



Intelligent Quality Inspection and Monitoring: A Good Partnership between Consumerism and Smart Manufacturing?

Lai Weng Kin

Department of Electrical & Electronics Engineering
Faculty of Engineering & Technology
Tunku Abdul Rahman University College
MALAYSIA

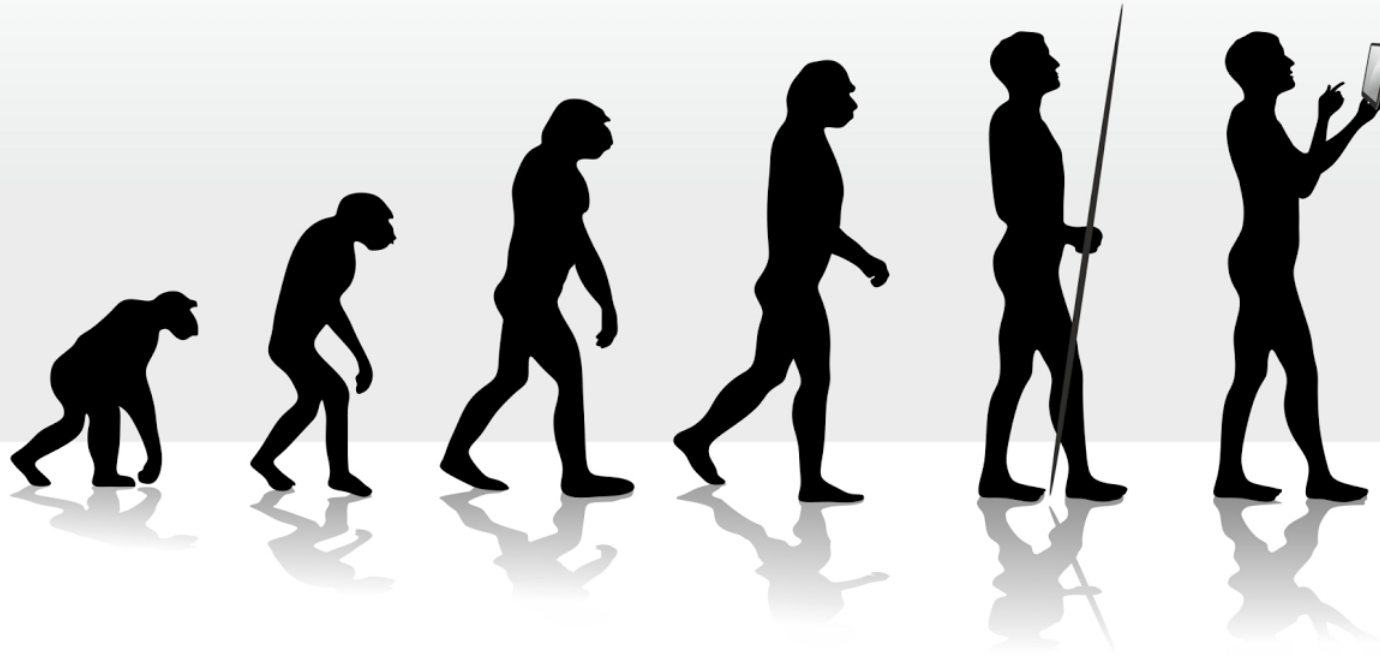


Agenda

- Background and Motivation
- Cheaper?
- Better?
- Faster?



Background



Age of Consumerism and the implications

Drives,

- ↓ ○ production cost – *higher profits*
- ↓ ○ selling price – *increases sales* – *cheaper!*
- ↑ ○ volume – *to satisfy customer demand*
- ↓ ○ time-to-market



Push towards automation

Benefits

- ✓ less human involvement – *faster!*
- ✓ improves quality – *better!*
- ✓ more consistent quality
(*by having less subjectivity*)
- ✓ minimizing the need to train the operators



- Age of Consumerism and the implications
- New computing paradigms emerging, especially those that mimic large brain-like structures

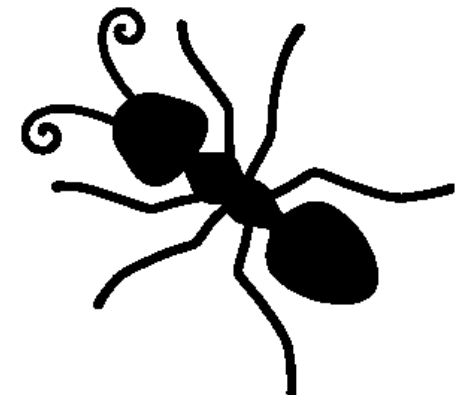




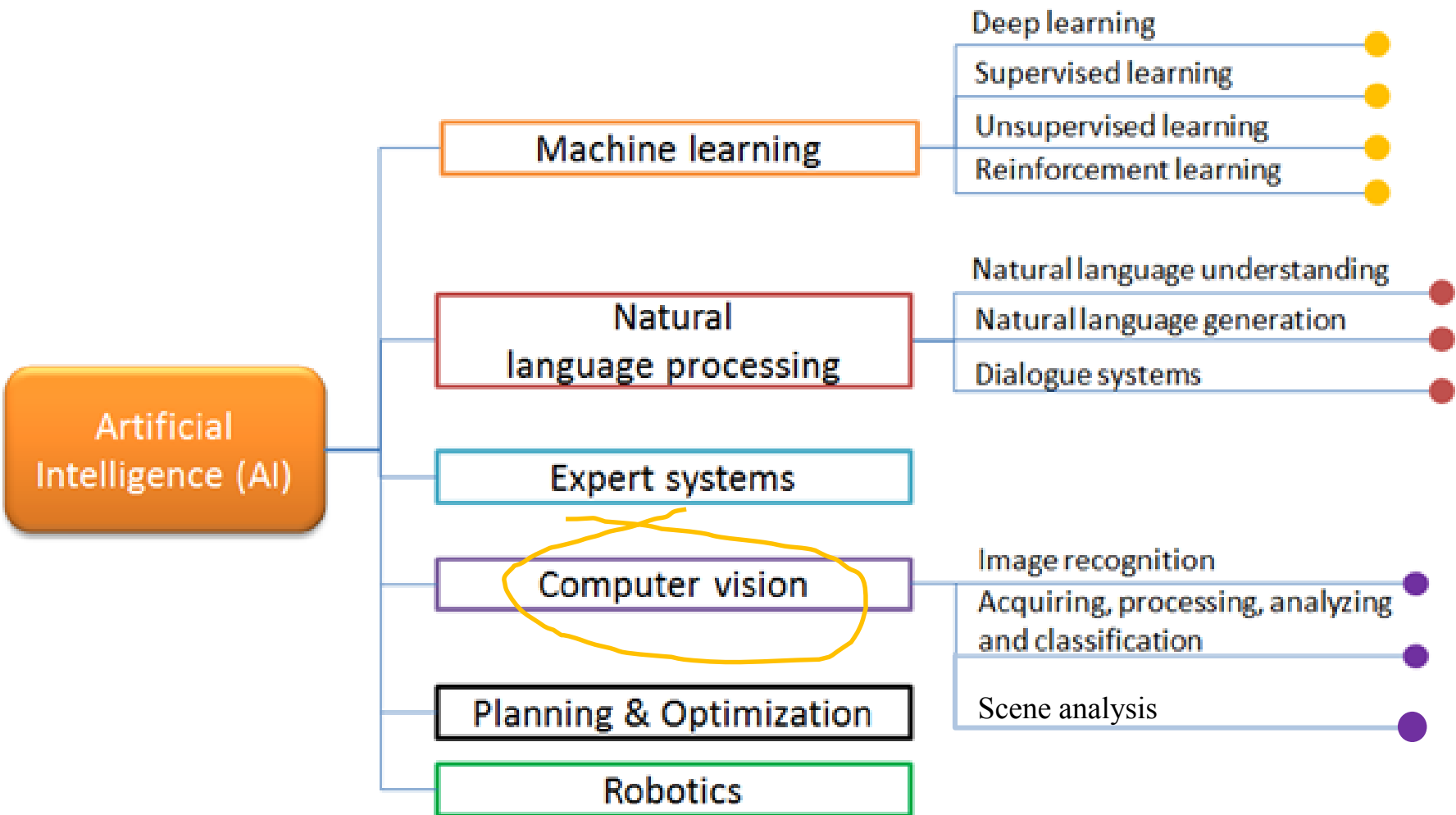
- Age of Consumerism and the implications
- New computing paradigms emerging especially those that mimic large brain-like structures
- Computing power and cheap but powerful sensors are some of the key drivers
 - ✓ Integration of different signal modalities can be a major challenge
 - ✓ CI is the final part of the number crunching process?
 - ✓ Working with big data – Hardware revolution needed*?



