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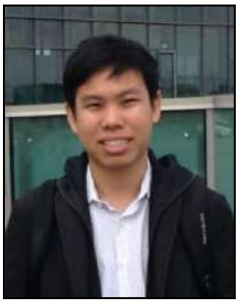
Message from Editor

Dear Valued ECTI Members,

In this issue, we are certainly pleased to publish a review article titled "Flood Monitoring and Early Warning Using Intelligent Information System" by Asst. Prof. Dr. Nattakan Puttarak and her team member (King Mongkut's Institute of Technology Ladkrabang). It describes a recently implemented mobile system prototype for a disaster monitoring station with integrated sensors for water level, water flow rate and direction, rainfall rate, as well as other weather parameters. In addition, the comparisons between observations and predictions are presented. On the "My Research Life Experience" article, Ms. Ohnmar Khin from Myanmar will share her educational and social experiences while studying her Master degree at King Mongkut's Institute of Technology Ladkrabang.

In addition to the activities/Workshops of each Technical Area as well as the ECTI Association, list of articles in the ECTI Journals, upcoming sponsored conferences and seminars, we welcome the articles related to the activities, collaboration projects at your research group, laboratories or research centers. In the near future, we will publish the articles or updates related to industry, graduate students and new researchers. Should you have any comments or suggestions to improve the ECTI E-Magazine so that it serves our members better, please do not hesitate to contact us via E-mail or Facebook.

Pornchai Supnithi
ECTI E-Magazine Editor



Watid Phakphisut
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Flood Monitoring and Early Warning Using Intelligent Information System

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ABSTRACT

In Thailand, the annual recurrence of flood in northern and central-region provinces during rainy season may turn out to be a major disaster with the lack of good management. This project aims to apply ICT in disaster management, particularly flooding. Flood preparedness includes flood monitoring and warning efforts. This is achieved by developing an intelligent flood monitoring system. A mobile system prototype for a disaster monitoring station with integrated sensors for water level, water flow rate and direction, rainfall rate, as well as other weather parameters, has been constructed. The mobile monitoring unit includes the control unit, power supply unit, sensing components and two-mode communication module. The communications is via cellular network in normal operation mode and via satellite link when all other communications channels are down from disaster. The mobile station periodically sends data to the central data management system. Besides collecting and storing the data, the central management system houses a risk analysis algorithm based on adaptive neuro fuzzy inference. It sends warning alarm to corresponding official response units in case of a predicted disaster. It also serves as the web server that hosts information accessible to the public.

Our system had been tested on site at the Hydrology Irrigation Center for Central Region in Chainat province. The data was successfully transferred to the central data management system. In addition, the water data from Thailand's Royal Irrigation Department Bangbal station in Ayuttaya province was used to test the risk analysis algorithm. We demonstrated that it is able to predict events of floods 24 hours in advance.

Keywords

Flood monitoring, early flood warning, disaster management, fuzzy inference, mobile sensor station

I. INTRODUCTION

The 2011 mega flood had a devastating effect on more than ten provinces of Thailand, especially in the central region along the Chao Phraya River including Bangkok. The disaster badly crippled the country both economically and socially. During that time, seven major industry estates were inundated, forcing many plants to shut down. People lost their jobs, as well as their home. Overall, this flood affected more than 13 million people and resulted in more than 680 deaths [2]. Unfortunately, this mega flood was not the only disaster we had to face. Each year many people suffer from heavy rains combined with tropical storms and landslides during a rainy season, while during crop season in the summer they face the droughts [3-5].

When it is not easy to access alert information about disaster occurrences, announcements from responsible officers may not reach appropriate people on time. Additionally, a thorough analysis on the causes of problems is crucial to prevent or alleviate possible damages in future disasters.

At present, we do not have a real-time disaster monitoring and warning system that can effectively estimate and also record statistical disaster-related data for analysis.

In flood detection and monitoring, efficiently monitor, control, and manage water level, water flow, and rainfall during each year's rainy season is valuable. This project aims to design a mobile system for flood information networking. We use sensors to detect water level, water flow rate and direction. In addition, rain fall rate and other meteorological data are measured by a weather station. All sensors, the weather station and processing unit are integrated in the mobile stations that can be moved easily and located closed to disaster-prone areas. For the communication part, all measured data is wirelessly sent to a central data center via a GPRS (General Packet Radio Service). However, when mobile operators are out of service due to severe disasters, the sensor data is sent via satellite. To test the system, the mobile station has been installed at the Royal Irrigation department in Chainat province, Thailand. The measured sensor data has been successfully transferred to the central data management system. Besides collecting and storing the data, the central management system houses the risk analysis algorithm and sends warning alarm to corresponding official response units in case of a predicted disaster. It also serves as the web server that hosts information accessible to the public.

The specific contributions of this project are 1) develop a prototype mobile monitoring station and communications system with integrated sensors for flood monitoring, 2) design and implement an intelligent early-warning algorithm which analyzes the sensing data and broadcasts warning of potential disasters to local communities, as well as alerts authorities, and 3) build a central information server for administrative management.

This paper is organized as follow. Section II shows the overall system design of this project. Section III introduces the mobile monitoring station, which consists of plug-in sensors, a weather station, a processing unit, and a power supply. Then, the communication components including GPRS and satellite are be described in Section IV. A flood prediction model using Fuzzy inference system is discussed in Section V. Lastly, the conclusion is given in Section VI.

II. THE SYSTEM DESIGN

The overview of our system design is given in Fig. 1. Different mobile monitoring stations containing various types of sensors suitable for disaster monitoring of choice are placed at disaster-prone locations across the country. During normal situation, the mobile stations communicate via mobile networks, sending sensor data and other relevant information to the central data management system. During or after disaster, stations within the vicinity of the affected areas where mobile network is down sent the data alternatively using satellite link. The central data management system contains the information server, monitoring data during normal operations and during disaster. It also houses the risk analysis algorithm using fuzzy expert system and sends warning alarm to corresponding official response units. Lastly, it serves as the web server that hosts information accessible to the public.

Figure 2 depicts the communications during normal situation. The sensor data and the location of the mobile station is routed to the mobile information server through the country's existing mobile network. In the cases that the mobile station is installed in the area where mobile network is not available, e.g. inside the jungle, in the valley, or in the disaster area where the terrestrial communication is disconnected, all measured data is sent to the server using the satellite communication link, as shown in Fig.3.

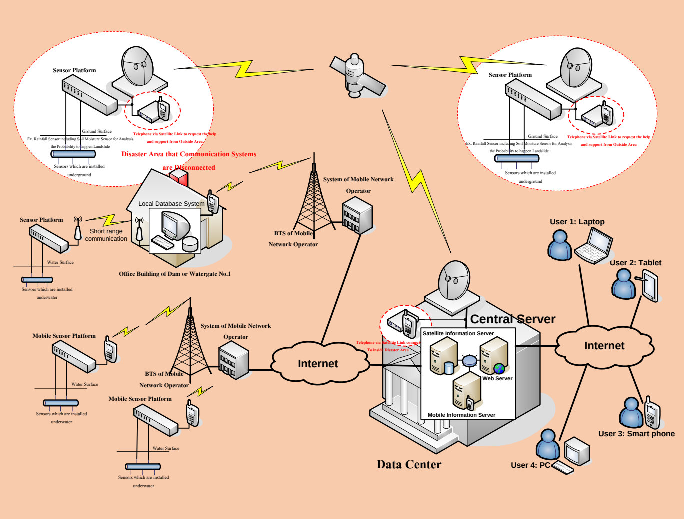

Figure 1: The system design.

