In this issue:

Message of Editor:

The No. 3, Vol. 9 of ECTI E-magazine has got a great honour from Mr. Manasit Sarigaphuti, SCG to write the article 1 entitled "Benefit of collaborate project between SCG and SIIT" telling us a successful sample story of collaboration between a Thai private company and a Thai academic institute. Hopefully, members of ECTI association may enjoy the collaboration sample, and initiate this kind of many collaborated research projects in the same manners in Thailand in the near future. We also have got another honour from Prof. Monai Krairiksh, KMITL to write the article 2 entitled "Microwave Sensors for Quality Control of Fruits". This article describes many applications of fruit quality control using microwave technology. In the issue, the ECTI association members can find the paper list of ECTI-EEC, Vol. 13, No. 2 (Aug-2014), report from ECTI-CARD 2015, and call-for-papers of ECTI-CON 2016.

I as editor of ECTI E-magazine have already edited 32 issues of the magazine from the beginning until now within eight years. This is the last issue of my term, but of course it is not the last one for the magazine. The magazine will be subsequently published as useful information for ECTI association members under Prof. Pornchai Supnithi, KMITL as new chief editor.

I would like to express my sincere thanks to all authors and other persons who support the magazine until now. Finally, I wish the new chief editor great success, and hopefully the magazine may provide fruitful and interesting academic information to all members.

Kosin Chamnongthai (KMUTT)

Chief Editor of ECTI E-magazine

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[Article 1]

Benefit of collaborate project between SCG and SIIT

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SCG Cement-Building Materials

Abstract

"Marine Cement" is one of commercial product which resulted from collaborated work between universities and industry which are SIIT, Burapha University, and Siam Cement Group (SCG). The product was successfully introduced to the market as eco-friendly cement which accounted for more than 40 percent reductions of greenhouse gas emission as well as increasing the durability of concrete and resistance of reinforced steel corrosion under marine environment.

Introduction

Reinforced concrete structures along the coast usually deteriorate before the proper time. This is caused by factors such as erosion from splashing of wave or destroying by sulfate. However, the ingress of chloride ion through concrete is the main cause since the main component of sea water is sodium chloride (27,000 ppm). When ingress through concrete, chloride ions are able to damage the passivation film on the reinforcing steel surface, this process is known as de-passivation and with the presence of moisture and oxygen, this can lead to corrosion on reinforcement. When rust occurred it can decrease the cross section area of reinforcement, increases iron volume, reduces tensile strength, and consequently leads to cracking in the concrete body. Examples of marine structure deterioration are shown in Figure 1.

Therefore, concrete designs for the structures along the coast are required to have a good resistivity to penetration of chloride. ASTM C1202 is used as a standard to test chloride resistance of concrete. According to ASTM C1202, concrete sample with 100 mm diameter and 50 mm thick, is tested by direct current electricity (DC) from a power supply (60 volts) as shown in Figure 2.

The values of chloride penetration can be obtained from the electric ion moving pass the sample for 6 hours. Coulomb charge passed can be calculated by the area of the graph which plotted between direct current and time for 6 hours.

Figure 1 Examples of marine structure deterioration

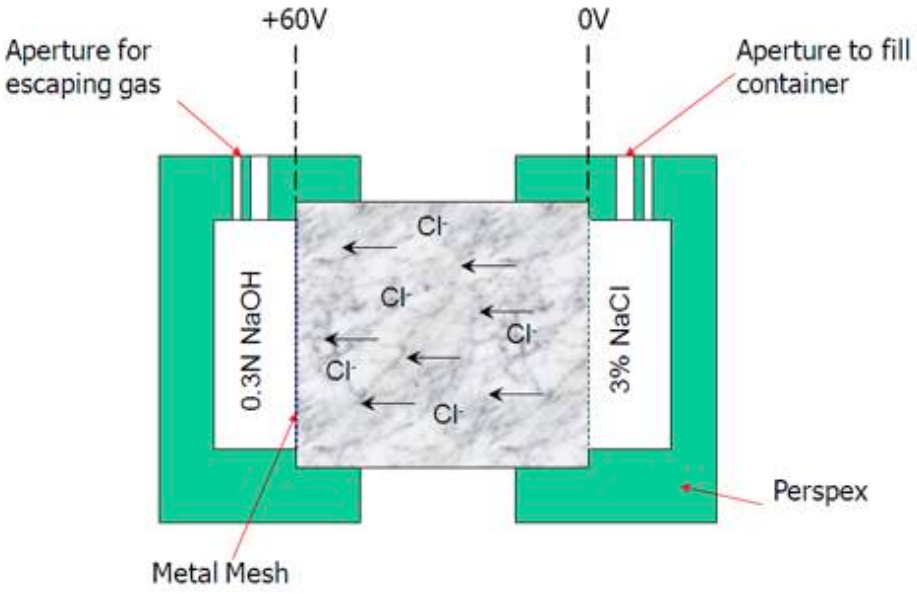

Figure 2 Test cell following ASTM C1202

$$Q = 900 \text{ X } (I_0 + 2I_{30} + 2I_{60} + 2I_{300} + 2I_{330} + I_{360})$$

Where Q is Coulomb Charge Passed (C)

I_0 is the current electricity at starting time, ampere (A)

I_t is the current electricity at t minute from the starting time, ampere (A)

ASTM also categorized the quality of concrete according to charge passed as follow in Table 1:

Table 1 The quality of concrete categorized by charge passed (coulombs).

Total Charge Passed (Coulombs)	*Permeability Classification*	*Concrete Quality*
> 4000	High	poor
2000 - 4000	Moderate	reasonable
1000 - 2000	Low	good
100 - 1000	Very Low	very good
< 100	Negligible	excellent

This test provides results quickly and practical because the conditions in this test is affected by the electricity acting as an accelerator for chloride to move. So, the movement in the real situation is not higher than the experiment. If the charge passed is within the standard criterion, it indicates that the concrete sample has ability to resist chloride penetration.

Develop of Marine Cement

For durability purpose, concrete along the coast should designed for very low chloride permeability or less than 1000 coulombs of charge passed (concrete quality is very good according to Table 1). From the result in Figure 2, it was found that cement used should contain 60% Ground Granulated Blast Furnace Slag (GGBS) and 40% Portland cement by weight and the water to cement ratio of concrete should less than 0.45.

Blast Furnace Slag is an industrial by-product for production of pig iron from iron ore in blast furnaces. Raw iron is decomposed into molten iron and molten slag when it is melted at a temperature of 1500^{o}C along with limestone in a blast furnace. Molten Slag is cooled and dried by means of granulation and transformed into the amorphous phase. Since this amorphous slag involves sufficient silica and alumina, it also shows some hydraulic properties if it is ground to a fineness of cement or higher, this product is called Ground Granulated Blast Furnace Slag (GGBS). GGBS consists of chemical component such as CaO (30-50%), SiO_2 (28-38%), Al_2O_3 (8-24%), MgO (1-18%), and Fe_2O_3 (0-3%). The main components are glassy phase of $CaO\text{-}SiO_2\text{-}Al_2O_3$. GGBS is

used along with Portland cement in order to increase concrete strength, increase economic life and protect the environment. Concrete including slag cement is less permeable and has high resistance against aggressive environments and is more resistant to dangerous chemicals.