- Age of Consumerism and the implications
- New applications emerging especially with regards to large brain-like structures
- Computing power and cheap but powerful sensors are some of the key drivers
- But not all applications need such solutions – do we need a tank to kill an ant? Depends on the industry and the recipients' available resources.



Artificial Intelligence in





Cheaper ?

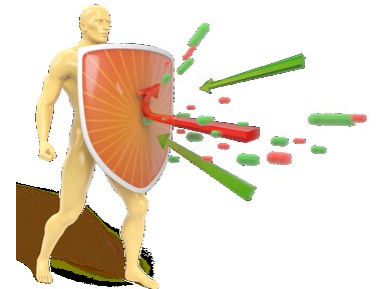


**EDIBLE BIRDS
NEST**

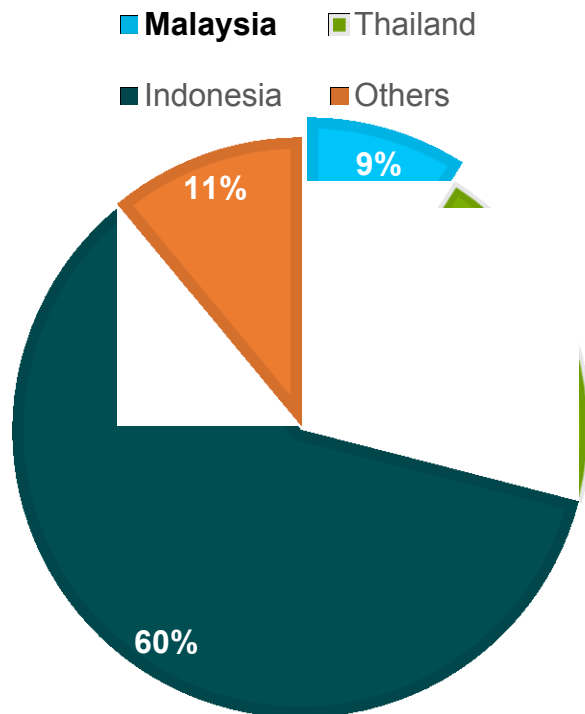
Background

Edible Bird Nest (EBN)

- Indulgences in the Chinese cuisine
- Numerous of health advantages
- Improve overall mental dexterity and physical health



Production of EBN





- ✓ Malaysia is the third largest producer of EBN in the world
- ✓ Annual production of EBN in Malaysia has reached a value of 1 billion ringgit (US\$290 million)

Edible Birds Nest

EBN Harvesting

Cave



Swiftlet houses



EBN Trading

- Swiftlet farming industry is **expanding** rapidly in Malaysia



- Expected to contribute **more than** RM5.2 billion to the Malaysia's Gross National Income (GNI).
- Achieved an estimated value of RM1 billion **per annum**.



PRIOR WORK

Computers and Electronics in Agriculture 96 (2013) 90–108



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Computers and Electronics in Agriculture

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Application of the fuzzy Failure Mode and Effect Analysis methodology to edible bird nest processing



Chian Haur Jong^a, Kai Meng Tay^{a,*}, Chee Peng Lim^b

^aFaculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

^bCentre for Intelligent Systems Research, Deakin University, Geelong Waurn Ponds Campus, Locked Bag 20000, Geelong, VIC 3220, Australia

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ABSTRACT

The focus of this paper is on the production processes of Edible Bird Nest (EBN) in Sarawak, Malaysia. Sarawak and Sabah (two states of Malaysia in the Borneo Island) are known as the second ranked resource area (after Indonesia) of the world for EBN production. In spite of the popularity of EBN as a food source and the important economic status of the EBN industry, the use of a quality and risk assessment tool for the production of EBN is new. As such, the implementation of an advanced quality and risk assessment tool, i.e., the fuzzy Failure Mode and Effect Analysis (FMEA) methodology, for EBN processing is described in this paper. Data and information are gathered from several EBN production sites, and fuzzy FMEA is adopted to analyze the collected data/information. It is worth mentioning that the EBN production in Sarawak is relatively traditional. As such, this work makes an important contribution to modernization of the EBN production industry in Sarawak, i.e., to improve the production process and ensure the quality of EBN via the use of a formal quality and risk assessment tool. Besides, this paper contributes to a new application of fuzzy FMEA to the agriculture and food domain.

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Edible Bird Nest Processing using Machine Vision and Robotic Arm

Yuvarajoo Subramaniam^a, Yeong Che Fai^{b,*}, Eileen Su Lee Ming^c

^aMalaysia Japan Institute of Technology (MJIT), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

^bCentre for Artificial Intelligence and Robotics, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia

^cFaculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

*Corresponding author: cfeong@fke.utm.my

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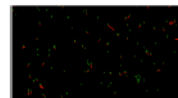
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Accepted :15 October 2014

Graphical abstract



Abstract

Edible bird nest food product is one of the demanding food product in food production industry. Government looking into ways to improve this industry to boost the economy. Many large scale production are being operated around Malaysia. One of the major difficulties faced in processing the bird nest is to remove its impurities or more formerly known as dirt. Current conventional cleaning method which is manual cleaning is not cost effective and time consuming. Furthermore, it also requires large number of workforce to be used for processing small quantities of bird nest. This paper presents an automated system which utilizes machine vision system and an industrial robot to accomplish a better processing system for edible bird nest. This system offers great advantage compared to conventional process by reducing the time consumed for processing and increase the efficiency.

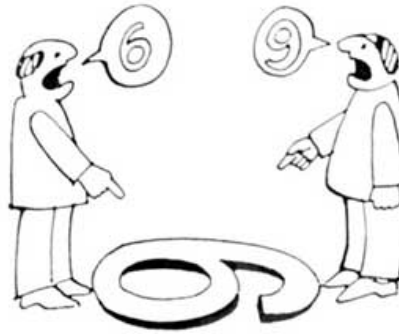
Keywords: Edible; bird nest; automation; vision; robotic

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Low skilled workers

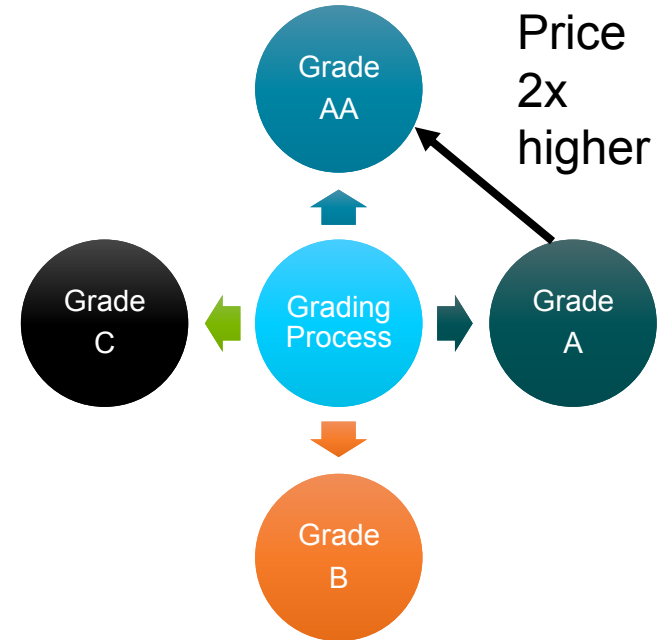
Subjective grading



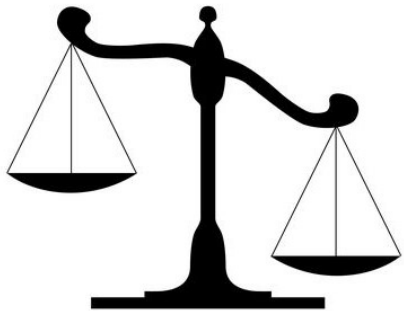
Tiredness



Problem Statement



Economic losses with Inaccurate grading



Features

Size

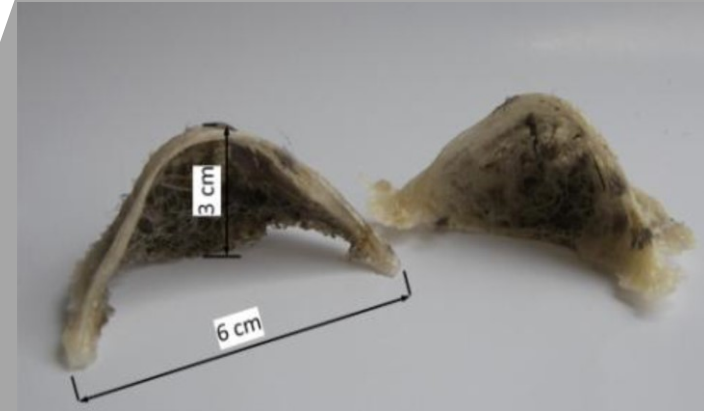
- Comparing the size of the EBN with index finger, middle finger and the ring finger of an adult
- Inconsistent

