Instinctive Computing

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What does distinguish people from machines? Instinct! As living creatures, human beings have biological needs. Instincts are the internal impulses, such as hunger and sexual urges, which lead humans to fulfill these needs. Freud stated that these biologically based energies are the fundamental driving forces of our life. They act everyday to protect us from danger and keep us fit and healthy. However, we are often barely aware of them. Perhaps the most striking things for us are hidden in our cells. Recent biological studies suggest that mammalian cells possess more intelligence than we can imagine. For example, the cell movement is not random. It is capable of immensely complex migration patterns, responses to unforeseeable encounters. Cells can 'see', for example, they can map the directions of near-infrared light sources in their environment and direct their movements toward them. No such 'vision' is possible without a very sophisticated signal processing system.

Instinctive computing is a computational simulation of biological and cognitive instincts. Instinct is a meta-program of life, just like the universal gravity in nature. It profoundly influences how we look, feel, think, and act. If we want a computer to be genuinely intelligent and to interact naturally with us, we must give computers the ability to recognize, understand, even *to have* and express primitive instincts.

The proposed research aims to development a new computational framework for Instinctive Computing, including components such as paleomorphology, default operations, survivability, diffusion models, sensory inhibition, information hiding, foraging, pheromones, deception, primitive vision, instinctual learning strategies and collective intelligence.

The new framework will attempt to unify the historical theories about biologically inspired computation models in the context of Instinctive Computing. For example, Norbert Weiner's computational models of Gestalt, self-reproduction and learning as the holistic communication between humans, animals and machine, which he called 'Cybernetics'. John von Neumann's the cellular automata model to simulate self-reproduction, which constitutes finite state cells interacting with one another in a neighborhood within a two-dimensional space. Conway's "Game of Life," in which an organism has its instinctual states, birth, movement, eating and death. Interesting patterns emerge from the cell interactions such as blooming, oscillation or extinction. The proposed framework will further expand the functions of cellular automata about the spatial and temporal interaction among entities and instinctual behaviors, which is the key to understanding the complexity and to reveal the natural human algorithms, from microscopic cellular morphology to the mass panic movement in subway stations.

The research also includes case studies in real-world applications of Instinctive Computing in mobility, power grid survivability, cyber-physical system security and data privacy, machine learning, image understanding, smart environment, empathic computing, ambient diagnostics, and virtual reality game design, such as the "Uncanny Valley" problem and so on. The anticipated new technologies from this project include cyborgs and the instinctual interfaces between humans and automated machines. For decades, we have been adapting to rapid growing machines. Our thumbs have evolved from holding things to entering cellphone messages in just a few years. Emerging cyborgs with a headset attached daily.

The expected results from this project include open source algorithms, demos and the monographic book: Instinctive Computing. A book contract has been signed with Springer-Verlag London. In addition, an annual Instinctive Computing workshop will be hosted in CMU. In 2010, the first Instinctive Computing Workshop was hosted at CMU with the sponsorship from NSF Emerging Computing program. The participants were from Germany, Italy, Spain and USA. The organizations were from universities, Google, Air Force Research Lab and Navy underwater research center. The disciplines covered psychology, robotics, energy systems, security and Artificial Intelligence.

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Program: Allen Distinguished Investigators (ADI) Program - Artificial Intelligence (AI) Focus

Sponsor: Paul G. Allen Family Foundation

PoP: 9/1/14-8/31/17

	# of Graduate Students:	**2**						
				Year One		**Year Two**		**Year Three**	**Total**
Personnel	Monthly Salary		Months		Months		Months		
Dr. Yang Cai, PI		$8,166.67	7.00	$57,166.69	6.50	$54,675.86	6.00	$51,984.12	$163,826.67
Graduate Student Tuition		$4,611.11	9.00	$83,000.00	9.00	$85,490.00	9.00	$87,980.00	$256,470.00
Graduate Student Stipend		$2,500.00	12.00	$60,000.00	12.00	$61,800.00	12.00	$63,600.00	$185,400.00
Total Personnel				**$200,166.69**		**$201,965.86**		**$203,564.12**	**$605,696.67**
Fringe Benefits			28.6%	**$16,349.67**		**$15,637.29**		**$14,867.46**	**$46,854.43**
Total Personnel & Fringe				**$216,516.36**		**$217,603.15**		**$218,431.58**	**$652,551.09**
Other Direct Costs									
Travel				$5,000.00		$5,150.00		$5,304.50	$15,454.50
Total Other Direct Costs				**$5,000.00**		**$5,150.00**		**$5,304.50**	**$15,454.50**
Administrative Fee Base				$221,516.36		$222,753.15		$223,736.08	$668,005.59
Administrative Fee			12.0%	**$26,581.96**		**$26,730.38**		**$26,848.33**	**$80,160.67**
Cost Sharing				**$(26,581.96)**		**$(26,730.38)**		**$(26,848.33)**	**$(80,160.67)**
Total				**$248,098.33**		**$249,483.53**		**$250,584.41**	**$748,166.26**