed to the hectic lifestyle of big cosmopolitan cities like Kuala Lumpur, Johor Bahru or Penang. Life in UniMAP, and Perlis in general, is dictated more by the natural environment, friendly community, and lower cost of living compared to other cities in Malaysia. Those who are quite used to a hectic lifestyle might not find it easy to adapt but for those who love peace and tranquility then UniMAP is the right university for them to pursue their studies.

Most higher degree students have never been to Malaysia or Perlis and they opine that UniMAP is a suitable university for them to study and to gain new experience. According to Omar Kareem from Iraq *"I have been studying here more than 2 years and I believe that Perlis is a good place to study without any diversion"*. Another student form India, Hariharan said *"It is simple and calm, no traffic. The people are very nice and really helpful, but the weather is hotter compared to other places"*.

The international students also involve themselves in various festivals and cultural activities like the International Students Carnival, International Cultural Night & Food Festival. They also partake in celebrating Hari Raya in UniMAP and attend wedding festivals of the various communities.

It is hoped that with the presence of the international community in UniMAP we can know more about the culture of various countries and respect the diversity that exist between us. The expertise and experience that they have are a valuable source of reference and guidance. As a country that is rich in custom and cultural heritage we are always deferential towards others and respect the differences that exist. Albeit being a university ensconced in a small state up north, UniMAP is able to blossom into becoming a competitive academic and research center and able to entice international students to come and pursue their studies here, thus promoting UniMAP and Perlis in total.






**Research, Development & Innovation (RDI)** continues to be a thrust to the forefront by UniMAP. In an effort to be competitive and recognized globally, UniMAP realizes the importance of RDI, which is an expensive activity and must be complemented by external fund sources. The following tables list the amount garnered by UniMAP per year.

## Research Grants Received To Date (July 2009)

| SOURCES OF RESEARCH GRANTS | 2006 (RM) | 2007 (RM) | 2008 (RM) | JULY 2009 (RM) |
|---|---|---|---|---|
| FUNDAMENTAL RESEARCH GRANT SCHEME – Ministry of Highier Education Malaysia. | 1,712,000.00 | 4,148,226.00 | 1,170,100.00 | - |
| SCIENCEFUND – Ministry of Science, Technology & Innovation | 1,405,500.00 | 5,249,912.00 | 1,655,390.00 | 345,986.00 |
| SHORT TERM GRANT – UniMAP | 606,020.00 | 30,000.00 | 514,482.00 | 293,800.00 |
| FELDA – Government Agency | 209,000.00 | - | - | - |
| Astronotic Sdn. Bhd. – Corporate Sector | 62,500.00 | - | - | - |
| Other Ministry of Highier Education Malaysia | - | - | 350,000.00 | 350,000.00 |
| Permodalan Nasional Berhad (GLC) | - | - | 59,980.00 | - |
| Ministry of Argriculture Research Grant | - | - | - | 208,900.00 |
| Others | - | - | 265,000.00 | - |
| **TOTAL** | **3,995,020.10** | **9,428,138.00** | **4, 014, 952.00** | **1,198,686.00** |

## Articles And Conference Papers Indexed By SCOPUS

An important measure of research in universities is publication output. How does one measure the quality of research and related publications? In answering this problem, the present scientific world has a self-regulated system of peer reviewing, impact factors and citation indices. The first, peer reviewing often uses researchers around the world to proof read a particular manuscript and cross-check against known theories and current advances. Impact factor relates to the quality of the journal. The higher its value, the more forefront is the research quality, as well as more prestigious.

The final quality check comes in the form of how seminal is the work published. If it is fundamental for technology advancement, then, many other researchers will cite it, hence, increasing its worth, measured as citation index. The impact factor can be measured in many ways but the most popular is that by ISI Thomson. Alternatively, Scopus uses all these values and lists them in a searchable archive on its website: www.scopus.com.