Impurities

- Number of impurities

Color

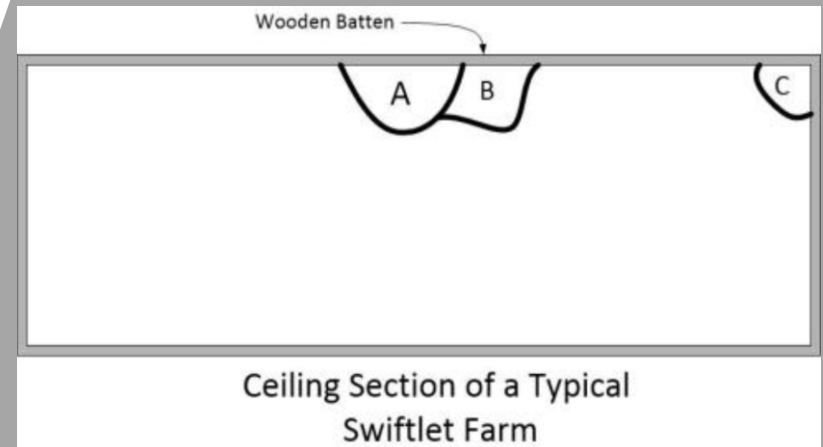
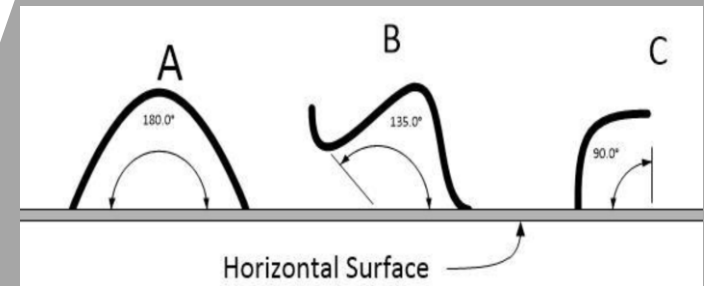
- White color nests are the highest grade

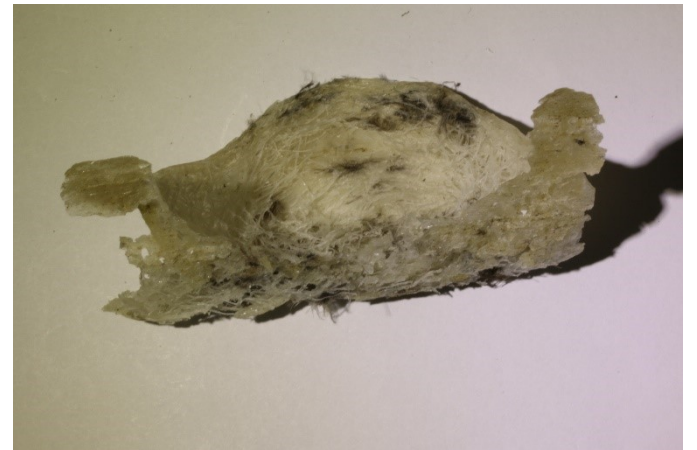
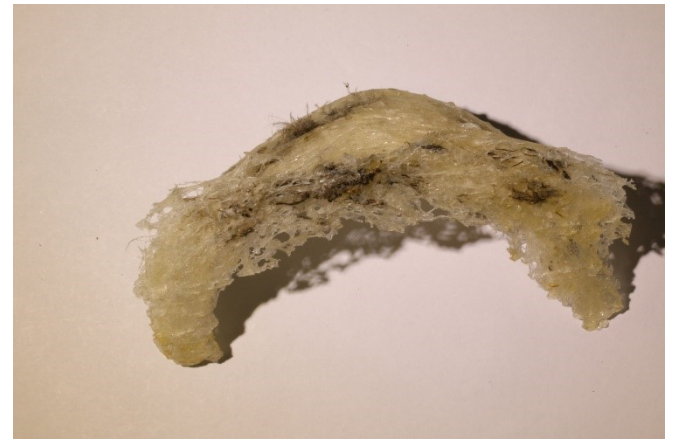


Features

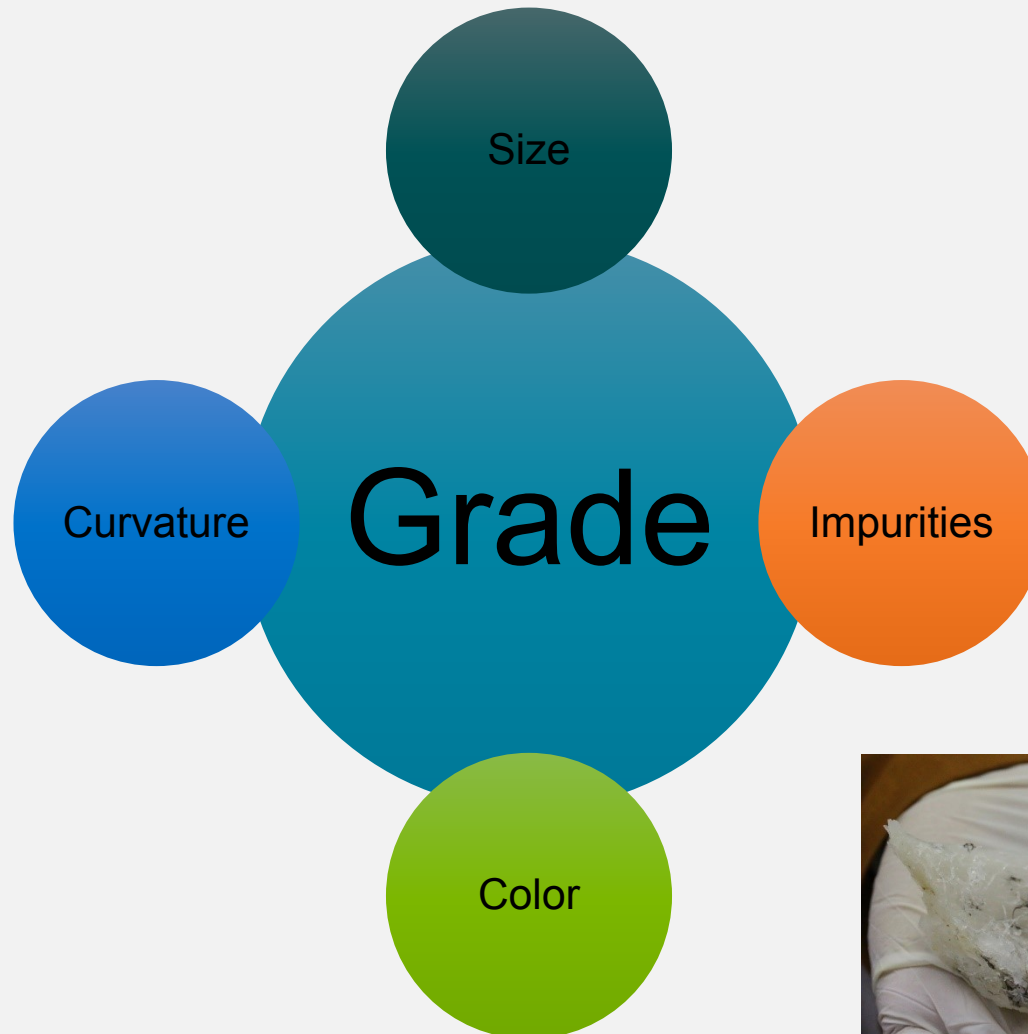
Curvature

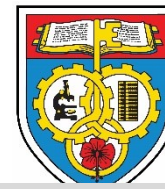
- The way and area that the swiftlets build their nests will affected the shape of EBN
- Corners need lesser resources and is easier to build the nest





Feature-based EBN grading



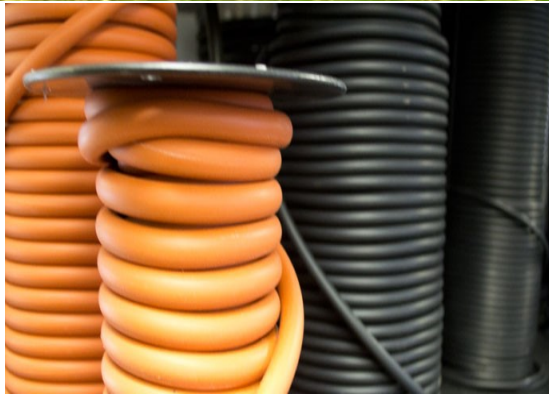


Better ?