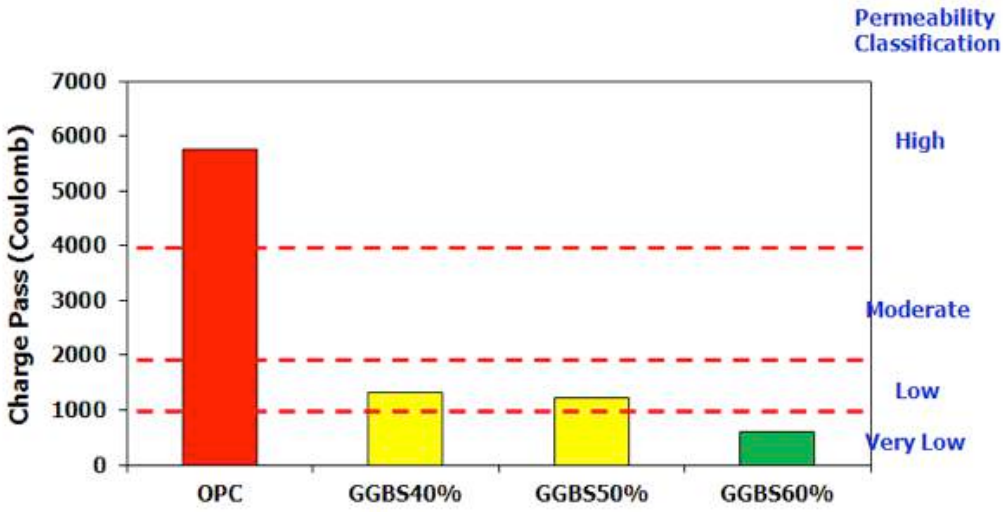

Figure 2 Charge pass from the test following ASTM C1202 of 28days concrete using different types of binder.

Where OPC = Ordinary Portland cement = Using only Cement as Binder in concrete
GGBS = Ground Granulated Blast-furnace Slag
GGBS40% = Using 60% OPC and 40%GGBS by weight of total Binder

Prediction of the service life under actual marine environment in Thailand

SCG has developed a new cement resulted in low chloride permeability but we also need to know how this cement perform in actual environment and its service life. As a consequence, we collaborated with Prof. Dr. Somnuk Tangtermsirikul from department of Civil Engineering, Sirindhorn International Institute of Technology (SIIT), Thammasat University who is the head of this project, and the co-project is Asst. Prof. Dr. Taweechai Sumranwanich, Department of Civil Engineering, Burapha University. They are the leading expert in the field of concrete durability in Thailand.

Service life prediction model is illustrated in Figure 3. From the beginning, due to high alkalinity of concrete, a protective oxide film is present on the surface of steel reinforcement preventing it from corrosion. This protective layer can be lost due to the presence of chloride in the presence of water and oxygen. Chloride can enter the concrete by diffusion from

environment. The amount of chloride required for initiating corrosion is called chloride threshold value. Maintenance-free service life is the time when chloride ion propagated into concrete until reach its threshold value or so called "Depassivation time". When steel start to corrode, the concrete structure can withstand for some time until reaching limit or designed state and the structure can no longer be in service without any maintenance. As rust start to appear, the reinforced steel will lose its cross- section dimension and apparently its tensile strength. Rust can also cause expansion and consequently cause cracking or spelling of concrete.

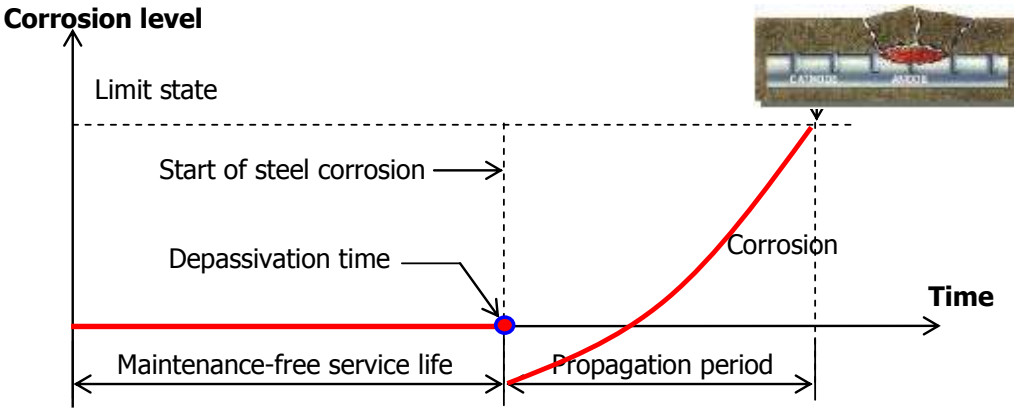

Figure 3 The model illustrating reinforced concrete encountering corrosion from chloride under marine environment

Diffusion is the main kinetic of chloride movement into pore structure of concrete. This chloride movement is occurred from the difference in chloride concentration. Chloride is moved from high to the lower concentration followed Fick's second law of diffusion. The diffusion rate and the amount of chloride at distance from the exposed surface can be related as shown in equation 1.

$$\frac{\partial C_t(x,t)}{\partial t} = -D_a \frac{\partial^2 C_f(x,t)}{\partial^2 x} \qquad (1)$$

Where x is the distance from the outer surface of concrete (cm)
t is the time expose to chloride (year)
$C_t(x,t)$ is the entire amount of chloride at x from the outside surface at t (mole/liter)
D_a is coefficient of chloride diffusion in concrete

The answer of equation 1 is shown in equation 2 which is in the form of error function.

$$C_d = \frac{(C_s - C_0)\left[1 - erf\left(\frac{c}{2\sqrt{D_a t}}\right)\right] + C_0}{B} \times 100 \qquad (2)$$

Where C_d is the amount of chloride ion on reinforced steel in concrete (%weight of binder)
C_s is the amount of chloride at concrete surface (kg/m^3)
c is the concrete covering of reinforced steel (cm)
D_a is coefficient of chloride diffusion (cm^2/ year)
t is the maintenance-free service life (year)
B is the amount of binder in 1 m^3 concrete

Although there were reports illustrated that different type of concretes have different chloride threshold value, Japan Society of Civil Engineer has set the standard amount of chloride threshold value at 1.2 kg/ m^3.