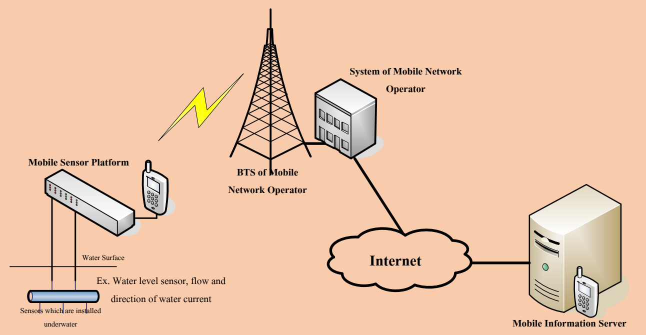

Figure 2: The communications during normal situation.

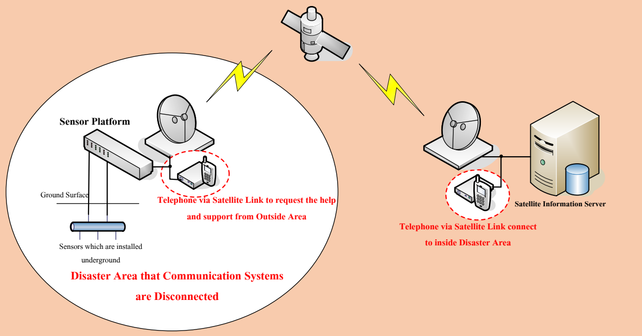

Figure 3: The satellite communications.

III. MOBILE MONITORING STATION

The mobile disaster monitoring station consists of two main parts—the control unit and the power supply unit. Sensor data received at the control unit are subsequently sent out to the central data management system to be analyzed for possible disasters either via a mobile network (normal situation) or a satellite link (during disasters). Components of the mobile monitoring station are displayed in Fig.4.

The mobile monitoring station can be powered two ways—using regular power outlets or using solar cells. For the units located in the city area, for example, units installed for additional measurements away from fixed-point monitoring stations, the units can use regular power outlets. Solar cells power is used for mobile units that are installed in the rural areas or difficult terrains without electricity, or used in the case that the electrical system is down due to disasters. For both power systems, inverter for charging reserve battery is provided. For usage, the user can choose the power supply manually.

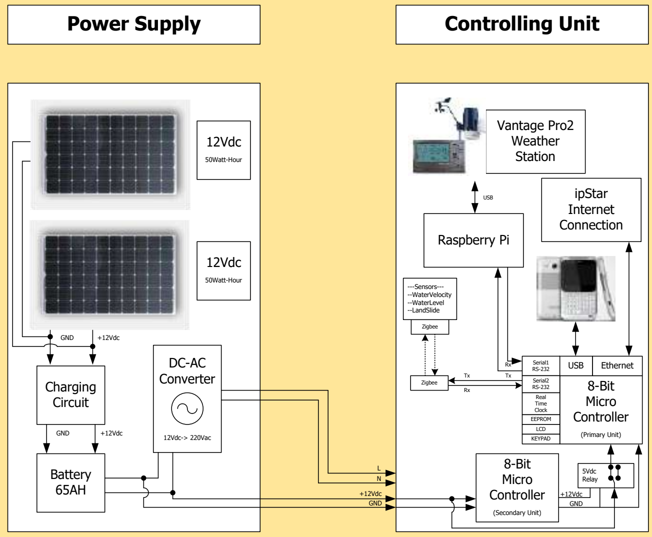

Figure 4: Block diagram of the mobile disaster monitoring station.

Figure 5: Hardware of mobile monitoring station.

Figure 5 depicts the hardware of mobile monitoring station located on top of the building of department of Telecommunications Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang for initial testing. Figure 6 and 7 show the actual hardwares of the supply unit and control unit including sensors installed at the mobile station.

Figure 6: Actual hardware of the power supply unit.

(a) (b) (c)

Figure 7: The control unit and sensors installed at the mobile station. (a) External of the control unit. (b) Internal of the top control unit. (c) Internal of the bottom control unit.

The mobile monitoring station for flood warning has been tested on site at the Hydrology Irrigation Center for Central Region in Chainat province during a visit from the Japanese experts. The data (water level, water flow rate, and weather parameters) are successfully transferred to the central data management system.

IV. SATELLITE COMMUNICATION UNIT

In case of natural disasters such as floods, landslides, tsunami, or earthquakes, infrastructures of terrestrial and cellular telephone networks are often damaged or out of order. Relief efforts to restore the original networks could take weeks, so communications between stranded disaster victims and other areas are cutoff. To quickly restore communications during or immediately after such disasters, Raspberry Pi, a credit-card sized computer, is used as a server to control and manage sensor data from the weather station. The data is sent to the database on the central server via an Internet network of IPSTAR satellite. This real-time sensor data can be monitored and utilized by people in the disaster areas, as well as other people outside the affected areas. An IP phone is used to send and receive calls between disaster area and safe areas. This satellite communications system is depicted in Fig. 8. Figure 9 illustrates the IP Phone system via the IPSTAR satellite, which is composed of the antenna, the modem, the IP phone, and the computer.

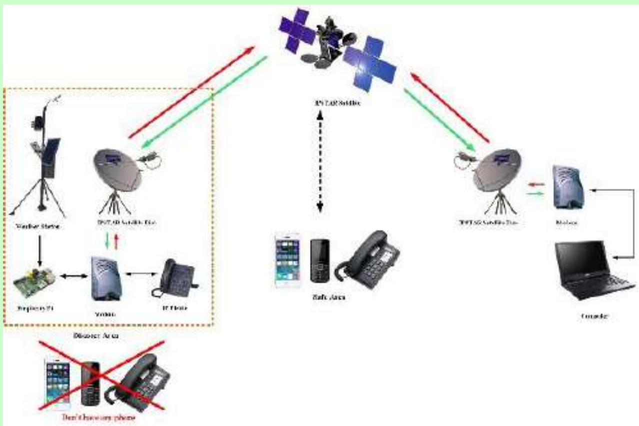

Figure 8: Communications system via IPSTAR satellite during disaster.

Figure 9: Block diagram of the IP phone system via IPSTAR satellite.

V. THE CENTRAL DATA MANAGEMENT SYSTEM

The central data management system has three main functionalities. First, it is the main server that combines data from the mobile monitoring station that is sent via GPRS module over cellular network and the data from satellite communications unit in case of cellular network damage or service disruption. Secondly, it houses the risk analysis algorithm using fuzzy expert system and sends warning alarm to corresponding official response units. Lastly, it serves as the web server that hosts information accessible to the public.