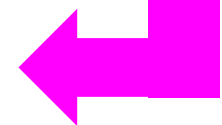
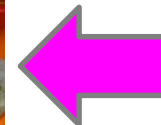
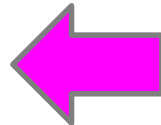
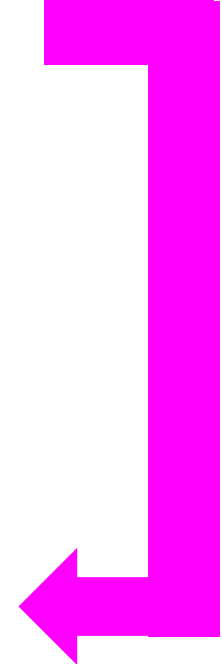
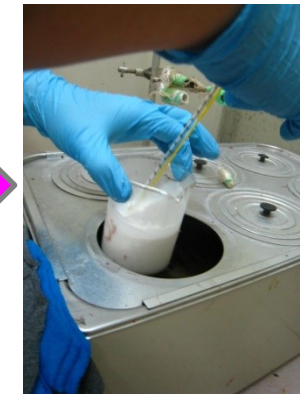
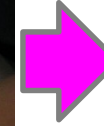
Rubber

- ✓ accounted for 3.1% of Malaysian's total export and was ranked top seven among other local industries in 2015.
- ✓ Export revenue from this industry continually to increase since 2009 - from RM 10.59 Billion in 2009 to RM17.99 Billion by 2015.

100 Baht = RM 12.46



Computer Vision Approach to Identify the Quality of Natural Rubber Latex



Plantation/Estate



Outgoing & incoming
quality inspection to
ensure processability and
quality of product

Product manufacturer



Determining the quality of *natural rubber*



Early or delayed coagulation of the rubber latex consignment can have a significant economical impact to the manufacturers.

The quality of the incoming consignment can have a profound effect on the production and manufacture of products made from *rubber latex*.

Product manufacturer



Natural rubber latex concentrate -- Determination of mechanical stability

ISO 35:2012 specifies a method for the determination of the mechanical stability of natural rubber latex concentrate. It is also applicable to prevulcanized natural rubber latex concentrate.

The method is not necessarily suitable for latices or prevulcanized latex preserved with potassium hydroxide, latices from natural sources other than *Hevea brasiliensis*, or for compounded latex or artificial dispersions of rubber, and it is not applicable to synthetic rubber latices.

*Natural Rubber Latex Concentrate –
Determination of Mechanical Stability.
ISO Standards 35: 2012.*



International
Organization for
Standardization

Quality Measure - MST

***Mechanical Stability** of colloidal liquids may be defined as the ability of the colloidal liquid to overcome the colloidal destabilization effects when mechanical influences such as shearing and agitation are applied.*

Hence the **Mechanical Stability Time (MST)** is the time taken for this to happen.



*Natural Rubber Latex Concentrate –
Determination of Mechanical Stability.
ISO Standards 35: 2012.*

Process using a Human Operator to determine the MST



Sample preparation



Filter the sample



Stir the sample at the speed of 14,000rpm



Shortcomings:

- Consistency subject to experience and skills of operator
- Subjective
- Human resources need to be trained.

Pick up a small drop of sample every 15 seconds & disperse it into a petri dish containing water



Observe whether the latex disperses or flocculates in water



MST is the time of first appearance of flocules

Consequences:

- Discrepancy of result between supplier of latex and end user of latex
→ accept/reject?
- Can cause huge process loss and high reject rate of product.

Industry Collaborator



Located in Batu Caves on the outskirts of Kuala Lumpur, Weir's Linatex rubber products facility has been producing premium natural latex using a patented process for over 90 years. They use locally sourced materials to produce Linatex Premium Rubber for use across the globe. This same facility is home to a sales office and research and development (R&D) laboratory.



Quality Measure - MST

A key instrument in determining the quality is the Latex Testing Machine (known as Klaxon Test Machine). These are used for the determination of the mechanical stability of natural or synthetic latex.

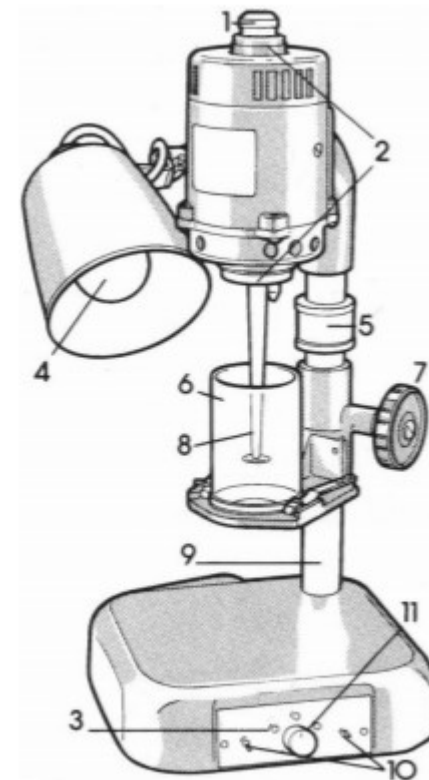


Latex testing machine (LTM)

Quality Measure - MST

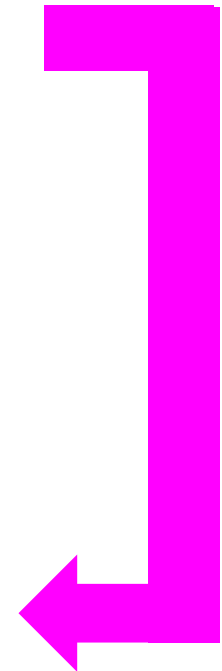
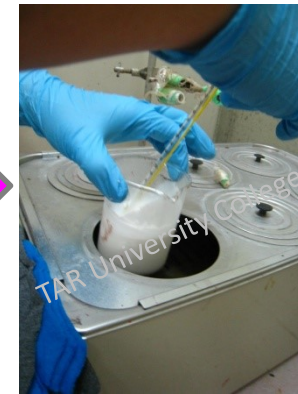
KEY

1. Chrome-plated screwed end cap
2. Bearing caps
3. Speed indication LEDs
4. 60w SB fitting lamp (adjustable)
5. Adjustable stop (for breaker table)
6. Latex beaker (glass – synthetic, Perspex – natural)
7. Moulded handwheel for table height adjuster.
8. Stainless steel paddle to ISO dimensions
9. Chrome plated column
10. Lamp and motor switches (as indicated)
11. Voltage/temperature compensation control



