Robust Digital Image Cryptosystem Based on Nonlinear Dynamics of Compound Sine and Cosine Chaotic Maps for Private Data Protection

S. Maksuanpan, T. Veerawadtanapong, W. San-Um
Intelligent Electronics Systems Research Laboratory
Faculty of Engineering, Thai-Nichi Institute of Technology
Patthanakarn Rd., Suanlaung, Bangkok, THAILAND, 10250, Fax: +662-763-2700, Tel: +66-2-763-2600
sarun.maksuanpan@gmail.com, tanachad.pong@gmail.com, and wimol@tni.ac.th

***Abstract*— this paper presents a digital image cryptosystem based on nonlinear dynamics of a compound sine and cosine chaotic map. The compound sine and cosine chaotic map is proposed for high-degree of chaos over most regions of parameter spaces in order to increase high-entropy random-bit sources. Image diffusion is performed through pixel shuffling and bit-plane separations prior to XOR operations in order to achieve a fast encryption process. Security key conversions from ASCII code to floating number for use as initial conditions and control parameters are also presented in order to enhance key-space and key-sensitivity performances. Experiments have been performed in MATLAB using standard colour images. Nonlinear dynamics of the chaotic maps were initially investigated in terms of Cobweb map, chaotic attractor, Lyapunov exponent spectrum, bifurcation diagram, and 2-dimensional parameter spaces. Encryption qualitative performances are evaluated through pixel density histograms, 2-dimensional power spectral density, key space analysis, key sensitivity, vertical, horizontal, and diagonal correlation plots. Encryption quantitative performances are evaluated through correlation coefficients, NPCR and UACI. Demonstrations of wrong-key decrypted image are also included.**

***Keyword*— Hash function, Chaotic Sinusoidal map**

Mr.Sarun Maksuanpan was born in Samutsakorn Province, Thailand in 1991. He is a 4th-year student pursuing B.Eng. in Computer Engineering from Computer Engineering Department, Faculty of Engineering, Thai-Nichi Institute of Technology (TNI). Currently, he is also a research assistant at Intelligent Electronic Research Laboratory. His research interests include information security systems, cryptosystems, artificial neural networks, and digital image processing.

Mr. tanachad veerawadtanapong was born in Bangkok, Thailand in 1991. He is a 4th-year student pursuing B.Eng. in Computer Engineering from Computer Engineering Department, Faculty of Engineering, Thai-Nichi Institute of Technology (TNI). Currently, he is also a research assistant at Intelligent Electronic Research Laboratory (IES). His research interests include information security systems, chaotic system, and artificial neural networks , and communication network system

Wimol San-um was born in Nan Province, Thailand in 1981. He received B.Eng. Degree in Electrical Engineering and M.Sc. Degree in Telecommunications in 2003 and 2006, respectively, from Sirindhorn International Institute of Technology (SIIT), Thammasat University in Thailand. In 2007, he was a research student at University of Applied Science Ravensburg-Weingarten in Germany. He received Ph.D. in mixed-signal very large-scaled integrated circuit designs in 2010 from the Department of Electronic and Photonic System Engineering, Kochi University of Technology (KUT) in Japan. He is currently with Computer Engineering Department, Faculty of Engineering, Thai-Nichi Institute of Technology (TNI). He is also the head of Intelligent Electronic Systems (IES) Research Laboratory. His areas of research interests are artificial neural networks, control automations, digital image processing, secure communications, and nonlinear dynamics of chaotic circuits and systems.