Based along this line of well established quality check-and-balance system built into the scientific community, UniMAP has also begun to accumulate quality publications. In 2008 a total of 115 articles and conference papers were published. This is a 42% improvement compared to 2007. It must be mentioned that this is by far the highest from all former technical-universities. The nearest from another is 57% lower! This bodes well for UniMAP's strategies and planning. The yearly increase in publications is indicative of a successful university in the making. This a good sign for UniMAP's R&D programmes.

## Research Products Registered For Patent Drafting 2009

| RESEARCHERS | TITLE | INTELLECTUAL PROPERTY NUMBER |
|---|---|---|
| Brigadier General Dato' Prof. Dr. Kamarudin Hussin<br>Prof. Dr. Shamsul Baharin Jamaludin, Assoc. Prof. Che Mohd RuzaidiGhazali<br>Dr. Khairul Nizar Ismail, Mohd Sobri Idris, Mohd Nazry Salleh. | KUKUM Artificial Marble | Filed (PI 20091253) |
| Ragunathan A/L Santiagoo<br>Dr. Ir. Salman Hissiensyah, , Azlinda Abdul Ghani,<br>Assoc. Prof Che Mohd Ruzaidi Ghazali, Roshasmawi Abdul Wahab. | Recyclable Construction Materials | Filed (PI 20090778) |
| Prof. Dr. Uda Hashim<br>Mohammad Nuzaihan Md Nor, Nur Hamidah Abdul Halim. | A Method Of Producing Nanowires And A Product Derives Thereof | Filed (PI 20091646) |
| Suhardy Daud<br>Prof. Dr. Shamsul Baharin Jamaludin, Assoc. Prof. Che Mohd Ruzaidi Ghazali<br>Mohd Nazry Salleh, Farizul Hafiz Kassim, Saiful Azhar Saad<br>Tengku Nadzlan Tengku Ibrahim. | A Board And Its Production Method | Filed (PI 20091352) |
| Mohd Ichwan Nasution<br>Prof. Dr. Shamsul Baharin Jamaludin, Assoc. Prof. Che Mohd Ruzaidi Ghazali<br>Faizul Che Pa, Che Idrus Omar. | A Cast Product And Its Method Of Production | Filed (PI 20090633) |
| Soh Ping Jack<br>Arzemi Abdullah Al- Hadi, Mohd Ezanuddin Abdul Aziz<br>Mohamad Ezral Baharudin, Assoc. Prof. Dr. R.Badlishah Ahmad. | A Dielectric Loaded Helical Antenna | Filed (PI 20091543) |
| Azremi Abdullah Al- Hadi<br>Soh Ping Jack, Assoc. Prof. Dr. R. Badlishah Ahmad, Suhaizal Abu Hassan<br>Mohamad Ezral Baharudin, C.S. Por, Saidatul Norylyana Azemi<br>Nurul Husna Mohd Rais. | Compact Planar Highly Efficient Antenna For Wlan Applications | Filed (PI 20091675) |

# Autonomous System and Machine Vision Research Cluster

**The Autonomous System and Machine Vision (Auto-MAV)** Research Cluster is dedicated to the research and development of techniques and applications of computer, automation, robotics and machine vision. The increased use of intelligent robotic systems in current indoor and outdoor applications bears testimony to the efforts made by researchers on all fronts. Autonomous Mobile Systems have greater autonomy than before, and new applications abound - ranging from factory transport systems, airport transport systems, road/vehicular systems, to military applications, automated patrol systems, homeland security surveillance, and rescue operations. Machine Vision (MAV) is the application of computer vision to industry and manufacturing. Whereas computer vision is mainly focused on machine-based image processing, machine vision most often requires digital input/output devices and computer networks to control other manufacturing equipment such as robotic arms. MV is a subfield of engineering that incorporates computer science, optics, mechanical engineering, and industrial automation.