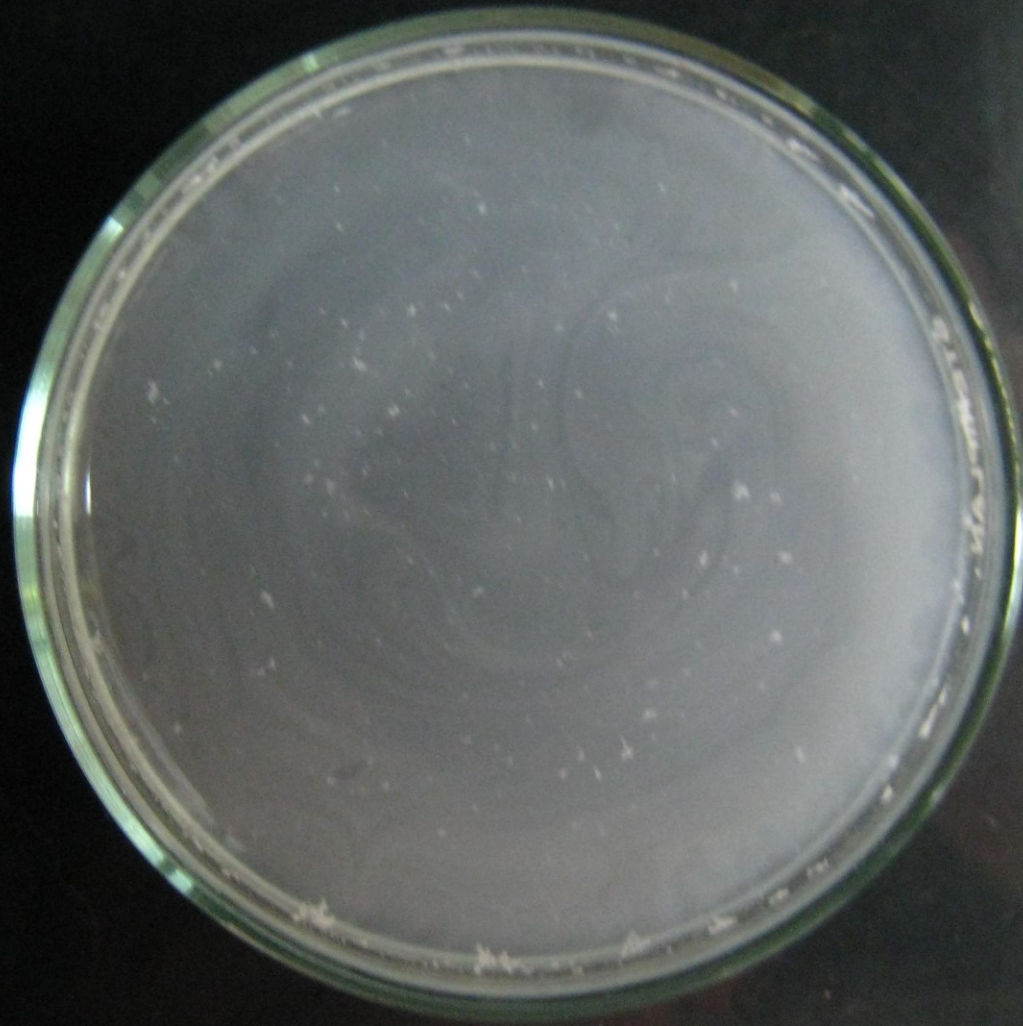
Latex testing machine (LTM)

Process using a Human Operator to determine the MST





At the start





Particle Size Characterization

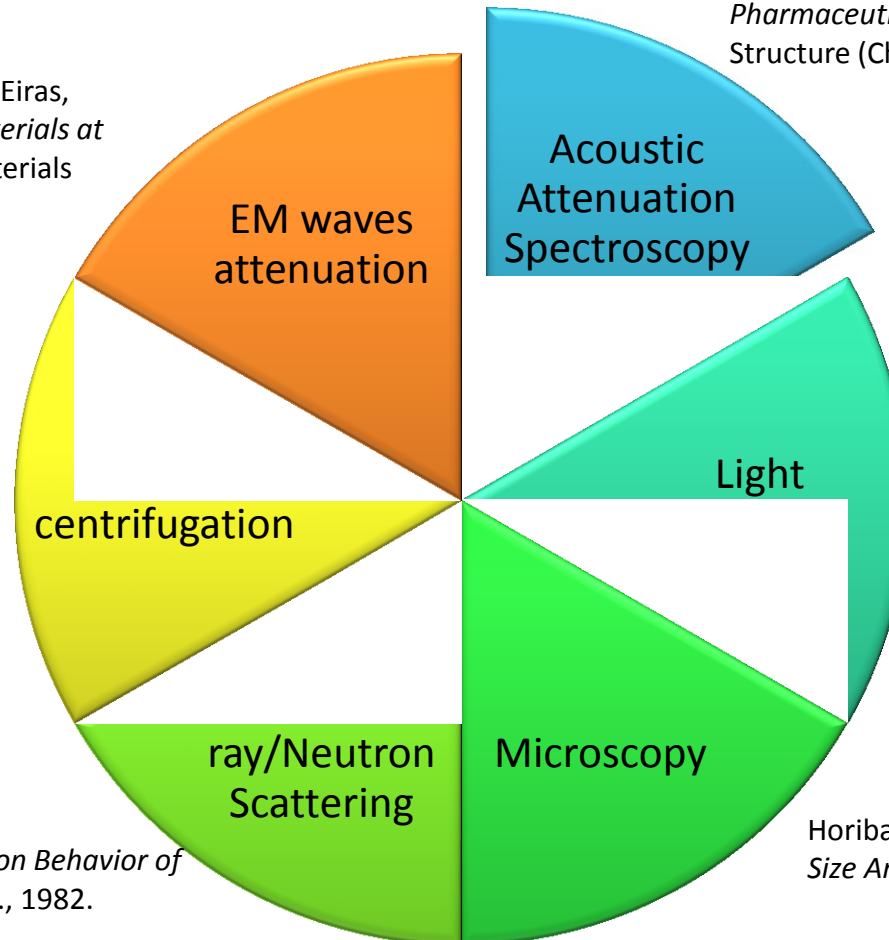
Prior Work

J de Los Santos, D. Garcia and J. A. Eiras,
“Dielectric Characterization of Materials at
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Kabanov, A.V., Makromol.
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1991

Bedwell B., and Gulari, E., in “Solution Behavior of
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Fletcher, P.D.I., Robinson, B.H., Bermejo-Barrera, F.,
Oakenfull, D.G., Dore, J.C., and Steytler, D.C.,
“Microemulsions” (I.D. Rob, Ed.), 1982.

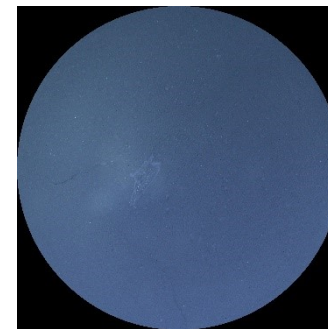
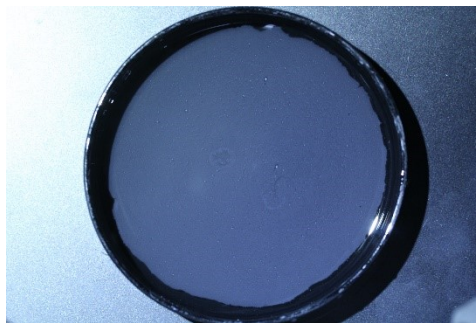
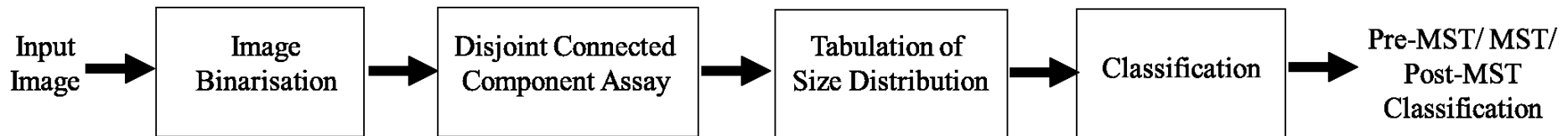


D. Fairhurst and A.S. Dukhin, “Acoustic
Attenuation Spectroscopy: A New Technique to
Characterize the Stability and Structure of Semi-
solid Topical Delivery Systems for Cosmetic and
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Structure (Chapter 11), 1965, pp 23 – 41

D Fairhurst, “Particle Size and Zeta
Potential—from Fundamentals to
End-use Performance”, Tire Tech
Intl, 1996.