The data center displays the location of the available mobile base stations. There is one mobile base stations currently sending data to the server. By clicking the “Show All” button all data from the mobile station can be monitored. Fig. 10 displays the sensor data received from the mobile floods monitoring station operating on the test site in Chainat province. The data can also be exported in .csv format (Fig. 11) to other programs for subsequent processing.

VI. FLOODING ESTIMATION MODEL

Disaster risk analysis and early warning algorithm has been developed for floods warning up to 24 hours in advance. The measured data from different sensor modules is sent and collected at the central data server. Risk analysis is performed using Adaptive Neuro Fuzzy Inference Systems (ANFIS). The ANFIS combines artificial neural network with the fuzzy inference system, where reference from disaster experts is used to construct the rule (rule-based fuzzy logic) for disaster inference.

The algorithm is installed on both the mobile monitoring station and the central data management system. Once the algorithm detects possible incoming disaster, the preliminary warning is promptly sent out from the mobile station. At the same time, the central data management system will report the detected potential disaster to the official disaster response unit, who will consequently analyze the severity of the situation. Official alarm and appropriate protocol will be sent to all related governmental units as well as to appointed local contact person. It is also possible to adjust the inference rule/criteria when additional local information or prior information on past disasters becomes available.

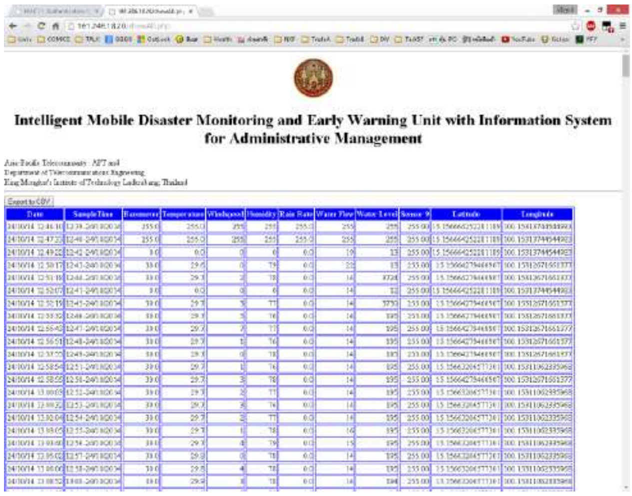

Figure 10: Data displayed after clicking the “Show All” button.

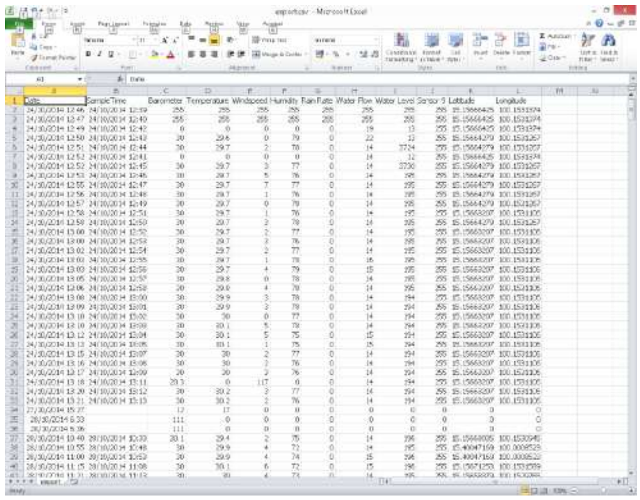

Figure 11: Sample data from mobile base station in .csv format.

A. Algorithm design

The disaster analysis and early warning algorithm has been designed for floods monitoring. The algorithm is designed to predict an event of floods 24 hours in advance. Floods prediction uses two ANFIS systems, as shown in Fig. 12. The Inputs of the system are today’s water level and flow rate, and the differential flow rate between yesterday and today. The first ANFIS uses today’s water level and the differential flow rate as inputs to predict tomorrow’s water level. The second ANFIS predicts tomorrow’s flow rate from today’s flow rate and the differential flow rate. The outputs are compared with the flooding criteria to determine whether it is normal, critical, or at flooding level. Note that these criteria (Normal, Critical, and Flood) are location-dependent. Floods happens when either the water level or the water flow rate meet the flooding criteria.

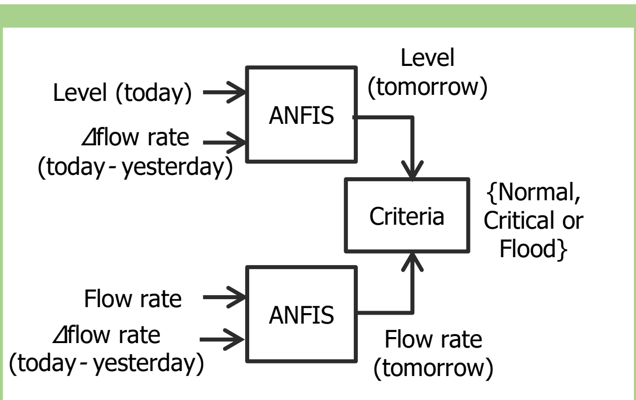

Figure 12: Block diagram of the early floods warning system.

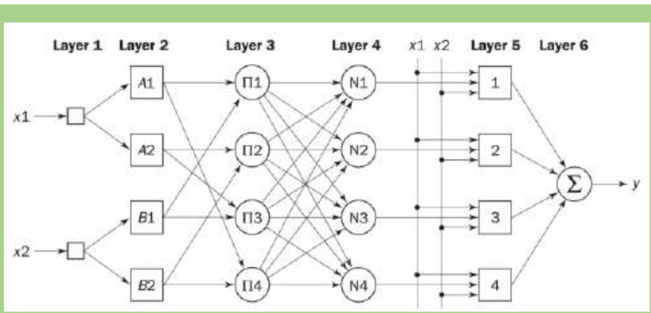

Figure 13: Architecture of the ANFIS.

The architecture of the proposed ANFIS for early flood warning is illustrated in Fig. 13. The structure consists of 6 layers according to the feed-forward neural network. There are two system inputs x_1 and x_2. Input x_1 corresponds to two fuzzy sets A_1 and A_2, whereas fuzzy sets B_1 and B_2 are for input x_2. There is one output y. Following Sugeno fuzzy model, we construct four rules:

Rule 1:
If x_1 is A_1
And x_2 is B_1
Then $y = f_1 = k_{10} + k_{11}x_1 + k_{12}x_2$

Rule 2:
If x_1 is A_2
And x_2 is B_2
Then $y = f_2 = k_{20} + k_{21}x_1 + k_{22}x_2$

Rule 3:
If x_1 is A_2
And x_2 is B_1
Then $y = f_3 = k_{30} + k_{31}x_1 + k_{32}x_2$

Rule 4:
If x_1 is A_1
And x_2 is B_2
Then $y = f_4 = k_{40} + k_{41}x_1 + k_{42}x_2$

k_{i0}, k_{i1}, and k_{i2} are consequent parameters of rule i.

The operations in each layer can be summarized as follows.

1) Layer 1: Input layer
This layer processes the inputs before passing it to Layer 2, using

$$y_i^{(1)} = x_i$$

where i is the index for the i^{th} neuron.