From the result of concrete exposed to marine environment for 5 years and the assumption of 1.2 kg/ m^3 chloride threshold value to initiate corrosion, service life can be calculated as shown in Table 2-3. This service life prediction is compared concrete using OPC and Marine Cement. It also takes mix-design of concrete, covering concrete thickness into an account. Mix-design of concrete is shown by using different water to binder ratio (W/B). Whereas, relative value is the life time of concrete using Marine cement compared to life time of concrete using OPC or Ordinary Portland Cement, showing how many time more durable when using Marine cement. Table 2 is the prediction using assumption of no crack and Table 3 using with crack assumption, since in real condition concrete usually has some hairy crack. In both cases, Marine cement shows superior performance than OPC.

Conclusion

"Marine Cement" is the example of successful product launched, resulted from collaborated work by industrial and universities. Both utilize their technologies and knowledge to ensure that outstanding products are delivered to the market. The new cement formula was developed by industrial under accelerated lab condition. The service life prediction was performed by universities using concrete specimens exposed to real marine environment for 5 years.

Table 2 Service life prediction of reinforced concrete using different type of cement (case: no crack)

W/B	Service life (years)					
	Concrete covering = 3 cm			Concrete covering = 5 cm		
	OPC	Marine Cement	Relative value	OPC	Marine Cement	Relative value
0.40	0.722	7.56	10.5	2.00	21.00	10.5
0.50	0.305	2.99	8.9	0.85	8.30	9.8
0.60	0.138	1.91	13.9	0.38	5.31	13.9

Table 3 Service life prediction of reinforced concrete using different type of cement (case: with crack)

W/B	Service life (years)					
	Concrete covering = 3 cm			Concrete covering = 5 cm		
	OPC	Marine Cement	Relative value	OPC	Marine Cement	Relative value
0.40	0.525	3.02	5.76	1.41	6.36	4.52
0.50	0.230	1.72	7.47	0.63	4.09	6.50
0.60	0.105	1.23	11.73	0.29	3.09	10.64

Manasit Sarigaphuti is R&D Director at Siam Research and Innovation Co., Ltd. a subsidiary company under SCG Cement-Building Materials. He received his MS in civil engineering in 1991 from Northwestern University and received his BS from the University of Illinois at Chicago in 1989. His research interests include composite cement, alkali-activated cementitious material, supplementary cementitous material and durability of concrete. He has filed over 15 patents and granted 3 patents.

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[Article 2]

Microwave sensors for quality control of fruits

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Abstract: Thailand exports large number of fruits to the global market which requires quality control. Since each fruit has specific characteristic, suitable sensors must be designed. This paper presents some sensors for fruit quality control using microwave that can be applied for this specific application.

1. Background

Thailand is a country in a tropical zone with population of almost 70 million. The area is around 500,000 square kilometer. The average annual temperature is about 29^oC ranging from 35^oC in April to 26^oC in December. Although it is rather hot for human being, it is suitable for growing agricultural products. That is why Thailand aims to be "Kitchen of the world".

Fruits are major export product of Thailand. The annual income is around US$1.2 billion [1]. Plenty of fruits are grown all year round. For instance, in May, mango, rambutan, mangosteen, durian, and orange give the products and are sold in the local and foreign markets.

Note that the top three exporting fruits are durian, longan, and mangosteen, respectively [1].

Taipei Brunei Vancouver

Fig.1 Thai fruits in foreign markets

Fig.1 shows examples of Thai fruits in foreign markets, e.g. durian in Tapei, mango in Brunei, and rambutan and mangosteen in Vancouver. This shows that Thai fruits are favorite to international markets. Nevertheless, customers require the quality control of fruits. It should be noted that fruits must be inspected non-destructively. Otherwise prize is reduced drastically. The problems in fruits are addressed as follows.

Orange is normally popular with good taste of sweet and sour. The most important issue is granulation: a condition in which the juice sacs shrivel because of gel formation. It is associated with fast growth of the fruit and it develops a flat, insipid taste as they loses some of their sugar and acid. This leads to low juice levels and loss of taste [2], see Fig.2 (a). In this case, it is necessary to have a non-destructive orange taste and granulation sensor.

(a) (b) (c) (d)

Fig.2 Problems in fruits

(a) Granulated orange (b) Sweet mango with sticky rice

(c) Translucent mangosteen (d) Immature durian

Mango is one of the popular fruits produced by many countries in a tropical zone. It can be consumed either when it is unripe or ripe. For ripe mango, people in Thailand enjoy eating sweet mango with sticky rice as seen in Fig.2 (b). However, with the same outlook, some mangoes can be either sweet or sour. However, only sweet mangoes are desirable for eating with sticky rice. Hence, it is necessary to test taste of mango non-destructively.

Mangosteen, so called Queen of fruits, is popular for good sweet and sour taste. Normal mangosteen has white pulp while translucent mangosteen suffers from excessive water while it develops. The appearance of translucent mangosteen is as shown in Fig.2 (c) and taste is not acceptable. In this regard, there is a requirement for non-destructive translucent detection.

Thailand exports durian with total value of US$240 million in 2012 [1]. Fig.2 (d) shows durian fruit. The major problem in exporting durian is that its maturity is unknown. The maturity stage of durian signifies how long durian can be eaten at the destination in foreign countries. Therefore, the method to identify maturity stage of durian non-destructively is required.

From the above examples, it is worth mentioning that the sensors that can inspect quality of fruits non-destructively are extremely required. Furthermore, the most important issue to be taken into consideration is cost must be in the acceptable level. It should not be too expensive.

2. Dielectric properties of fruits

Although there are variety of sensors, i.e., near infrared (NIR), acoustic, visible, etc. [3], it is found that radio wave can be a good candidate due to its wavelength is not too short and can penetrate through peel to pulp. Oda *et al*. [4] successfully utilized millimeter wave for measuring sugar content in apples. Note that in order to effectively inspect fruits non-destructively using radio wave, dielectric properties of fruits must be known. S.O.Nelson published dielectric properties of agricultural products [5] and they are widely used for developing sensors for fruit classification. Without existing information on dielectric properties, it is necessary to measure them before designing sensors.

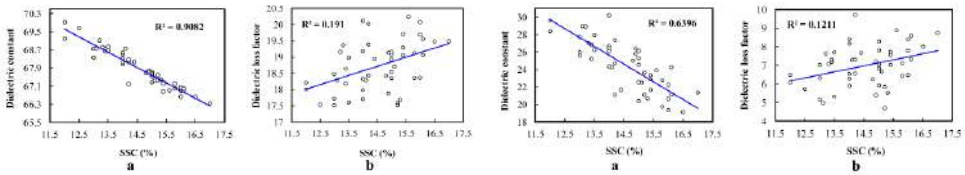


Fig.3 Dielectric properties of tangerine [6]

(a) Dielectric constant of tangerine juice (b) Dielectric loss factor of tangerine juice

(c) Dielectric constant of unpeeled tangerine (d) Dielectric loss factor of unpeeled tangerine

Fig.3 shows dielectric properties of tangerine versus soluble solid content (SSC) we reported in [6]. Fig.3 (a) and (b) show dielectric constant and dielectric loss factor of tangerine juice, respectively. Increasing SSC, dielectric constant of tangerine juice decreases whereas dielectric loss factor varies in opposite manner. For unpeeled tangerine (which non-destructive measurement is conducted), Fig.3 (c) and (d) show respectively dielectric constant and dielectric loss factor. The variation versus SSC is similar to those in Fig.3 (a) and (b). However, the values are lower due to the effect of composition of peel and pulp.