Horiba Scientific - A Guidebook to Particle
Size Analysis

Proposed Machine Intelligence Approach



*Feature Extraction **VS** Complex Learning*

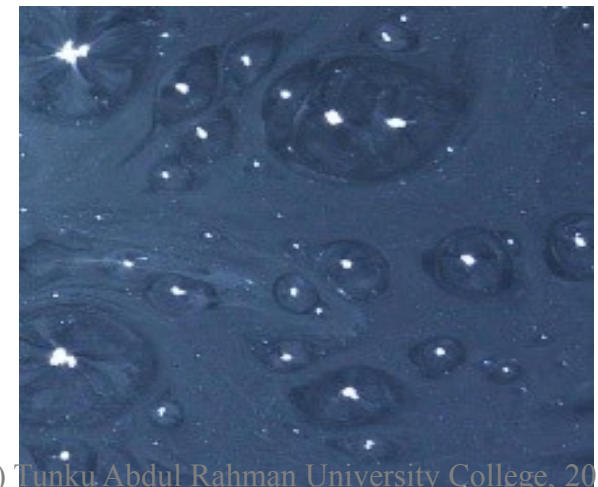
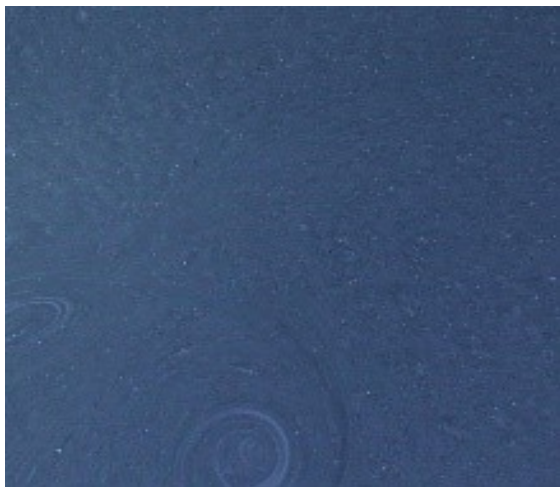
- ✓ 50 laboratory experiments resulting in 600 high-resolution MST images – labour intensive with each test taking an average of 30 minutes per test!
- ✓ pre-MST, MST, and post-MST classes totalled 400, 87, and 133 images respectively
- ✓ Downsize the larger classes to the minority class



pre-MST

MST

post-MST





A Machine Intelligence Approach to Identify the Quality of Natural Rubber Latex

SUMMARY

- Machine Intelligence and the motivation for automation
- Computational intelligence ?
- Automation for quality measurements
- A case-study in determining quality of rubber latex



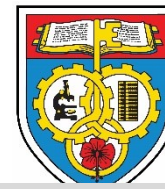
A Machine Intelligence Approach to Identify the Quality of Natural Rubber Latex

SUMMARY (cont'd)

- Open research question

Can such features be automatically learned, i.e. with Deep networks?

- *Minimum Training Set?*
- *Amount of effort (time) in collecting data?*
- *Accuracy tradeoff?*
- *Ease of use – non-technical personnel?*



Faster ?

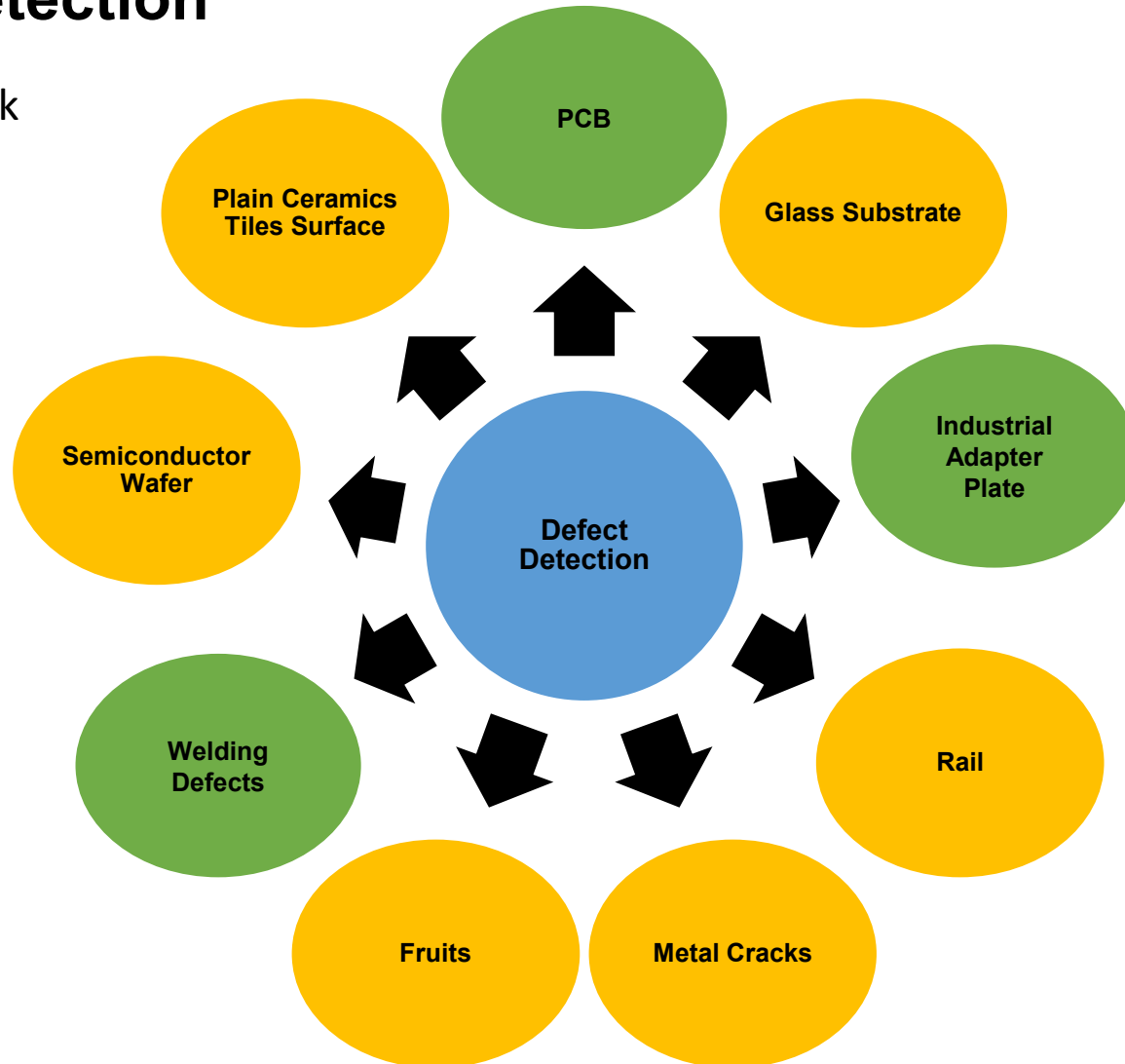
自動車のワイパーの欠陥検出

Defects Detection of Car Wiper Arm



Defects Detection

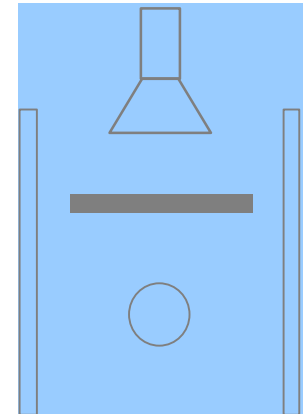
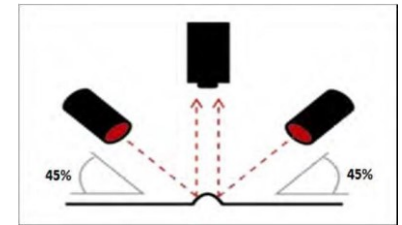
Prior Work



Detecting scratches in extruded aluminium profiles

(Hasan Al-Jabbouli, 2015)

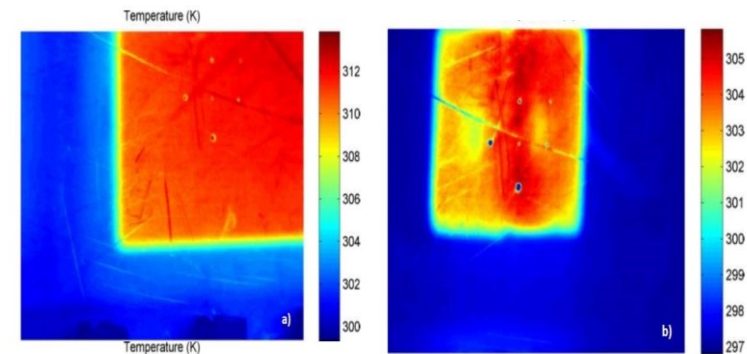
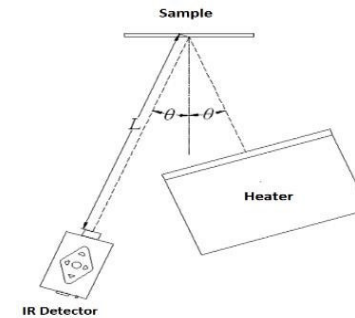
- Emphasizes on lighting environment
- Placement of light source at an angle
- Black field lighting technique



Defects detection on metal sheets

(Harik Marc Anthony, 2010)

- Infrared Thermography was used
- Requires appropriate heating – hence heater required



WHAT'S DRIVING THE GLOBAL AUTOMOTIVE WIPER SYSTEM MARKET?