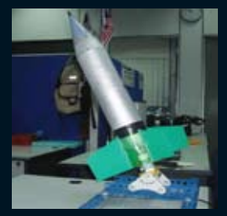



## OBJECTIVE

- To attract researchers in the field of Autonomous Mobile System Design and Machine Vision.
- To build up national and international co-operation with the industry and fellow institutes
- To lead in autonomous and machine vision technology and applications area
- To enhance publication output in terms of refereed journal articles

## RESEARCH INTEREST AREAS

**Autonomous Mobile System & Artificial Intelligence**
- Modeling and Control
- Map Building and Path Planning
- Decision Making and Autonomy
- Real Time Systems



**Machine Vision System**
- 2D and 3D Image Processing
- Signal Processing and Analysis
- Recognition and Positioning
- Real Time Processing
- Biometric Systems

**UAV & Anti-Gravity**
- Vertical Short Take-Off and Landing (V/STOL) Air Craft
- Active Landing Gear Stability System

**Robotics**
- Navigation and Motion Planning
- Robotic Modeling and Design
- Robotic Control Systems
- Communication, Perceiving and Acting Robotics

## RESEARCH ACTIVITIES

### *Current Projects*

- Real-Time Mobile Robot Motion Control for Stable-Target Trajectory Tracking Control
- Design and Development of Autonomous Quad-Rotor UAV to Study Flight Dynamics and Control
- Real-Time Biometric Face Recognition System for Criminal Investigation and Identification
- Investigation on Stereo Vision Based Robotic Bin Picking System for Agile Manufacturing
- Mobile Robot Positioning and Stable Target Recognition Based on Stereo Vision System
- Development of Bipedal Walking Robot with Balance and Control
- Design of Artificial Intelligence Diagnostics System for Tuberculosis
- Embedded Heart Disorder Portable Screening System Using Time-frequency Features and Extraction Algorithm of Heart Sound Signals
- Design of A Portable Continuous Blood Pressure Monitoring Kit With Built-in Low and High Blood Pressure Early Warnings

### *Future Projects*

- Total Staff, Student, and Iventory Management and Monitoring Security System (T-SIMS)
- Development and Application of Hydrofuel Concept For 4 Stroke Carburetor Engine
- Development of UAV Active Landing Gear System for Vibration Damping and Stability Improvement
- Automated Inspection System for Color and Shape Using Machine Vision
- Development of A New Hybrid Parallel Mechanism

## CONTACT

**Dr. Hazry Desa**
Head of Cluster, Automation System and Machine Vision Cluster,
Universiti Malaysia Perlis(UniMAP),
Bangunan Pengkalan Indah, Jalan Pengkalan Asam,
01000, Kangar, Perlis, MALAYSIA.

Tel: 04-9798499
Fax: 04-9798142





# Doctorate Workforce

**Since** its inception almost eight years ago, UniMAP has always stressed on the importance of improving the intellectual potential of her academic workforce, in order to enhance effective teaching to students. Hence, increasing the number of Ph.D (Doctor of Philosophy) lecturers has been a focus. As early as 2003, the first batch of lecturers were sent abroad to further their studies.

This proactive role by the university management is a bold balancing act because as a newly set-up university the balance between an ever increasing number of undergraduates and its effective teaching force comes to a critical point. However, in view of long-term effectiveness this has to be done.


A total of seven of the first batch of lecturers sent are now back in UniMAP, and in various leading positions. Dr. Hazry Desa, from Oita University, Japan focused on mechatronics engineering. Another five from various schools or dicsiplines were sent to United Kingdom while one obtained his Ph.D locally. Dr. Mohd. Saifuldin Abdul Manan and Dr. Khairul Azwan Ismail are both at the School of Manufacturing Engineering, but pursued their Ph.D's from University College, London and University of Cambridge, respectively.

School of Microelectronic Engineering has Dr. Asral Bahari Jambek from University of Edinburgh and Dr. Mukhzeer Mohamad Shahimin from University of Southampton. Dr. Asral specialized in IC Design while Dr. Mukhzeer specialized in Bio-Photonics. Dr. Mohd. Fareq Abd. Malek, currently at the School of Computer & Communication Engineering, obtained his Ph.D from the University of Liverpool. Dr. Luqman Musa of Materials Engineering had obtained his doctorate from Universiti Sains Malaysia.