2) Layer 2: Fuzzification layer
The fuzzification step takes the inputs from Layer 1 and determines the degree to which these inputs belong to each of the fuzzy sets via the membership functions $\mu_{A_i}(x)$

$$y_i^{(2)} = \mu_{A_i}(y_i^{(1)})$$

when $y_i^{(2)}$ is the membership function of A_i.

The membership function adopted from Jang's model is the Bell activation function, whose equation is

$$y_i^{(2)} = \frac{1}{1 + \left(\dfrac{y_i^{(1)} - a_i}{c_i}\right)^{2b_i}}$$

where a_i, b_i, and c_i are the parameters for controlling the center, the width, and the slope of such function, respectively.

3) Layer 3: Rule layer
The rule layer computes the firing strength of the rules for each neurons. The result in this layer is from the product

$$y_i^{(3)} = \prod_{j=1}^{m} x_{ji}^{(3)}$$

For example, the output of rule layer for the rule in the first neuron (Π_1) is

$$y_1^{(3)} = y_1^{(2)} \times y_3^{(2)} = \mu_1$$

μ_1 is the firing strength or truth value of Rule 1.

4) Layer 4: Normalization layer
The Normalization calculates the normalized firing strength

$$y_i^{(4)} = \frac{\mu_i}{\sum_{j=1}^{n} \mu_j} = \bar{\mu}_i$$

5) Layer 5: Defuzzification layer
This layer calculates the weighted consequent values of the rules using the inputs,

$$y_i^{(5)} = \bar{\mu}_i \left[k_{i0} + \sum_{j=1}^{m} k_{ij} x_j \right]$$

6) Layer 6 :Summation neuron

The output y of the ANFIS is finally calculated using

$$y = \sum_{i=1}^{2m} y_i^{(5)}$$

The ANFIS training algorithm utilizes a hybrid learning algorithm, which combines a least-square estimator with a gradient descent method, to adjust parameters *k*'s and the membership functions. The weights in the feedforward pass are determined using least-square estimations. The backward pass applies the back-propagation algorithm.

For the Sugeno-style ANFIS used in this algorithm, the output is a linear function. Therefore, from the input-output pattern we can write linear equations to represent the parameter outputs as,

$$f = y_i^{(5)}$$

Alternatively, in matrix form we have

$$\mathbf{y_d} = \mathbf{Ak}$$

Where $\mathbf{y_d}$ is $P \times 1$ vector of the desired output.

$$\mathbf{y_d} = \begin{bmatrix} y_d(1) \\ y_d(2) \\ \vdots \\ y_d(p) \\ \vdots \\ y_d(P) \end{bmatrix}$$

$\mathbf{A}$ is a $P \times n(1+m)$ matrix,

$$\mathbf{A} = \begin{bmatrix} \bar{\mu}_1(1) & \bar{\mu}_1(1)x_1(1) & \cdots & \bar{\mu}_1(1)x_m(1) & \cdots & \bar{\mu}_n(1) & \bar{\mu}_n(1)x_n(1) & \cdots & \bar{\mu}_1(1)x_m(1) \\ \bar{\mu}_1(2) & \bar{\mu}_1(2)x_1(2) & \cdots & \bar{\mu}_1(2)x_m(2) & \cdots & \bar{\mu}_n(2) & \bar{\mu}_n(2)x_n(2) & \cdots & \bar{\mu}_1(1)x_m(1) \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots & \cdots & \\ \bar{\mu}_1(p) & \bar{\mu}_1(p)x_1(p) & \cdots & \bar{\mu}_1(p)x_m(p) & \cdots & \bar{\mu}_n(p) & \bar{\mu}_n(p)x_n(p) & \cdots & \bar{\mu}_1(1)x_m(1) \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots & \cdots & \\ \bar{\mu}_1(P) & \bar{\mu}_1(P)x_1(P) & \cdots & \bar{\mu}_1(P)x_m(P) & \cdots & \bar{\mu}_n(P) & \bar{\mu}_n(P)x_n(P) & \cdots & \bar{\mu}_1(1)x_m(1) \end{bmatrix}$$

and $\mathbf{k}$ is an $n(1+m) \times 1$ vector of the unknown parameters,

$$\mathbf{k} = [k_{10}\ k_{11}\ k_{12} \ldots k_{1m}\ k_{20}\ k_{21}\ k_{22} \ldots k_{2m} \ldots k_{n0}\ k_{n1}\ k_{n2} \ldots k_{nm}]^T$$

Typically, if the number of equations P in the learning process is larger than the number of parameters ($n(1+m)$), the system of linear equation is over-determined, and we can use the pseudo-inverse technique to solve for *k*,

$$\mathbf{k}^* = (\mathbf{A}^T\mathbf{A})^{-1}\mathbf{A}^T \boldsymbol{y_d}$$

We can calculate the error vector,

$$\boldsymbol{e} = \boldsymbol{y_d} - \boldsymbol{y}$$

The Back-propagation algorithm is utilized in the backward pass, and the parameters are updated using chain rule. When there is an update of the weight for parameter $\boldsymbol{a}$ of Bell activation function for neuron A_1, we obtain the following chain rule,

$$\Delta \boldsymbol{a} = -\alpha \frac{\partial \boldsymbol{E}}{\partial \boldsymbol{a}} = -\alpha \frac{\partial \boldsymbol{E}}{\partial \boldsymbol{a}} \times \frac{\partial \boldsymbol{e}}{\partial \boldsymbol{y}} \times \frac{\partial \boldsymbol{y}}{\partial(\bar{\boldsymbol{\mu}}_i \boldsymbol{f}_i)} \times \frac{\partial(\bar{\boldsymbol{\mu}}_i \boldsymbol{f}_i)}{\partial \bar{\boldsymbol{\mu}}_i} \times \frac{\partial \bar{\boldsymbol{\mu}}_i}{\partial \boldsymbol{\mu}_i} \times \frac{\partial \boldsymbol{\mu}_i}{\partial \boldsymbol{\mu}_{A1}} \times \frac{\partial \boldsymbol{\mu}_{A1}}{\partial \boldsymbol{a}}$$

The variable α is the learning rate, and E is the error of the ANFIS output.

Because

$$\boldsymbol{E} = \frac{1}{2}\boldsymbol{e}^2 = \frac{1}{2}(\boldsymbol{y_d} - \boldsymbol{y})^2$$

Hence,

$$\Delta \boldsymbol{a} = -\alpha(\boldsymbol{y_d} - \mathbf{y})(-1)\boldsymbol{f}_i \times \frac{\bar{\boldsymbol{\mu}}_i(1-\bar{\boldsymbol{\mu}}_i)}{\boldsymbol{\mu}_i} \times \frac{\boldsymbol{\mu}_i}{\boldsymbol{\mu}_{A1}} \times \frac{\partial \boldsymbol{\mu}_{A1}}{\partial \boldsymbol{a}}$$

or

$$\Delta \boldsymbol{a} = \alpha(\boldsymbol{y_d} - \boldsymbol{y})\boldsymbol{f}_i \bar{\boldsymbol{\mu}}_i(1-\bar{\boldsymbol{\mu}}_i) \times \frac{1}{\boldsymbol{\mu}_{A1}} \times \frac{\partial \boldsymbol{\mu}_{A1}}{\partial \boldsymbol{a}}$$

where

$$\frac{\partial \boldsymbol{\mu}_{A1}}{\partial \boldsymbol{a}} = -\frac{1}{\left[1 + \left(\frac{\mathbf{x}1 - \boldsymbol{a}}{\boldsymbol{c}}\right)^{2\boldsymbol{b}}\right]^2} \times \frac{1}{\boldsymbol{c}^{2\boldsymbol{b}}} \times 2\boldsymbol{b} \times (\mathbf{x}1 - \boldsymbol{a})^{2\boldsymbol{b}-1} \times (-1)$$

$$= \boldsymbol{\mu}^2{}_{A1} \times \frac{2\boldsymbol{b}}{\boldsymbol{c}} \times \left(\frac{\mathbf{x}1 - \boldsymbol{a}}{\boldsymbol{c}}\right)^{2\boldsymbol{b}-1}$$

Parameters $\boldsymbol{b}$ and $\boldsymbol{c}$ can be calculated in a similar manner.