KEY MARKET FIGURES

SURGING AUTOMOTIVE SALES

Global four wheeler production in is expected to reach

108.95 million
units by 2020.

ROAD SAFETY AWARENESS

The NHTSA revealed that **46%** of car crashes happen due to rain.

VEHICLES IN BRICS

The BRICS countries are expected to account for more than **50%** of light vehicle sales by 2018.

GLOBAL MARKET GROWTH

2015
VALUE

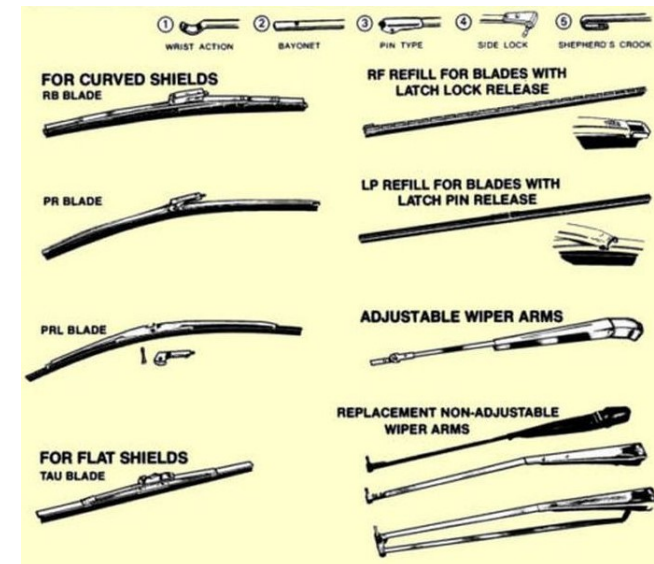
\$6.99 billion

2020
VALUE

\$8.64 billion

**\$1.65
BILLION**

INCREMENTAL GROWTH



Source: <https://www.hemmings.com/blog/2013/12/27/tech-101-what-you-need-to-know-about-windshield-wipers/>

Global Wiper System Market Share (%) By Region (2018)



CAGR -5.00% (2018-2026)



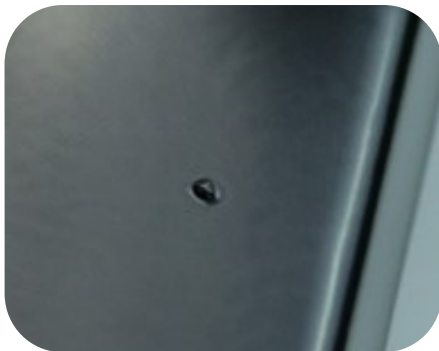
- Asia Pacific
- Europe
- North America
- Latin America
- Middle East and Africa

Source: Transparency Market Research, 2018

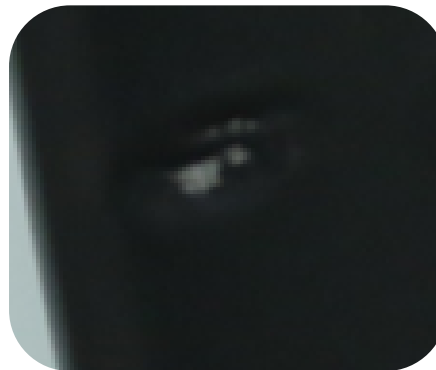
Wiper Arm



Defect Types



Bumps: protuberance on the surface



Dents: slight hollow on the surface



Scratches: marks on the surface usually caused by a sharp or pointed object



‘Orange skin’: defect happened when the spray gun is too close to the surface or the air pressure is too low for proper atomization of the paint when spraying.