Now, they have all come back with a doctorate and are highly committed to contributing their skill, knowledge and experience to UniMAP. The seeds of a bold action plan are finally seen. Their presence has contributed to significant growth and improvement to UniMAP. Most of them are still young and energetic and not only are they contributing academically, they are also into administration and research as well.

Dr. Hazry Desa, for example, with his skills and credibility has been appointed as the Dean of the Centre for Communication Skills and Entrepreneurship as well as being a lecturer for Mechatronic Engineering. He has also been appointed as the Head of 'Autonomous System and Machine Vision' Research Cluster where he leads a group of researchers in their related fields. On the other hand, Dr Saifuldin Abdul Manan and Dr. Mohd Fareq Abd. Malek have been appointed as Deputy Dean of Research and Academic for their respective schools, Manufacturing Engineering and Computer & Communication Engineering.

As of July 2009, 159 of UniMAP's staff are continuing their post-graduate (doctoral) degree all over the world. When they have completed their studies and returned, they will continue UniMAP's tradition to always remain dynamic and competitive not only locally but also globally.

*Their presence has contributed to significant growth and improvement to UniMAP. Most of them are still young and energetic and not only are they contributing academically, they are also into administration and research as well.*

This year is a windfall year for UniMAP conferences. Various schools have been invited by outside counterparts, to host a variety of conferences, ranging from bio-systems to power electrical systems.

This is another testimony of the acceptance of UniMAP by other established universities. An important point not to be overlooked is the hard work of the members of organizing committees besides teaching and project supervision.

For more information on the conferences, please visit our website: www.unimap.edu.my











# Agrotechnology Research Station

## University Malaysia Perlis (Agrotech@UniMAP)

**Introduction**

The state of Perlis and her people are very closely linked to agriculture and land-produce, especially with padi, sugar cane, mangoes, grapes, vegetables and other crops. Farming in general has, however, remained largely traditional with minimal use of new and advanced technology and techniques. The establishment of Agriculture Research Station at University Malaysia Perlis (Agrotek@UniMap) is one of the initiatives of UniMAP's Strategic plans to service the local agriculture industry . The station, part of UniMAp's R&D program, aims for the future and to broaden the perspective of farming by generating a portfolio of technologies for K-agriculture. It will leverage its engineering strength to spur new opportunities.

**Approach**

A one stop centre to innovate agriculture technology through the convergence of Biotechnology (BT) with Information and Engineering Technology (IT and ET) aims at sustainable productivity, resources use efficiency and socio-economic acceptability. The UniMAP's seven research clusters of engineering specialization will provide additional support. The concept of E-Farming will be promoted to increase farming activities in the following techniques : Engineering technology, Electrical connectivity, Eco-friendly, Efficiency, Enterprising, Empowerment and Education.

**Roles and Functions**

- To generate a portfolio of agriculture technology, products and services benefiting the agriculture sector.
- As a feeder to academic programmes with research-first approach.
- Provide platform for collaborations and outreach programs
- Generating local-centric, high engineering content farming technology.
- Provide training to bridge the technology gap and increase opportunity options
- Focal point of agrotechnology networking in the north and the hinterlands of Indonesia Malaysia Thailand Growth Triangle (IMTGT).

**Contact:**

**Assoc. Prof. Mahmad Noor,** Director of Agrotechnology Development Unit
Agrotechnology Research Station, Kampus Sg Chuchoh Padang Besar, Perlis, Malaysia.
Tel: 04-9456614 Fax: 04-9456603

# UniMAP Invention Exposition 2008 : Quality Research Products

**This** year's Inventions Exposition, held on 8 January 2009, is the third of its kind in UniMAP. Similar to previous years, participation and enthusiasm has been overwhelming. There was an increase in the number of participation too, numbering a total of 112 research products. The main reason for having this exposition, held in Education Centre 2 Complex, Jejawi, is to filter and select products that are eligible to participate in national or international competitons or expositions.