3. (a) Tangerine

This section briefly presents a microwave sensor for tangerine classification based on coupled patch antennas [6]. First, dielectric properties of tangerine were measured as shown in Fig.3, then microstrip patch antennas were designed to match with sweet tangerine at 2.4 GHz. Fig.4 shows geometry of the sensor and the dimensions are listed in [6].

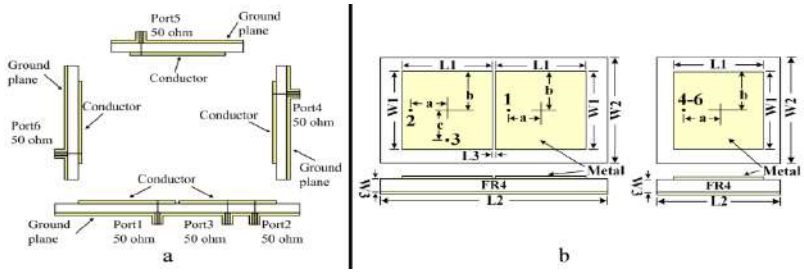


Fig. 4 Geometry of a sensor for tangerine classification [6]

By using the designed patch antennas, the S-parameters are considered as shown in Fig.5.

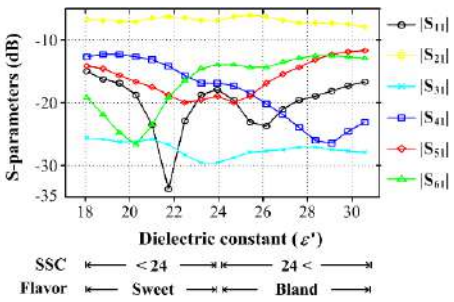


Fig.5 S-parameters [6]

Patch 1 is used for transmitting microwave signal whereas those for 2-6 are used for receiving microwave signals. Patch 2 and 3 are the same patch but with different feed position that provides parallel and perpendicular polarization with the transmitting antenna. With a model of sweet orange ($\varepsilon_r' = 22, \varepsilon_r'' = 7$) having ten sectors covered by a 1 mm thick peel, Fig.5 shows S11-S61 which clearly exhibits good matching with sweet tangerine. S21 and S31 do not change with taste of tangerine since field distribution on those patches are very small. Hence, it is disregarded and the configuration of the sensor is four-patch surrounding a tangerine. We used variation of S11, S41, S51 and S61 for training an artificial neural network (ANN) and a diagram of the prototype of the sensor is shown in Fig.6. One hundred tangerines were tested with this sensor and the results show that the error is less than 5%.

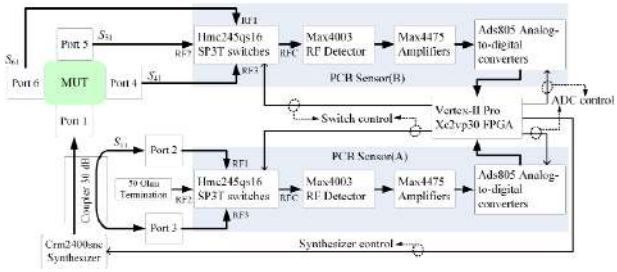
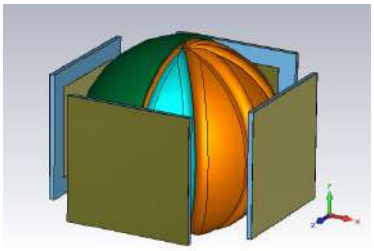


Fig.6 Diagram of the sensor [6]

Note that the sensor operates at 2.4 GHz which is in the industrial, scientific and medical (ISM) band, it can be interfered by a microwave oven, WiFi, etc. It was found that the sensor should be in an environment that interference has power level less than -40 dBm and the temperature is less than 30^{o}C.

For granulation detection, we proposed to investigate variation of mean and standard deviation (S.D.) of measured reflected and coupled signals in the sensor when a tangerine is located in the sensor [7]. Since dielectric properties of normal and granulated oranges are different, when one sector is granulated, the reflected signal (S11) of normal tangerine is different from the granulated one. In addition, the normal tangerine has uniform dielectric properties whereas the granulated one has different dielectric properties for different positions when the tangerine is rotated around itself in the sensor. Hence, the reflected and coupled signals vary with position and are not constant that result in high S.D.



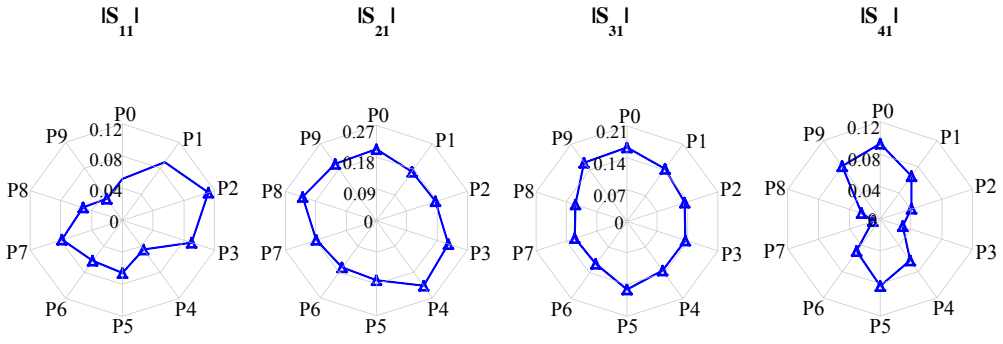


Fig.7 Granulation detection [7]

Fig.7 shows variation of S11, S21, S31 and S41 for different positions. It is observed that S11 and S41 are obviously different as a tangerine is rotated while those for S21 and S31 are not significantly changed.