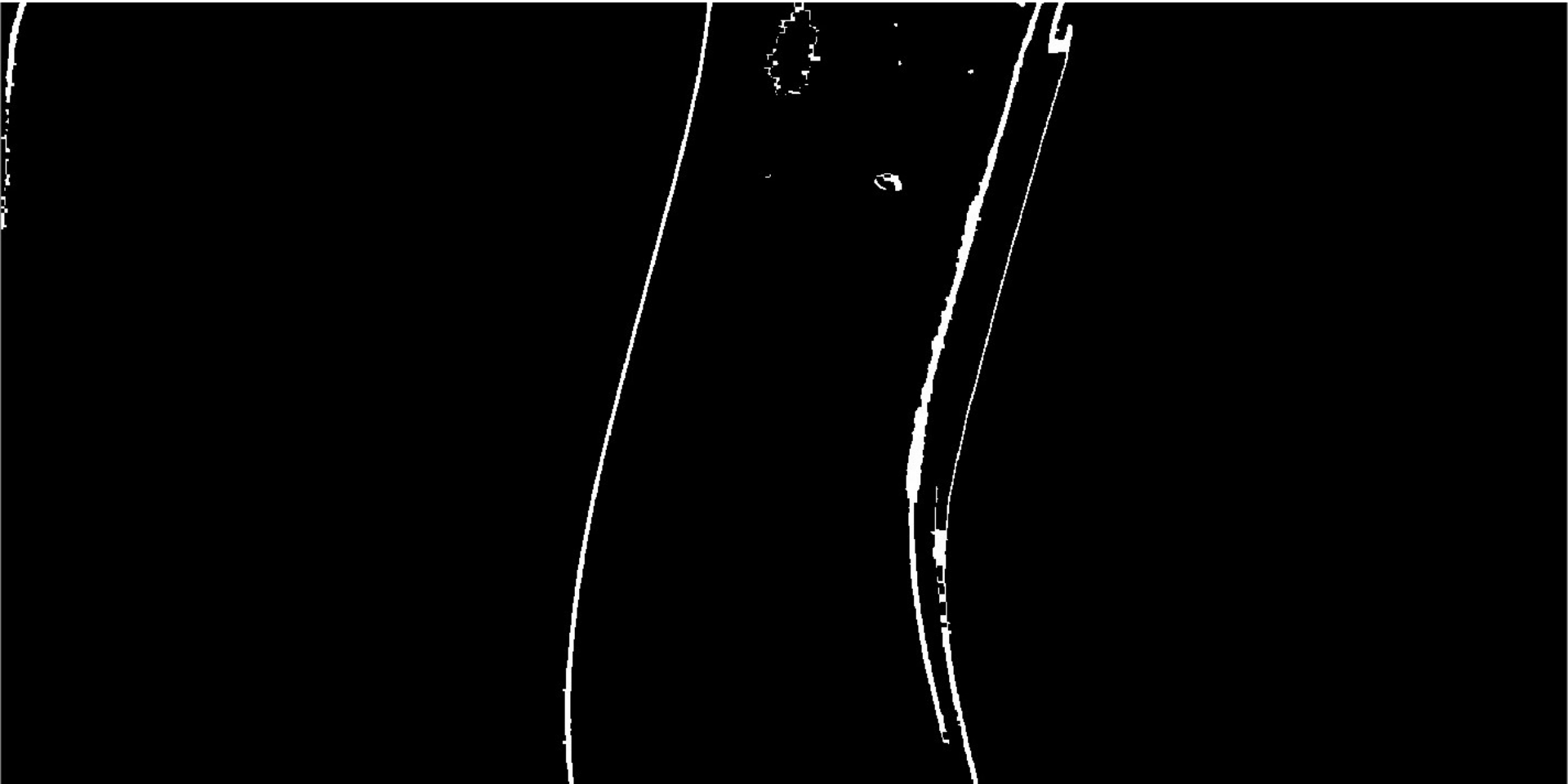
Challenges



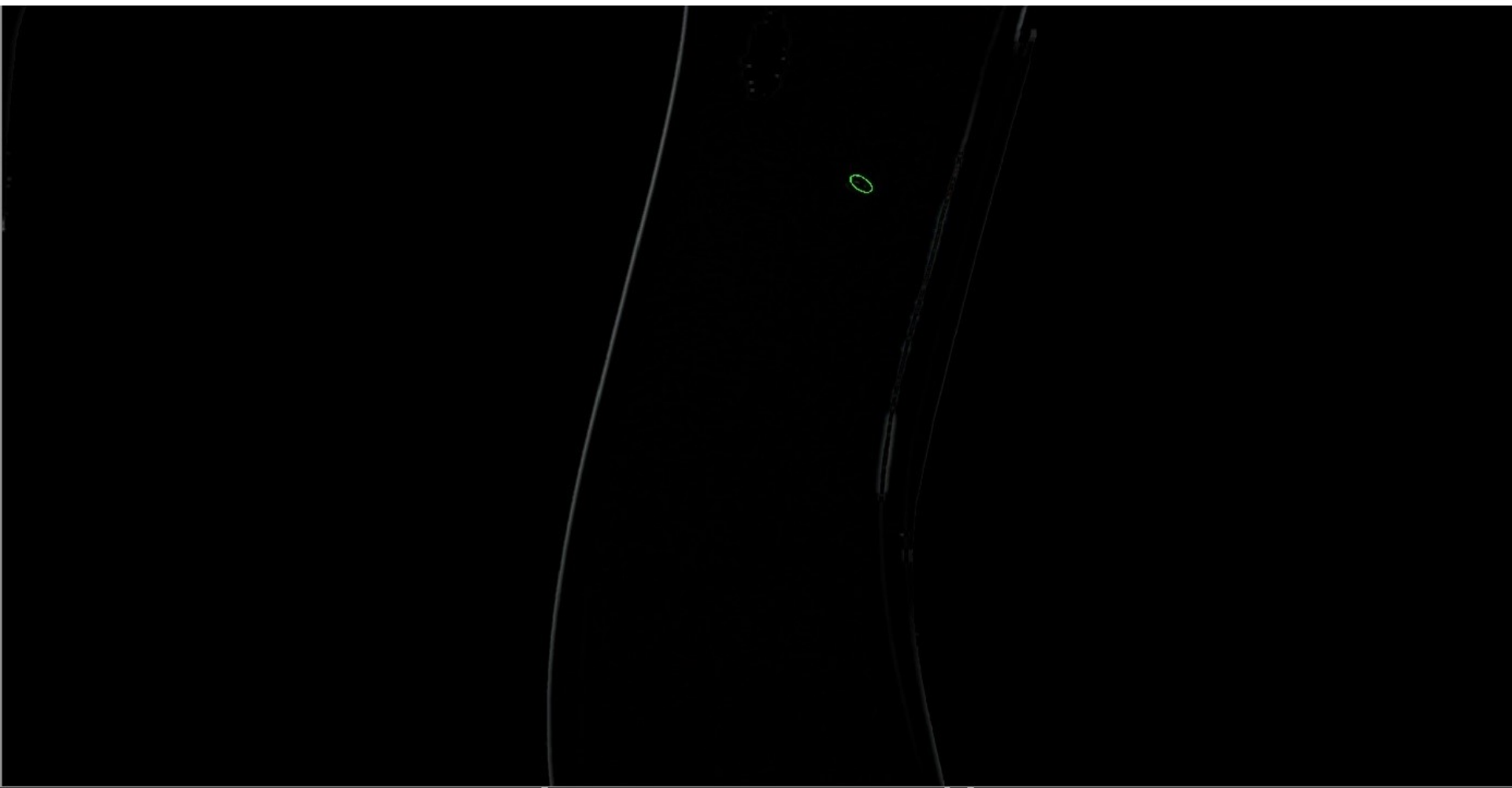
Original image



Background subtraction



After Edge detection



Filtering and contour approximation

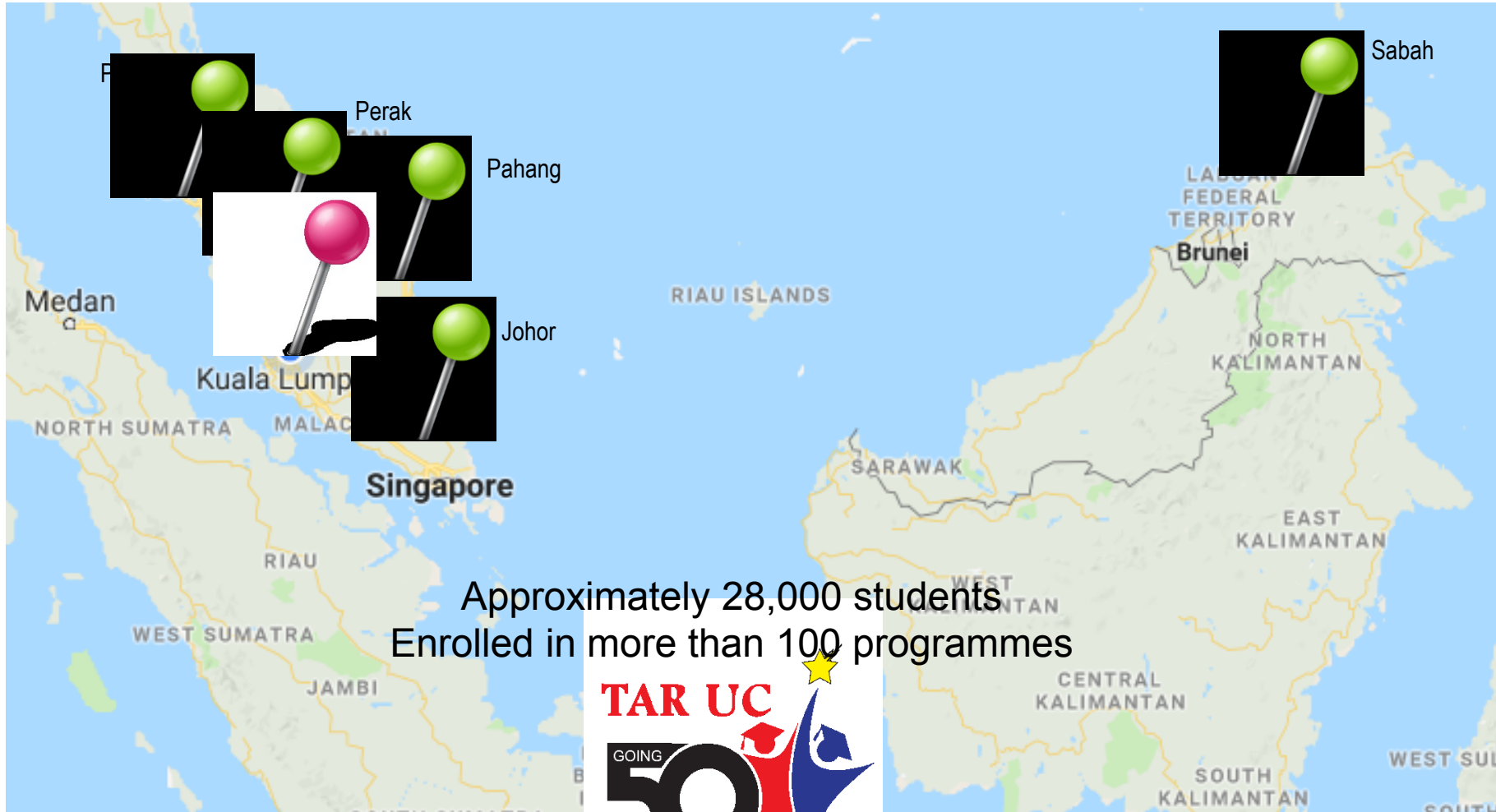
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UNIVERSITY COLLEGE





Approximately 28,000 students
Enrolled in more than 100 programmes



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Students

- ✓ Zerahny Kia Yuan **Chew**
- ✓ Qin Feng **Chia**
- ✓ Jack En **Gan**
- ✓ Sze Liu **Gan**
- ✓ Mei Yuan **Koay**
- ✓ Daniel **Koey**
- ✓ Cih Yuan **Lim**
- ✓ Selina **Loh**
- ✓ Jiwei **Ooi**
- ✓ Por Han **Ting**
- ✓ Ming Chieng **Tan**



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Thank You

laiwk@tarc.edu.my