B. Algorithm testing for early floods warning

We test the performance of our algorithm using the data at Bangbal station (C_{37}) in Ayuttaya province, Thailand. This location experiences annual flooding during the rainy season. Hence, there are sufficient data to create flooding criteria based on actual events. During flooding, the water level and water flow rate exceed the river capacity. The flooding criteria at C_{37} station are displayed in Table 1.

Table 1: Flooding criteria at Bangbal station

Water level (m)			Water flow rate (m^3/s)		
Normal	Critical	Flood	Normal	Critical	Flood
< 3.35	3.35-3.80	>3.80	< 110	110-134	> 134

The system learns from the water level and water flow rate data between 2008 and 2011. For the fuzzification layer (layer 2), the fuzzy sets of the first input (A_1 and A_2) and those for the second input (B_1 and B_2) in terms of the membership functions are illustrated in Fig. 14. Using the bell activation function,

$$y_i^{(2)} = \frac{1}{1+\left(\frac{y_i^{(1)}-a_i}{c_i}\right)^{2b_i}}$$

a_i, b_i and c_i are calculated to be

A_1 : a_1 = -34.83 b_1 = 1.345 c_1 = 33.71
A_2 : a_2 = 32.32 b_2 = 2.11 c_2 = 33.09
B_1 : a_3 = -1.752 b_3 = 0.3962 c_3 = 0.3962
B_2 : a_4 = 3.711 b_4 = 10.27 c_4 = 2.267

For defuzzification layer (Layer 5) the coefficients k_{i0}, k_{i1} and k_{i2} for the first order equation,

$$y_i^{(5)} = \bar{\mu}_i\left[k_{i0} + \sum_{j=1}^{m} k_{ij}x_j\right]$$

, are

k_{10} = 2.573 k_{11} = 0.1058 k_{12} = 0.3198
k_{20} = -1.767 k_{21} = -0.04154 k_{22} = 1.333
k_{30} = -2.322 k_{31} = 0.1372 k_{32} = 1.572
k_{40} = 1.54 k_{41} = 0.0432 k_{42} = 0.7214

Similarly, we obtain the membership functions for the 2nd ANFIS, as depicted in Fig.15 along with the following coefficients,

A_1 : a_1 = -31.12 b_1 = 6.494 c_1 = 34.83
A_2 : a_2 = 28.38 b_2 = 20.04 c_2 = 32.48
B_1 : a_3 = 5.509 b_3 = 1.488 c_3 = 212.4
B_2 : a_4 = 419.3 b_4 = 2.241 c_4 = 209.7

And

k_{10} = -5.135 k_{11} = -0.206 k_{12} = 0.9859
k_{20} = -30.66 k_{21} = 0.6983 k_{22} = 1.084
k_{30} = 4.163 k_{31} = 0.4111 k_{32} = 0.9912
k_{40} = 34.38 k_{41} = 0.7558 k_{42} = 0.9029

After training, the algorithm predicts the daily water levels and water flow rates for 2012. The predicted water levels and flow rates, compared against the actual measurements, are depicted in Fig.16 and Fig.17, respectively.

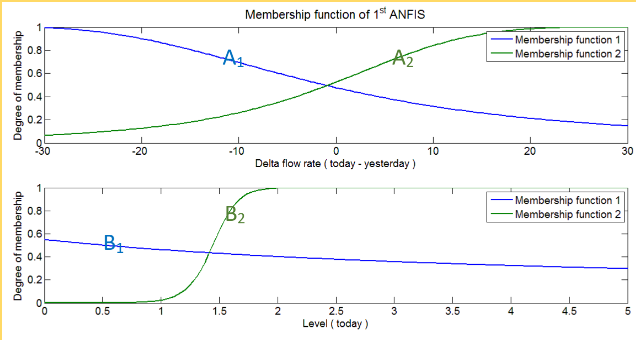

Figure 14: Membership functions of the 1st ANFIS.

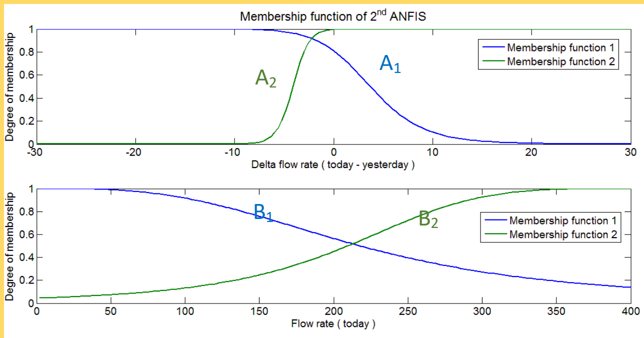

Figure 15: Membership functions of the 2nd ANFIS.

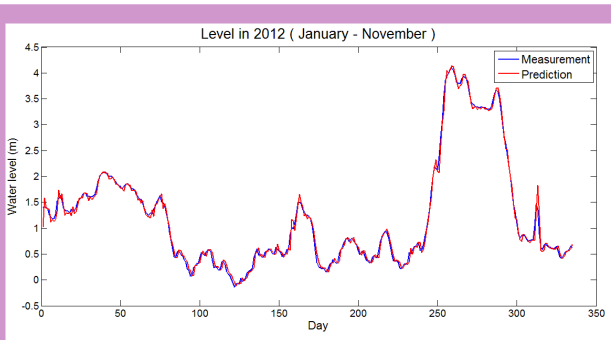

Figure 16: Predicted and measured daily water level in 2012.

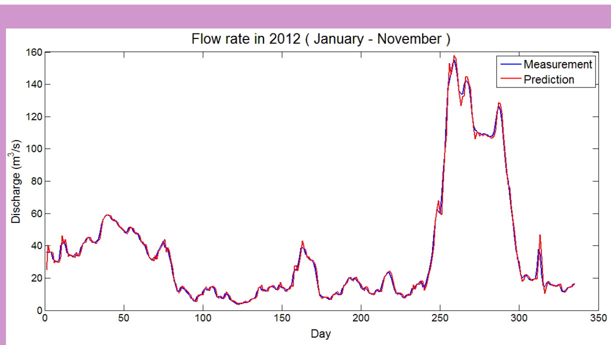

Figure 16: Predicted and measured daily water flow rate in 2012.