Sixteen of UniMAP's experienced lecturers were chosen to evaluate the research products in this expo. A total of 17 golds, 18 silvers and 40 bronze medals were given away, making a total of 75 eligible products for national level expositions such as Malaysia Techlogy Expo (MTE), Pameran IKS Kebangsaan (SMIDEX) and Pertandingan R&D IPTA (PECIPTA).

Another first for UniMAP's Invention Exposition is coverage by Bernama, RTM perlis and Utusan Malaysia. Prof. Dr. Zul Azhar Zahid Jamal, Deputy Vice Chancellor of Research and Innovation gave briefings, objectives and tour of the exposition.


# UniMAP Shines in Malaysia Technology Expo (MTE 2009)

**MTE 2009** saw UniMAP sending 20 entries. The event was held at the Putra World Trade Centre, Kuala Lumpur between 19 – 21 February 2009. The 20 participations had been thoroughly filtered at the university level and must be a bronze medalist at the very least to be able to reach national level competitions / expositions. This year also saw a record highest participtionever, with 460 research products competing in the expo.

UniMAP's preparedness and planning had enabled her researchers to haul 17 medals from this exposition. A single gold, seven silvers and nine bronze medals had been won.

UniMAP's single gold medalist was Mr. Mohd Hafiz Fazalul Rahiman from the School of Mechatronics Engineering. His research product title was "Ultrasonic Tomgraphy Imaging Instrument". Additionally, UniMAP also won 'Best Booth Design' in the category of 'Bare Space Booth'.

# ENVEX 2009

**Azliyana Ahmad**, a final-year student from the School of Materials Engineering, won the coveted main prize at the UniMAP Engineering Invention & Innovation Exhibition or ENVEX 09 that was held at Dewan Kolej Kediaman Kg. Wai, Kuala Perlis on 23 Mac 2009.

Her invention, "CD-R Waste Recycling Process : Ultrasonic Separation Process of Gold", was judged to be good enough to help her bag a gold and a special research award in the "Environmental, Energy and Water" category. She took home RM 1,000 for best prize and RM 500 for the special award, a medal and certificate.

Sixty-four UniMAP students from all engineering schools took part in the inaugural expo. The competition was divided into seven categories: Category A (Mechanic and Engine), Category B ( Computer Science, Video and Telecommunications), Category C (Electronic Technology), Category D ( Building, Civil Engineering, Woodwork, and Materials), Category E (Electrical Technology), Category F (Environmental, Energy and Water) and Category G (Biotechnology and Agriculture).






# Five Country Collaboration on Research and Education

**On March 30 2009**, King Mongkut's University of Technology Thonburi (KMUTT), Thailand hosted an international forum in Bangkok to advance educational and research collaborations among Thailand, China, Canada, Vietnam and Malaysia. The forum was attended by Hunan University (HNU), Xiamen University of Technology (XMUT), China, University of Regina (U of R), Canada, PetroVietnam University Project Management Board (PVUPMB), Vietnam, and Universiti Malaysia Perlis (UniMAP), Malaysia. The four member UniMAP delegation to the forum was headed by Prof. Zul Azhar Zahid Jamal, the Deputy Vice Chancellor (Research and Innovation).

To encourage educational and research collaborations, the six institutions have agreed to the following forms of collaboration:
- Joint education and research activities
- Exchange of academic materials and academic publications
- Exchange of faculty members for research, lectures, and discussion
- Exchange of students for study, research, and other activities
- Organisation of joint academic and scientific conferences

The current secretariat, KMUTT, will serve until March 2010. The next forum will be held in 2011 by XMUT which will take over as the secretariat for the period April 2010 to March 2012.

In the next forum, the participating institutions will have extensive discussions regarding various aspects of bilateral and multi-lateral collaborations. To benefit from these collaborations, it is hoped that all schools, institutes and centres will initiate proposals for collaborations and forward them to the Deputy Vice Chancellor (Research and Innovation) for further action.