Table 1 S-parameters for normal and granulated oranges

Tangerines	Mean			
	$\|S_{11}\|$	$\|S_{21}\|$	$\|S_{31}\|$	$\|S_{41}\|$
Non-granulated	0.020	0.195	0.113	0.109
Granulated	0.068	0.192	0.137	0.054

Table 1 shows mean values of non-granulated and granulated oranges. It is observed that S11 increases from 0.020 to 0.068 whereas S41 decreases from 0.109 to 0.054. The changes are higher than twice in both cases. For S21 and S31, variation of mean values are slightly changed and we disregard these cases. The S.D. of S11, S21, S31 and S41 are 0.024, 0.023, 0.016 and 0.028, respectively. They are not markedly different but S11 and S41 possess the highest level. The ratio of mean over S.D. is calculated and the corresponding values for S11 to S41 are 2.83, 8.35, 8.56 and 1.93. These figures can be used for justifying granulated tangerine. By considering non-granulated tangerine having S.D. approached zero, the mean/S.D. is very high. For granulated tangerine, mean/S.D. of S11 is less than 2.83 and that for S41 is less than 1.93. It should be noted that we can detect granulation simply by putting a tangerine between two perpendicular patch antennas and measuring reflected signal (S11) and coupled signal (S41). After rotating a tangerine for many positions around itself and calculating mean and S.D. of S11 and S41, we can justify granulated tangerine from the ratio of mean/S.D.

3. (b) Mango

Variation of dielectric properties of immature and mature mangoes have been measured at the different frequencies [8]. From this information, a vector reflectometer using self-mixing oscillator antennas [9] has been developed that utilized a simple configuration and is cost effective as shown in Fig.8.

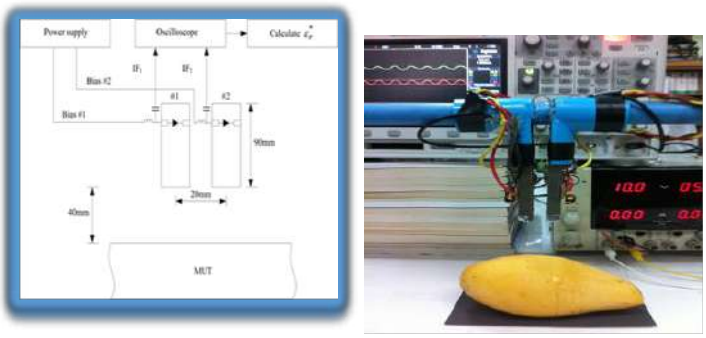


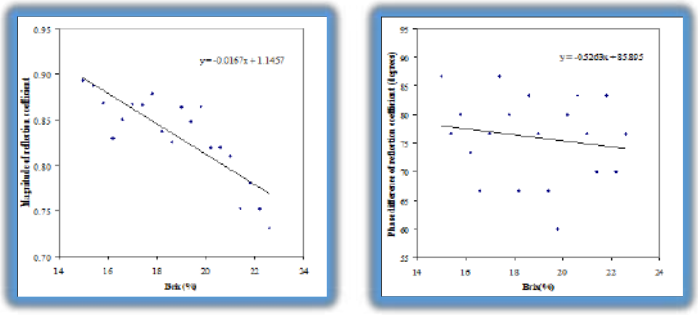
Fig.8 A sensor for testing taste of mango [9]

(a) Diagram (b) Experiment setup

The proposed reflectometer utilized two self-mixing oscillator antennas. Each one has the same structure consisting of a Gunn diode for oscillating and mixing signals at the frequency around 9.8 GHz. The Gunn diode is mounted in a rectangular waveguide that serves as a resonator and an antenna. The difference of frequency from

the two oscillator antennas is the down converted intermediate frequency (IF). When the two oscillator antennas are well isolated, the measured IF signals are the reflected signal from the object under test.

The above reflectometer was used for measuring twenty Namdokmai mangoes (Mangifera indica Linn.) which have average length of 150 mm and average weight of 300g.



(a) (b)

Fig.9 Magnitude and phase of reflection coefficient vs Brix [9]

(a) Magnitude (b) Phase

Fig.8 (b) shows experimental setup and results versus brix are shown in Fig.9. The brix higher than 20% in Fig.9 (a) and (b) means sweet mango and the magnitude of reflection coefficient of less than 0.81 provides the justification of sweet mango. Note that phase of reflection coefficient does not have good correlation with brix. This reflectometer can be applied for mango taste classification.

3. (c) Durian

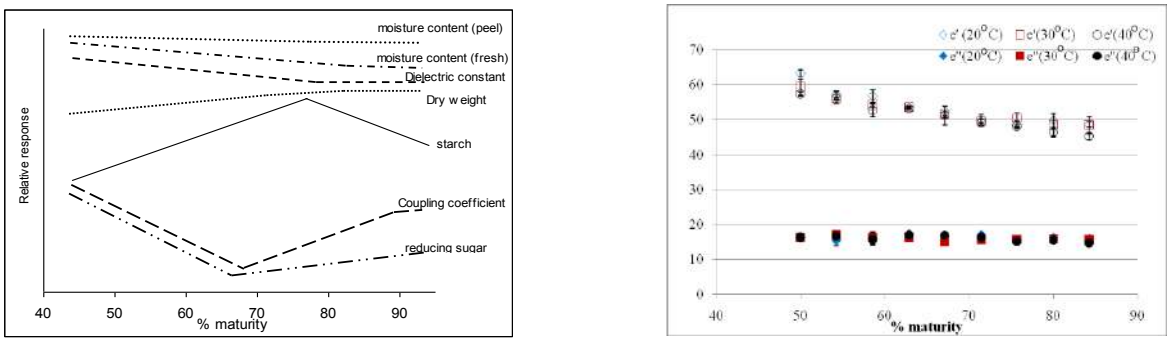
Thailand exports durian to international market. However, the immature durian that cannot ripe at the market is a problem that a big lot of durians can be rejected if some immature durians are sampled. Also, even in the local market, merchants who sell immature durian are imprison and fined since it is illegal. Hence, it is necessary to ensure the mature durians are sold. The maturity stage of durian can be classified into six levels as seen in Table 2.

Table 2 Maturity stage of durian

Level	1	2	3	4	5	6
Maturity stage (%)	50	60	70	80	90	100
Physical property	Immature, will not be ripe	Immature, take long time to ripe, taste is not good	Minimum ripeness for exporting, ripe within 7-10 days, acceptable taste	Mature, good for local and exporting market, ripe within 4-6 days, good taste	Mature, ripe within 2-3 days, good taste	Most mature, ripe within 1 day, good taste

Level 3 with maturity stage of 70% is a suitable level for exporting since it is in the minimum ripeness that will be ripen in 7-10 days. The taste at this level is acceptable. Generally, it is used for exporting. According to the

requirement of the durian classification, plenty of research have been conducted, e.g. [10]-[12]. Since cost is still high, they are not used in practice and the traditional method of knocking and listening to the response sound is used. Nevertheless, this method relies on human that causes of error.