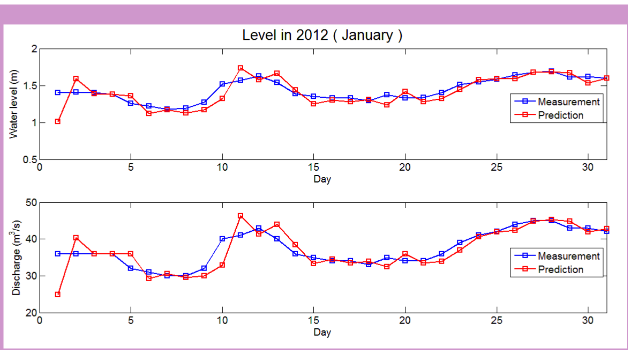

Figure 17: Predicted and measured daily water level and flow rate in January 2012.

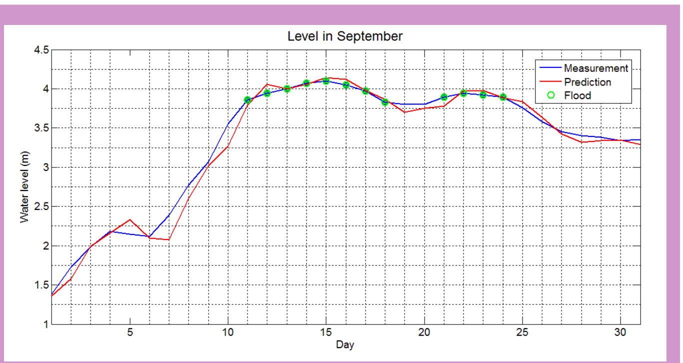

Figure 18: Floods predictions in September 2012

It is observed that the predicted results are in excellent agreement with the actual measurements with minimal errors. The maximum errors for the algorithm predictions are 0.3 m for water level, and 0.45 m^3/s for water flow rate. Fig. 17 illustrates the predicted results in January 2012.

We measure the efficiency of our algorithm using three indices, namely the mean absolute deviation (MAD), the mean square error (MSE), and the efficiency index (EI). These quantities are given by the following equations.

$$MAD = \frac{\sum_{i=1}^{N}|t_i - z_i|}{N}$$

$$MSE = \frac{\sum_{i=1}^{N}(t_i - z_i)^2}{N}$$

$$EI = \frac{(ST - SSE)}{ST}$$

With $ST = \sum_{i=1}^{N}(t_i - \bar{t_i})^2$ and $SSE = \sum_{i=1}^{N}(t_i - z_i)^2$. t_i and z_i are measured and predicted values, respectively. The performance of the algorithm in terms of these performance measures are given in Table 2. Note that the efficiency indices are above 99% for all cases, confirming the efficacy of our algorithm.

Table 2: Performance indices for the early floods warning algorithm using data at C37 station.

	Water level		Water flow rate	
	2008-2011 data	2012 data	2008-2011 data	2012 data
MAD	0.0691 m	0.0605 m	2.0260 m^3/s	1.6687 m^3/s
MSE	0.0102 m	0.0073 m	11.1248 m^3/s	6.5649 m^3/s
EI	0.9960	0.9932	0.9986	0.9949

For 2012, there were two floods happening in September (during September 11-18, 2012 and 21-24 September, 2012). Our algorithm is able to correctly predict both events, as shown in Fig.18.

The early flood warning algorithm is installed in the central data management system. It analyzes the data sent to the central server from the mobile monitoring stations. The display GUI is designed using LabVIEW. Fig.19 is an example of the GUI which monitors Bangbal station (C37). The left panel shows the location of the monitoring station on a Google map. The right panel displays the monitoring status. In Fig. 20 the system sends out a warning that there would be floods occurring on September 11, 2012 based on the predicted water level (4 m, shown in red graph). The measured sensor data in Fig.21 (blue graph) confirms that the prediction was correct and the water level was in the flooding zone (3.8 m).

In addition, the GUI displays other sensor data acquired from the weather station at C3 7 , for example, temperature, atmospheric pressure, humidity, wind speed and direction, and rainfall rate, as shown in Fig.22.

Figure 19: Display GUI of the floods monitoring system.

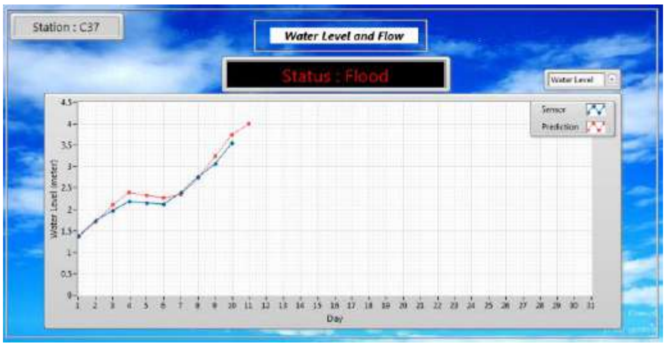

Figure 20: Flooding is predicted on September 11, 2012.

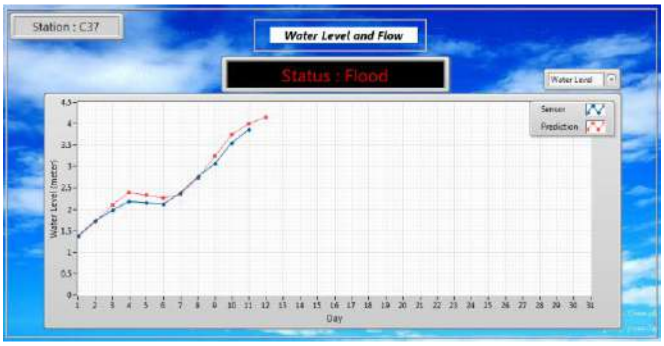

Figure 21: Flooding is observed on September 11, 2012.

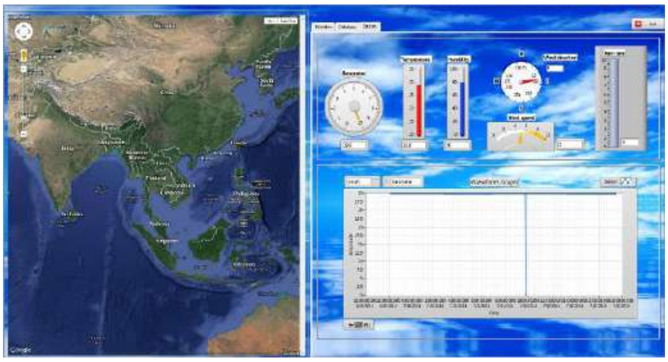

Figure 22: Weather parameters displayed on the GUI.

VII. CONCLUTION

We has developed an early-warning system integration for flood disaster management in the form of a unified platform. The platform is flexible. It is customizable based on local needs and budget because all modules are plug-in. In addition, the mobile unit itself is portable and is easy to install. It can also be a stand-alone unit because it can send out early flood warning even without any communications with the central data management system. With the integration of the central data server, however, the system provides a complete nation-wide flood warning and response system that can be monitored wirelessly and can exchange information among corresponding governmental units promptly and seamlessly.