# UniMAP Agrotechnology Research Station

**On 13 May 2009**, HRH the Raja of Perlis, Tuanku Syed Sirajuddin Putra Jamalullail had consented to officiate UniMAP Agrotechnology Research Station at Sungai Chuchuh, Perlis.

Also present during this historic event were his consort Raja Perempuan Perlis, Tengku Fauziah Tengku Abdul Rashid, and the Crown Prince who is also the Chancellor of UniMAP, Tuanku Syed Faizuddin Putra Jamalullail. Other distinguished guests were the Menteri Besar, Datuk Seri Dr. Md. Isa Sabu, State Exco members and UniMAP Vice Chancellor, Brig. Gen. Dato' Prof. Dr. Kamarudin Hussin.

HRH the Raja of Perlis expressed his admiration and was truly confident that the setting up of the station would have a huge impact on the agricultural sector of the state within a relatively short period of time. HRH hoped that with the sophisticated infrastructure and immense technical know-how of UniMAP staff the station would be able to play a prominent role in boosting local produce to be more value added and to generate higher productivity for small-and-medium sized industry, especially in areas close to the Malaysia-Thai border.

The Agrotechnology Research Station is part of UniMAP's second campus site with an area of about 250 acres. The campus is to be known as UniMAP Sungai Chuchuh Campus. The development of this campus is a result of UniMAP Strategic Planning and is based on the concept of integrating academic knowledge with practical agricultural practices that are supported by existing engineering disciplines in UniMAP.

# NRIC 2009

**On 21 May 2009**, Universiti Malaysia Perlis (UniMAP) once again notched a commendable success when two of its students' research products reaped the 'Motorola Invention Award' and 'Best Invention & Innovation Award' sponsored by Motorola (M) Bhd. at the 2009 National Research and Innovation Competition (NRIC) which was held recently. The two products were Roombot – A Housekeeping Robot by Vivian Tang Sui Lot and Blind's Man Navigation Robot (ROVI) by Melvin A\L Andrew @ Prabu. Both are from the School of Mechatronic Engineering. The three-day competition held at Universiti Sains Malaysia saw UniMAP taking home two gold medals, two silver and three bronze. These honours put UniMAP in second place behind Universiti Teknologi Malaysia.

# IMT-GT AREX Met Its Target

**After** successfully organizing the 11th IMT-GT Varsity Carnival last March involving sports and cultural activities for students, UniMAP felt that a similar event should also be extended to involve academic staff and researchers from universities that come under the Indonesia-Malaysia-Thailand Growth Triangle or IMT-GT. Thus the idea to organize the 'IMTGT – Academic & Research Exposition' (IMTGT-AREX 2009) was mooted.

The expo, which took place from 16-17 June 2009, was held in conjunction with the Raja of Perlis' 66th birthday celebration. The event which took place at Dewan 2020 in Kangar garnered the latest research products from universities under the IMT-GT region. 'Strengthening Agricultural Entrepreneurship through Engineering' was the theme for the expo and most of the research products displayed were based on the theme. Several research institutions and selected agencies from all over the country were invited to participate in the expo.

Among local institutions of higher learning involved were Universiti Sains Malaysia, Universiti Utara Malaysia, Universiti Teknologi MARA Perak Campus, Universiti Teknologi MARA Shah Alam Campus, Universiti Perguruan Sultan Idris, Universiti Tun Hussien Onn Malaysia, Politeknik Arau, Kolej Matrikulasi Perlis and Kolej Komuniti Arau. International participants were from Hatyai University, Walailak University, Prince Of Songkla University, Thaksin University, Universitas Sumatera Utara, Universitas Negeri Medan, Universitas Muhammadiyah Sumatera Utara and Institut Teknologi Medan, Indonesia.

The expo was officiated by HRH the Chancellor of UniMAP. The first day of the event was witnessed by the Menteri Besar of Perlis, Chairman of the University Board of Directors, Vice Chancellor of UniMAP and other distinguished guests from within and outside the country. HRH the Chancellor also consented to presenting mementos to all exhibitors and visited the display booths.