(a) (b)

Fig.10 Physical and dielectric properties vs maturity stage [13]

We started studying correlation of maturity stage with chemical, physical and dielectric properties of durian pulp [13] as seen in Fig.10 (a) where moisture content and dielectric constant decrease along the increase of maturity stage. On the other hand, dry weight is in opposite manner and the acceptable level, at maturity stage of 70%, is 32%. Variation of starch and reducing sugar are in opposite manner as seen in Fig.10 (a).

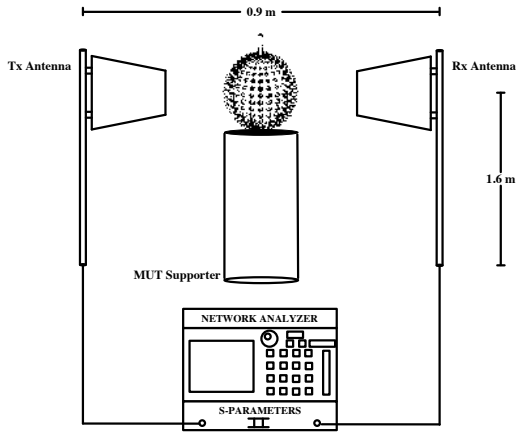
A sensor, consisting of transmitting and receiving patch antennas, is attached to the durian fruit and the coupled signal at different maturity stages (result from overall effects) decreases from maturity stage of 40-67%. Then, it turns out to increase along the maturity stage. The variation of dielectric properties at 2.4 GHz with maturity stage and temperature are shown in Fig.10 (b) where dielectric constant decreases as maturity stage increases. The dielectric loss factor is rather constant.

Post-harvest sensor

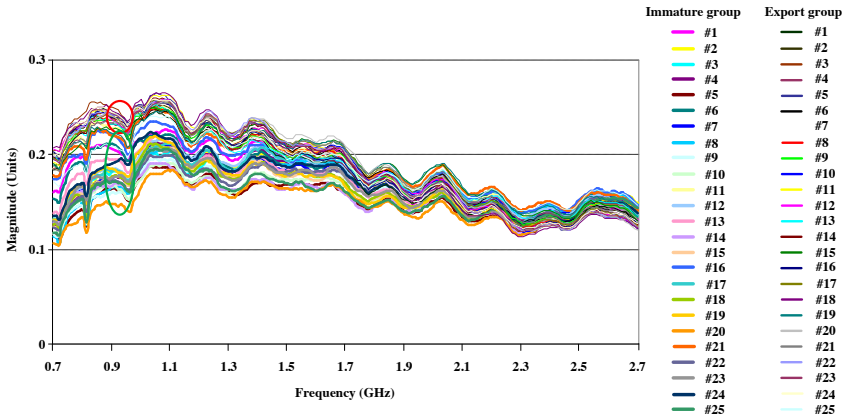
Durian sensor using transmission measurement

We divided durian classification into two categories; post-harvest classification and pre-harvest classification. Post-harvest classification is used for classifying the harvested durian to know which one has maturity stage higher than 70%. The one having maturity stage less than 70% will be rejected. From the information in Fig.10 (b) that dielectric constant decreases with increased maturity stage, by measuring the wave through the durian fruit, the received signal from the mature durian is higher than those of the immature durian.

The measurement setup is in Fig.11 (a). Fig.11 (b) show the measurement results where two groups of durian (immature (maturity stage <70%) and export stage (maturity stage >70%) are measured. The system is calibrated by subtracting the free space complex signal measurement from those from the durian results.



(a)



(b)

Fig.11 (a) Experimental setup (b) results [14]

Fig. 11 (b) shows the measured results from 50 durian fruits where the bold lines represent the immature group and the slim lines represent the export group. The obvious different in the frequency range of 700-1300 MHz is observed. The export group has higher transmitted signal due to lower dielectric constant as expected. The mean values of the measured signal can clearly classify the two groups by setting the appropriate threshold level. This system has been utilized as a pilot system for helping Chumporn province in law enforcement of immature durian merchant in 2015.

Durian sensor using propagation channel measurement

The wireless communications channel can be classified to line-of-sight and non-line-of-sight channels [15]. For the line-of-sight channel, the Rician k-factor is used to imply how much the line-of-sight signal is observed. The scattered wave from the object in the channel depends on dielectric properties, size and shape.

Since durian fruit has irregular size and shape, the durian inspection should be performed statistically. We therefore used the Rician k-factor which is the ratio of direct wave to scattered wave.

Experimental investigation of scattered wave from durian fruits at different frequencies and maturity stages were performed [16]. The frequency of 433 MHz, 915 MHz and 2450 MHz were used for measuring 100 durian fruits.

Two groups of durian (immature: 15%<dry-weight<35%) and (early developed: 35%<dry-weight<41%) are used. We found that frequency of 2450 MHz is too high to penetrate thick peel to pulp. 433 and 915 MHz are more appropriate. The work in [16] shows that immature durian has lower k-factor than early developed durian since scattered wave or multi path component from immature durian with higher dielectric constant is higher than that from the early developed durian. The results for 915 MHz are shown in Table 3 where markedly difference is observed.

Table 3 k-factor for S11 at 915 MHz

k-factor for S11 (915MHz)	
Immature	Early stage
361	2777

Pre-harvest sensor

Pre-harvest sensor is desirable for precision farming. The farmers want to check durian fruit-by-fruit whether it is ready to harvest. In this case, there should be a sensor like a Radar to monitor the fruit on the tree as scenario in Fig. 12.

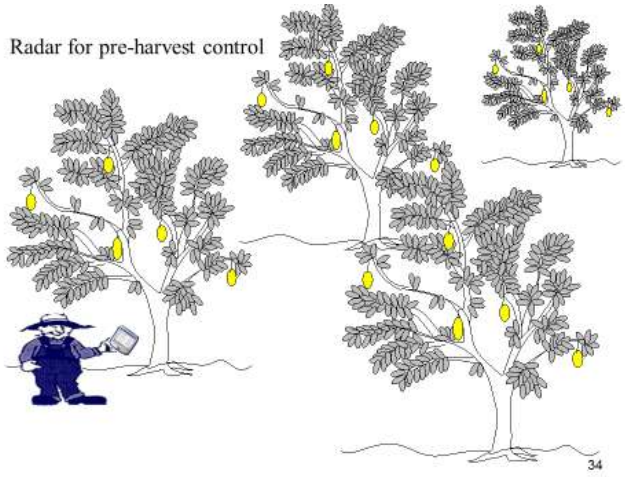


Fig.12 Scenario for pre-harvest classification

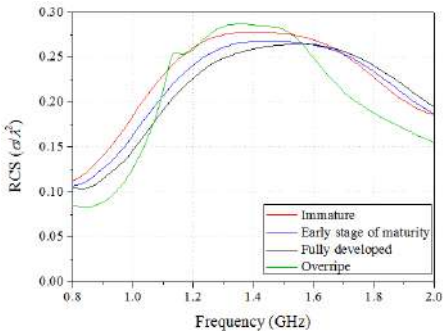
We have developed a sensor using a singularity expansion method (SEM) which transient temporal responses of various scatterers behave as a composition of damped sinusoid. Each damped sinusoid corresponds to a pair of complex conjugate poles in the complex frequency domain. The target detection and recognition can be performed by comparing the mapping of these poles with a library of poles of the target.