We also develop a new algorithm for analyzing potential floods from measured sensor data using the adaptive neuro fuzzy inference system. The disaster inference rules are designed using local information about the disasters. The algorithm is fully automated; the preliminary early warning alarm is sent from the mobile unit promptly while waiting for the official confirmation at the central data management system about proper protocol that the public should follow. This two-step warning (preliminary-official) allows the public to be informed and prepared for the potential disaster in a timely manner. The algorithm has been tested that it is able to predict events of floods 24 hours in advance.

ACKNOWLEDGEMENT

This project was partially supported by King Mongkut's Institute of Technology Ladkrabang grant #KREF085701 and the HRD programme for exchange of ICT researchers and engineers from the Asia-Pacific Telecommunity (APT). We would like to thanks the Hydrology Irrigation Center for Central Region for supporting us to demonstrate our system prototype on site in Chainat province.

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[4] Strategic plan 2010-2013. Royal Irrigation Department, Ministry of agriculture and cooperatives, Thailand.

[5] Guidelines for strengthening and promoting public involvement in flood management networks. Bureau of Research, Development and Hydrology, Department of Water Resource, Ministry of Natural Resources and Environment, Thailand. December 2010.

My Research and Life Experience

Ohnmar Khin, Myanmar

I studied my Master's Degree at King Mongkut's Institute of Technology Ladkrabang (KMITL) on August 1st, 2016. The expedition began with my friend, Myanmar student. We were picked up at the airport by the KMITL officer and the senior AUN/SEED-Net scholars. I got two advisors, Dr.Somsak Choomchuay and Dr.Montri Phothisonothai. They warmly welcomed me and introduced with other lab members. My advisors held a welcome party at the restaurant. They are kind and active. They advise all things that I should do.

My research is about Myanmar License Plate Extraction from Car Image based on Image Processing, Faculty of Engineering and International College, KMITL. This preliminary study presents an image processing method for localizing a Myanmar license plate. The proposed system is implemented based on captured car images. The off-line feature extraction process of the number plate is done by MATLAB. I intend the project that can be practical used by traffic-light development in Myanmar.

My life experience in the KMITL is invaluable. Studying abroad provides an international exposure which is quite imperative for one's career building process. I have the opportunity to study new subjects not available to me at my university. Workshop gives new knowledge and new experience for students. I had a great time at the 5th ECTI Workshop. By studying abroad, I have foreign friends. That's one way to learn the language, dialect, gestures, accent, culture and traditions. I will return with a new perspective on culture, language, skills, a great education and a willingness to learn. Needless to say, all of these are very attractive to future employers.

Paper List of ECTI Transaction

ECTI-EEC Transaction: -
Website: http://www.ecti-eec.org/index.php/ecti-eec/

Two issues are available annually. The next issue will be available soon.

ECTI-CIT Transaction: -
Website: https://www.tci-thaijo.org/index.php/ecticit

Two issues are available annually. The next issue will be available soon.

Report from Conferences/Workshops/Seminars/Events

2nd Mini Symposium for ISAP 2017

Date: March 31, 2017
Venue: Faculty of Engineering, Kasetsart University
Attendance: 50 students and lecturers

Student Award Winners:

- 1st Winner: 1,500.00 Baht
  "Miniaturization of Power Dividers Using Quarter-Wave-Like Transformers (QWLTs),"
  Sorawis Korananan, Panuwat Janpugdee, and Danai Torrungrueng
- 2nd Winner: 1,000.00 Baht
  "Heuristic UTD Diffractions for Antenna Problem"
  Awika Pimpatang, Titipong Lertwiriyaprapa, and Chuwong Pongcharoenpanich
- 3rd Winner: 500.00 Baht
  "Design of Antenna with Two Layer Frequency Selective Surfaces Reflector for Directivity Enhancement in UWB Application"
  Pansamon Singsura, Tanan Hongnara, Wanwisa Thaiwirot, and Prayoot Akkaraekthalin

ECTI Workshop on Teaching and Research Techniques

Date: April 22, 2017
Venue: School of Information Technology, Mae Fah Luang University, Chiang Rai
Attendance: 15 lecturers

Speaker: Assoc. Prof. Dr. Somsak Choomchuay (ECTI President)
Prof. Prayoot Akkaraekthalin
Prof. Dr. Kosin Chamnongthai
Dr. Sataporn Promwong

ECTI Workshop on Research Issues in IT

Date: April 29-30, 2017
Venue: Electrical Engineering Department, Faculty of Engineering, Ubonratchathani University
Attendance: 15 lecturers

Speaker: Assoc. Prof. Dr. Somsak Choomchuay (ECTI President) on "ECTI Association and Collaboration"
Prof. Prayoot Akkaraekthalin
Prof. Dr. Kosin Chamnongthai on "Writing and Publishing Research Articles"
Dr. Keattisak Sripimanwat on "Crazed Engineering & Fraud: a case study in OQC "and
"Visible Light Communication (VLC)"

ECTI Workshop on Research Issues in IT

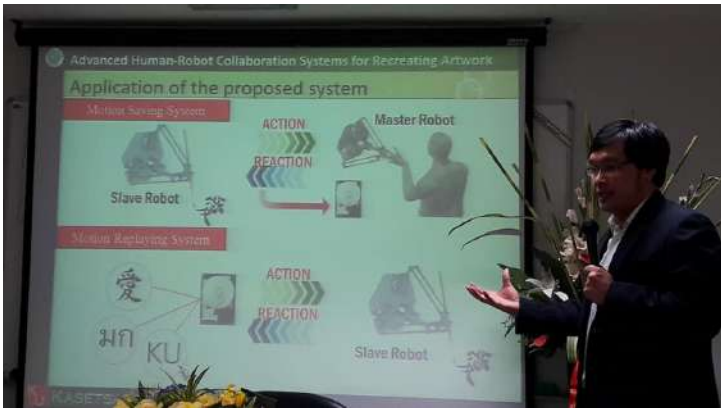
Date: May 8, 2017
Venue: Royal University Phnom Penh (RUPP), Cambodia
Attendance: 60 students and lecturers

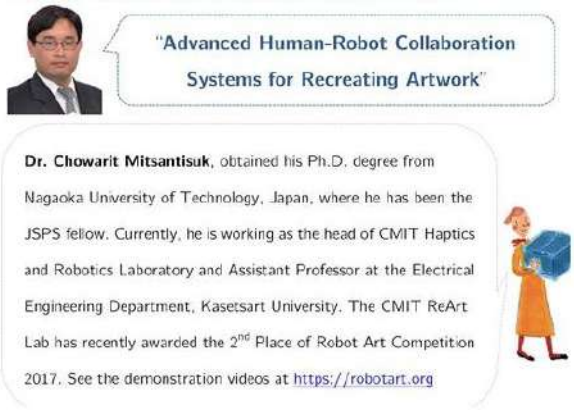
Invited speaker: Assoc. Prof. Dr. Somsak Choomchuay (ECTI President)
Prof. Dr. Kosin Chamnongthai
Prof. Dr. Pornchai Supnithi