# MUCEET 2009 – Continuous Cordial Working Relationship Between MTUN Members

**MUCEET 2009** or Malaysian Technical Universities Conference on Engineering and Technology was the third conference that involved academic staff from the four technical universities in Malaysia, viz. Universiti Tun Hussein Onn(UTHM), Universiti Teknikal Melaka Malaysia (UTeM), Universiti Malaysia Pahang (UMP) and Universiti Malaysia Perlis (UniMAP).

Universiti Malaysia Pahang was chosen to host the event that was held at Hotel M.S. Garden, Kuantan, Pahang from 20 – 22 June. Two-hundred conference papers were presented with 50 papers from each university. Apart from paper presentation, the host also organized an exposition to display research products from the four participating universities.

UniMAP sent in 8 products for display and these were showcased at the foyer of Berjaya Megamall, Kuantan. Four categories of competition were designated at MUCEET 2009, viz. Manufacturing, Emerging Technology, Science & Engineering and Social Science & Management.

UniMAP won a prize in the "Emerging Technology" category via Dr. Mukhzeer Mohamad Shahimin from the School of Microelectronic Engineering with his paper presentation titled "Optimisation of polymer particles propulsion on caesium ion-exchanged channel waveguide for stem cells sorting applications". His delivery was also deemed excellent enough to bag him the Best Paper Presentation Award. His winning effort brought in cash reward of RM1,000 and a laptop.







# UniMAP Meritorius at ITEX 2009

**Universiti Malaysia Perlis** recently participated in the 20th International Invention, Innovation, Industrial Design & Technology Exhibition 2009 or ITEX and it was its fifth participation in the exhibition. A total of 610 research products from 9 countries were entered for competition at this year's event. Apart from Malaysia, 8 other foreign countries took part and these include Iran, Taiwan, Hong Kong, Korea, Croatia and Australia. At this year's event UniMAP sent in 39 research products and these made up the second highest number of entries after Universiti Kebangsaan Malaysia.

The research delegation from UniMAP at ITEX 2009 were deeply honoured by the presence of its Vice Chancellor Brig. Gen. Dato' Prof. Dr. Kamarudin Hussin who took a tour of the exhibition to lend moral support to UniMAP researchers. He was accompanied by Prof. Dr. Zul Azhar Zahid Jamal, Deputy Vice Chancellor (Research & Innovation).

The participation was well worth the effort. UniMAP researchers won 9 gold, 17 silver and 9 bronze medals. It was a glorious day for UniMAP when it was also handed the Gold Award for its booth adjudged to be the best in the 54 sq. ft and above category. On the whole, team UniMAP had put up a tremendous performance at ITEX 2009. Kudos to all researchers for swelling the fame of the university and may the effort stoke the flame of success for others to follow in time to come.

# MoU With ROMSTAR Sdn. Bhd.

**A Memorandum of Understanding (MoU)** was undertaken by signatories UniMAP and Romstar Sdn. Bhd., an oil and gas service establishment. This MoU bolsters UniMAP position and rapport with the industry. Romstar Sdn. Bhd. is a wholly local establishment that provides testing and certification services of pipelines for the oil and gas, and the energy industry internationally. In its quest to continually upgrade service quality and to keep abreast with technology, Romstar had expressed interest in fostering a joint project with UniMAP after a visit mooted late last year.

As a follow-up to the initial visit, a second visit involving a bigger number of people from both parties took place early this year. It must be mentioned that Y.B.M. Dato' Seri DiRaja Syed Razlan Ibni Syed Putra Jamalullail had played an active role in bringing both parties together, and to Perlis. The next obvious step was an MoU, where four different disciplinary centres from UniMAP joined forces and expertise. These centres are the School of Mechatronic Engineering, School of Materials Engineering, Teaching Factory and Engineering Centre. The MoU between UniMAP and Romstar Sdn. Bhd. was held at the Perdana Felda Hall, Kuala Lumpur where UniMAP was represented by Brigadier General Dato' Prof. Dr. Kamarudin Hussin, while Romstar was represented by her executive director, Mr. Baharom Hamzah.