The Cauchy method is applied for approximating the transfer function in the frequency domain. The frequency response of the system is modeled by a ratio of two polynomials [17]. With the dielectric properties of the immature, early developed stage and fully developed stage durians in Table 4, the radar cross section of a

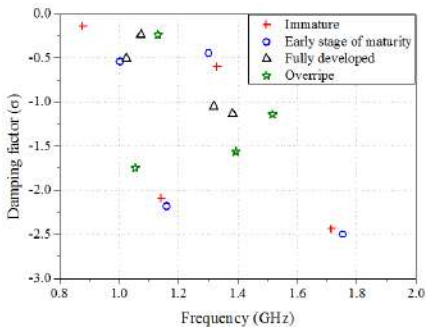
concentric spherical dielectric with peel has fixed dielectric properties as in Fig.13 (a) are analyzed. The corresponding natural poles are shown in Fig.13 (b).

Table 4 Physical properties of durian fruits at different stages of maturity [17]

Stages	Maturity (%)	Days after anthesis	Dry weight (%)	Dielectric properties	
				ε'	ε''
Immature	50	90-100	11.96	58±2	14±1
	60	100-105	19.66	55±2	14±1
Early stage (export quality)	70	105-110	32.98	51±1	14±1
	80	110-115	34.08	50±2	14±1
	90	115-120	34.69	49±2	14±1
Fully developed	100	120-125	35.67	48±3	14±1



(a)



(b)

Fig.13 Scattering responses of durian fruits at different stages of maturity [17]

(a) Radar cross section (b) Natural poles at different stages of maturity

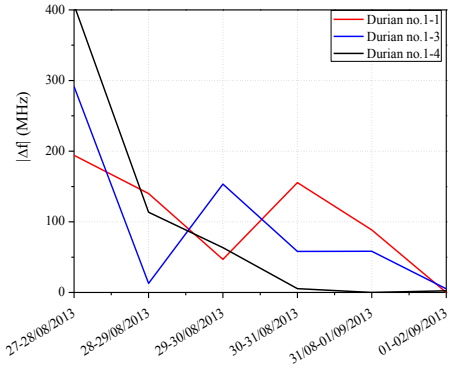
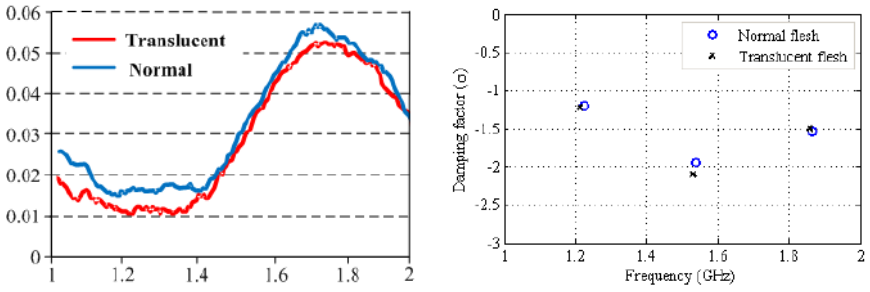


Fig.14 Frequency difference at different dates

The graph of over ripe durian in Fig.13 (a) is different from the others since air gap between peel and pulp is taken into account. The frequencies of the poles are not varied in a regular manner. It is noted that the different poles can be applied in classifying maturity stage of durian. The experiments on many durian fruits (each is measured for many days) to find natural poles at different days. Fig.14 shows the difference of resonance frequency for different days. It is relevant that the frequency difference between day 27-27/08/2013 and 28-29/08/2013 are about 300 MHz while those for other days are less than 200 MHz. This significant different results from the significant different of dielectric constant of pulp in Fig.10 (b). In addition, the dry-weight of 35% corresponding to the 103 days after anthesis reveals the maturity stage of 70%. The radar can serve as a sensor for pre-harvest control of durian.

4. Mangosteen

Apart from durian, it should be pointed out that this technique can be applied to other fruits. One of the examples is mangosteen. The work in [18] shows that with different dielectric properties of translucent flesh and normal flesh of mangosteen, shown in Table 5, the natural frequency is different, see Table 6 [18].The radar cross section and natural poles are shown in Fig.15 (a) and (b), respectively. The difference in first order natural frequency is 12.5 MHz. The measured results are 11.8 MHz. These values show the applicability of this radar in translucent mangosteen inspection.



(a) Radar cross section (b) Extracted poles

Fig.15 Measurement results

Table 5 Natural frequencies of mangosteens

NATURAL FREQUENCIES OF MANGOSTEENS

	Translucent flesh	Normal flesh	Δf (MHz)
Natural Frequency (GHz)	1.1330	1.1455	12.5
	1.4342	1.4501	15.9
	1.6304	1.6408	10.4
	1.8378	1.8433	5.5

Conclusion

According to the demand for low cost, non-destructive sensors for fruits quality control, this paper shows some sensors we have developed. The high frequency as 2.4 GHz and 10 GHz can be applied to thin peel-fruits like orange, mango and mangosteen. For the thick-peel fruit like durian, the lower frequency about 1 GHz is more suitable. The current interest is the post-harvest sensor for grading fruits. However, for the precision farming, the pre-harvest sensor is desired and challenged.

Acknowledgement

The works in this paper are supported by Thailand Research Fund (TRF), National Research Council of Thailand (NRCT), and King Mongkut's Institute of Technology Ladkrabang Research Fund. The author faithfully appreciate the contribution of colleagues and students that make these projects success.

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Monai Krairiksh was born in Bangkok, Thailand. He received the B.Eng., M.Eng. and D.Eng. degrees from King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand in 1981, 1984, and 1994, respectively.

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Dr.Krairiksh was the chairman of the IEEE MTT/AP/Ed joint chapter in 2005 and 2006. He served as the General Chairman of the 2007 Asia-Pacific Microwave Conference, and the advisory committee of the 2009 International Symposium on Antennas and Propagation. He was the President of the Electrical Engineering/ Electronics, Computer, Telecommunications and Information Technology Association (ECTI) in 2010 and 2011 and was an editor-in-chief of the ECTI Transactions on Electrical Engineering, Electronics, and Communications.

He was a Senior Research Scholar of the Thailand Research Fund in 2005 and 2008 and a Distinguished Research Scholar of the National Research Council of Thailand in 2010.

Dr.Krairiksh was a distinguished lecturer of IEEE Antennas and Propagation society in 2013-2014. He is currently an Associate Editor of IEEE Transactions on Antennas and Propagation.