The 6th ECTI Workshop on Research Paper Writing

Date: May 26, 2017
Venue: Faculty of Science and Technology, Suan Dusit University (SDU)
Attendance: 10 Thai students and lecturers, 2 non-Thai Students

Invited speaker: Asst.Prof.Dr.Chowarit Mitsantisuk
Department of Electrical Engineering, Kasetsart University




“Advanced Human-Robot Collaboration Systems for Recreating Artwork”

Dr. Chowarit Mitsantisuk, obtained his Ph.D. degree from Nagaoka University of Technology, Japan, where he has been the JSPS fellow. Currently, he is working as the head of CMIT Haptics and Robotics Laboratory and Assistant Professor at the Electrical Engineering Department, Kasetsart University. The CMIT ReArt Lab has recently awarded the 2nd Place of Robot Art Competition 2017. See the demonstration videos at https://robotart.org

ECTI-CON 2017

Date: June 27-30, 2017
Venue: Phuket Graceland Resort and Spa

Keynote speaker: *Coalitional Game with Application in Cloud Computing*
Dusit Niyato, Nanyang Technological University, Singapore

Applying Quantum Key Distribution Technology in Real-Life Networks
Wei Chen, University of Science and Technology of China

Smart Signal Quantization for Control
Toshiharu Sugie, Kyoto University

Distributed Simulation in the Cloud
Stephen John Turner, King Mongkut's University of Technology Thonburi


Announcements/Upcoming events/Call-for-Papers

ITC-CSCC 2017

The 32nd International Technical Conference on Circuits/Systems, Computers and Communications

July 2~July 5, 2017 | Haeundae Grand Hotel, Busan

Welcome to ITC-CSCC

The 32nd International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC 2017) will be held on July 2-July 5 at Haeundae Grand Hotel, Busan, Korea.

Topics

The conference is open to researchers from all regions of the world. Participation from Asia Pacific region is particularly encouraged. Proposals for special sessions are welcome. Papers with original works in all aspects of Circuits/Systems, Computers and Communications are invited.
Topics include, but not limited to, the followings:

- **Circuits & Systems**
  - Computer Aided Design
  - Analog Circuits
  - Modern Control
  - Semiconductor Devices & Technology
  - Sensors & Related Circuits
  - Power Electronics & Circuits
  - RF Circuits
  - Medical Electronics & Circuits
  - VLSI Design
  - Intelligent Transportation Systems & Technology
  - Linear / Nonlinear Systems
  - Neural Networks
  - Verification & Testing
- **Computers**
  - Artificial Intelligence
  - Internet Technology & Applications
  - Multimedia Service & Technology
  - Face Detection & Recognition
  - Watermarking
  - Image Processing
  - Computer Systems & Applications
  - Computer Vision
  - Security
  - Biocomputing
  - Motion Analysis
  - Object Extraction & Technology
  - Image Coding & Analysis
- **Communications**
  - Antenna & Wave Propagation
  - Optical Communications & Components
  - IP Networks & QoS
  - Ubiquitous Networks
  - Visual Communications
  - Network Management & Design
  - Circuits & Components for Communications
  - Communication Signal Processing
  - Multimedia Communications
  - Future Internet Architectures
  - Audio / Speech Signal Processing
  - Radar / Remote Sensing
  - MIMO & Space-Time Codes
  - UWB - Mobile & Wireless Communications

PROCEEDINGS

All registered participants are provided with conference proceedings. Authors of the accepted papers are encouraged to submit full-length manuscripts to IEIE JSTS (Journal of Semiconductor Technology and Science) or IEICE Transactions. Papers passed through the standard editing procedures of the IEIE JSTS or IEICE Transactions will be published in regular issues. The authors (or their institute) are requested to pay the publication charge for the IEIE JSTS or IEICE Transactions when their paper is accepted.

SUBMISSION OF PAPERS

Prospective authors are invited to submit original papers of either MS Word or PDF format written in English. Abstracts are limited to two pages of text and figures. Paper submission procedures will be announced later.

AUTHOR'S SCHEDULE

Will be announced later.

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ISMAC 2017

2017 International Symposium on Multimedia and Communication Technology

August 23 – 25, 2017

Classic Kameo Hotel & Serviced Apartments, Ayutthaya, Thailand

Phranakhon Si Ayutthaya Rajabhat University

http://ismac2017.aru.ac.th

Contact information:

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ismac2017aru@gmail.com

Call for Paper

2017 International Symposium on Multimedia and Communication Technology is the seventh international symposium. The symposium will be held at Pranakhon Si Ayutthaya, 600-year-old ancient capital of Thailand and covers the world heritage as a historical city. ISMAC 2017 has many scopes in multimedia and communication technology. New and updated technologies in these research fields will be introduce and discussed. **The topics for regular and special sessions include, but are not limited to, the following :**

1. **Multimedia Processing and Systems**
   - 1.1 Speech Processing and Coding
   - 1.2 Video Processing and Coding
   - 1.3 Natural Language Processing
   - 1.4 Video and Multimedia Technology & Communications
   - 1.5 Audio/Acoustic Signal Processing
   - 1.6 Multimedia Processing for e-Learning
   - 1.7 Intelligent Signal Processing for Multimedia & Systems
   - 1.8 Security Signal Processing for Multimedia & Systems
   - 1.9 Others
2. **Signal Processing**
   - 2.1 Adaptive and Multirate Signal Processing
   - 2.2 Digital Filters and Filter Banks
   - 2.3 Wavelets and Multirate Signal Processing
   - 2.4 Fast Computations for Signal Processing and Communication Systems
   - 2.5 Intelligent Signal Processing for Communications & Systems
   - 2.6 Security Signal Processing
   - 2.7 Neural Networks and Fuzzy Logic Prcessing
   - 2.8 Artificial Intelligence and Applications
   - 2.9 Others
3. **Industry and Regulatory Development for Communications**
   - 3.1 High Speed Networks
   - 3.2 Intelligent Computer Networks
   - 3.3 Next Generation Networks Technology
   - 3.4 Network Management and Design
   - 3.5 Network Protocol and Standardization
   - 3.6 Next Generation Network Regulations
   - 3.7 VoIP, IPTV and Wireless broadband Internet Regulations
   - 3.8 Others
4. **Communication Systems**
   - 4.1 Communication Theory
   - 4.2 Broadband Communication Technolog
   - 4.3 Multimedia Services and Technologies
   - 4.4 Intelligent Communication Systems and Network Protocols
   - 4.5 Signal Processing for Communications
   - 4.6 Wireless/Mobile Communications
   - 4.7 Wideband Communications
   - 4.8 Communication Circuit Design
   - 4.9 Others
5. **Emerging Technologies in Multimedia and Communication Technology**

Author's Schedule:

Deadline for Special Session Proposal	**June 2, 2017**
Deadline for Submission of 4-page Full-Paper:	**June 2, 2017**
Notification of Acceptance:	**July 7, 2017**
Deadline for Submission of Camera Ready Paper	**July 28, 2017**

Submission Instruction

Paper must be written in English and should describe the authors' original research work. *The length of the paper is limited to 4 pages including* figures, tables and references.

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