Paper List of ECTI-EEC Trans., Vol.13, No. 2, Aug-2015 issue

http://www.ecti-thailand.org/paper/journal/ECTI-EEC

Circuits and Systems

Impact of Strain on Fully Depleted Strained Gate Stack Double Gate MOSFET: A Simulation Study

S K Mohapatra, K P Pradhan, P K Sahu, S Parija

Communication Systems

Improvement of RF-Pilot Based Phase Noise Compensation in CO-OFDM Communication Systems

Kidsanapong Puntsri

Electrical Power Systems

Design and implementation of a new multilevel push pull inverter topology

Ali Ajami, Babak Nayeri, Farhad Mohajel Kazemi

Signal Processing

The Ultimate's Detection Capability of Diversely Polarized Antenna Arrays using Higher Order Statistics

Supawat Supakwong

Comparative Experimental Exploration of Robust Norm Functions for Iterative Super Resolution Reconstructions under Noise Surrounding

Vorapoj Patanavijit

Report from Conferences and Workshops

1. ECTI-CARD 2015 (reported by Chaiwat Sakul, RMUTS)

ECTI-CARD 2015, Trang, Thailand

7th Conference on Application Research and Development, ECTI-CARD for Energy and Environment

ECTI-CARD 2015, the 7th annual conference organized by Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology Association of Thailand (ECTI Thailand) was held in Thumrin Thana Hotel, Muang-Trang, Trang, Thailand, form July 8-10, 2015.

The conference aims to promote application, research and development on all aspects of Computer Systems and Control including Artificial Intelligence, Computer Networks, DSP and Image Processing, Information Technology, Computing Theory, Bioinformatics, Knowledge Discovery, Information Retrieval, Grid and High performance computing, Natural Language Processing, Knowledge Management, Embedded System and Robotics, Software engineering, Multimedia Analysis, Computer Vision and Graphics and E-commerce. The conference proceedings are published and accessible via ECTI Association website, http://www.ecti-thailand.org/.

Static & Facts about ECTI-CARD 2015

« There are 232 papers submitted and 195 papers accepted as regular paper.
(Oral presentation = 171 papers and Poster presentation = 24 papers)
« There are totally 195 papers from 45 universities.
« There are totally 358 exhibitors

The technical program included 3 keynote speeches, 1 workshop, 6 lecture sessions and 1 poster session. Six best paper awards and 1 ECTI president award were announced in the conference banquet.

Keynote speeches for ECTI-CARD 2015

Prof.Dr.Dusit Kruangam
"Solar energy Alternative energy for Thailand"

Asst.Prof.Dr.Waranon Kongsong
"New generation of engineers for ASEAN community"

Assoc.Prof.Dr.Sompol Kosolwat
"Antenna model DVB T2 for Digital TV"

The best award: Oral presentation

Mobile Application for Location Based Tour Guide with Augmented reality technology Case Study: Bangkok University
Mr.Todsapon Banklongsi

An Optimization of Bricks Transport Control System using regression analysis method for Automatic Robot Wall Builder
Mr.Jatupum Aeino, Mr.Kamol Boonlom. Mr.Atikhom Siri and Thanawut Thanavanich

Application Development for Display Vital Sign on Android
Ms.Tasawan Puttasakul and Ms.Sukarnda Huangsangwan

Development of Nutrients Measurement System for Hydroponic Plot through Wireless System
Mr.Noppadon Sisuk, Dr.Kriangsak Prompak and Ms.Suphawadee Suphramit

The best paper awards: Poster presentation

Multiband Antenna for WLAN/2G/3G Applications

Ms.Rassamitut Pansomboom, Ms.Nuttawadee Krittayopas, Mr.Natthawit Sanguansakbaramee and Assoc.Prof.Dr.Chuwong Phongcharoenpanich

Respiratory Rate Monitoring System during Sleep

Dr.Nattakan Puttarak, Asst.Prof.Dr.Tulaya Limpiti, Assoc.Prof.Wipa Saengpisist, Miss.Piyanee Kreadtichaiwanit and Mr.Poonawit Pispeng

ECTI president award

Growth of seedlings in the nursery cactus system off automatically

Mr.Pakkapon Janmaha and Mr.Sarayut Suanluang

Activates in ECTI-CARD 2016

ECTI-CARD 2015 have more programs, such as Welcome Sea food party on the beach at RMUTSV, Trang campus, Banquet party with wonderful musical and south traditional show for all registrants at Thumrin Thana Hotel.

The next ECTI-CARD 2016 will be held in Hua Hin Grand Hotel and Plaza, Prachuap hiri Khan, July 20-22, 2016. For more information, please access to the website ttp://ecticard2016.ecticard.org/.

2. Professor Roadshow

ECTI Association contributes in Thai academic society by delegating Prof. Monai Krairiksh (KMITL), Prof. Prayoot Akkaraekthalin (KMUTNB), and Prof. Kosin Chamnongthai (KMUTT) to give speech and discuss in front of lecturers at KKU, RMUTI, and BUU on Sep 4, 18, and 25, 2015 respectively.

3. International Seminar for Scholarly Publishing

ECTI and IEICE Associations co-organised the international seminar for scholarly publishing at KMUTNB on Sep 23, 2015. The objective is to train and encourage reviewers for international journals.

2nd Announcement & Call for Papers

International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology

ECTI-CON 2016 June 28th - July 1st, 2016 at Chiang Mai, Thailand

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Call for Papers
On behalf of Rajamangala University of Technology Lanna (RMUTL) and ECTI Association, we are delighted to welcome all delegates and all the distinguished guests to Chiang Mai for the 13th International Conference that will take place in the downtown of Chiang Mai, northern Thailand in June 28th - July 1st, 2016. This is Chiang Mai's largest annual event devoted to the science and practice of Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology and it will give participants a platform to exchange ideas, discover novel opportunities, reacquaint with colleagues, meet new friends and broaden their knowledge. Accepted papers will be published in the proceedings of ECTI-CON 2016 and will be submitted for inclusion into IEEE Xplore. Acceptance will be based on quality, relevance and originality.

Important dates:
Submission of Full Paper: January 31st, 2016
Notification of Acceptance: May 7th, 2016
Submission of Final Manuscripts: May 22nd, 2016
Registration of Authors and Early-bird: May 22nd, 2016

Paper submission:
1) Prospective authors are invited to submit original full papers **WITHOUT author's names and affiliations, in English**, of 4-6 pages in standard IEEE two-column format only, reporting their original work and results, applications, and/or implementation in one or more of the listed areas.
2) Papers must be submitted only by internet through the submission system of the conference website.
3) At least one author of each accepted paper **MUST** register and present paper at the conference in order for the paper to be included in the program. The program will be submitted for inclusion into IEEE Xplore.

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