Give Your Hand a Hand

PROF.: The *New York Times* calls the hand "our all-purpose resident mechanic: the expressive instrument of a Picasso, a Menuhin, a Balinese dancer."

VOICE: A painter, a violinist, a dancer.

PROF.: The more we learn about the hand, the more enthused we are – to "Give your hand a hand!"

FORMAT: THEME AND ANNOUNCEMENT

PROF.: "A robotic hand which can perform tasks with the dexterity of a human hand is one of the holy grails of science." That statement is by Dr. Honghai Liu, Professor of Intelligent Systems and Biomedical Robotics at Portsmouth University Institute of Industrial Research. He and his colleagues specialize in artificial intelligence – including intelligent robotics, image processing and intelligent data analysis. He adds, "Nothing which exists today even comes close."

VOICE: What's so complex about the human hand, that is difficult for scientists and engineers to duplicate?

PROF.: It's a long and impressive list. First, the fingers have astounding dexterity. That's because of the coordinated actions of seven muscles that control the index finger, five muscles unique to the thumb, and three other muscles that move the little finger.

VOICE: I'm surprised that so many muscles can fit in the small space of the hand.

PROF.: The muscles aren't in the fingers or hand. To enable the hand to be compact and flexible, its control muscles are located in the forearm, between the elbow and the wrist. They work remotely from there, by pulling on tendons that activate the hands – like strings controlling a marionette.

VOICE: The palm and fingertips can lock into a "power grip" to carry a heavy hammer, while the thumb and index finger gently pick up a potato chip without crushing it.

What a combination of "muscularity and micro-force"!

PROF.: The July 7, 2017 issue of EvolutionNews.org published an article entitled "Design at Your Fingertips: Researchers struggle to model sense of touch." Dr. Stephen C. Meyer began, "The late pianist Victor Borge [BOR-guh] was beloved…for the sensitivity of his keyboard touch. He maintained the ability to interpret the most subtle pieces such as *Claire de Lune*…with extreme delicacy all the way to age 90... It would be hard to design a robot with that level of durability, reliability, or sensitivity. Scientists know, because they're having a hard time understanding it, let alone imitating it." [1]

VOICE: Observing the hand doing things that no man-made copy can equal.

PROF.: Four researchers have made major progress over previous attempts to model the sense of touch. They published a paper in the *Proceedings of the National Academy of Sciences*, "Simulating tactile [2] signals from the whole hand with millisecond precision." They described ways a hand's nerves, muscles and tendons perform in various fingertip-touch experiments. They hope their new knowledge will someday assist robotics engineers to develop artificial hands with a realistic sense of touch.

Dr. Meyer points out that the article's authors often used the words *code* and *information.* They say, "When we grasp an object, thousands of tactile nerve fibers become activated and inform us about its physical properties (e.g., shape, size, and texture). Although the properties of ***individual*** fibers have been described, our understanding of how object information is encoded in ***populations*** [3] of fibers remains primitive."

Previous experiments simply attempted to measure signals from individual sensors in the skin of monkeys or humans. This new model uses knowledge of ***three kinds*** of sensors and how ***thousands*** of them are distributed in the skin of the human hand. Each fiber produces a series of code signals that combine to "give the brain a rich array of data."

VOICE: The brain interprets this "rich array of data" to learn about an object's size, shape, and texture. Each fingertip contains nearly 1,000 nerve fibers, so "dense" that a blind person can read Braille letters with his fingertips.

PROF.: Dr. Meyer notes that the National Academy of Sciences researchers "omitted important capabilities such as temperature or pain – two important inputs that can generate reflex actions that activate arm muscles to jerk the hand away before the brain is aware of danger."

VOICE: Yes, when a finger touches a hot stove, it doesn't wait for the brain's approval to move to a cooler location.

Their model completely overlooked things like sweat glands, blood vessels, immune cells, and all the other equipment packed into a fingertip.

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1 It is hard to understand it, even harder to duplicate it.
2 Related to the sense of touch.
3 Large numbers in groups.

PROF.: Dr. Meyer adds, "Let's dive one level deeper into the details to consider what goes on at the cellular level. A neuron…'feels' the outer skin changing shape slightly as it touches an object… That's the electrical 'spike' the authors talk about, but it doesn't just happen without each neural cell first being ***equipped with molecular machines*** able to respond to pressure, and able to quickly reset and re-fire as the source changes."

VOICE: Like a computer constantly on the alert to receive up-to-the-millisecond information.

As the signals proceed toward the brain, the neurons cross synapses that **convert the electrical signals to chemical signals,** and almost immediately other synapses convert chemical signals back to electrical signals. During the entire process, the information **and the timing** of the signals are preserved without error or distortion.

PROF.: Meyer observes, "Once again, the simplest, ordinary action of touching a fingertip on a surface is vastly more complex than we could conceive, challenging scientists to come up with **simplified models to understand it**. With this in mind, try an experiment: with your eyes closed, touch your index finger to a variety of surfaces around you: a table top, clothing, bread, liquid, the skin of your arm, a puff of air from your lips. Try to discern by touch alone information about each object's…temperature, smoothness, shape and hardness. Think of all those thousands of sensors providing that information to the brain with millisecond precision!"

VOICE: Many authors conclude their scientific papers by making a statement about evolution. They often speculate about how natural processes may have produced the intricate organ or function that the publication describes.

PROF.: But referring to the article "Simulating tactile signals from the whole hand with millisecond precision," Dr. Meyer notes, "The authors say nothing about evolution in their paper. **Design** is so abundantly obvious in the human body, …[that] our best engineers cannot even conceive of approximating that level of functional coherence, performance and integration. Not even close."

Another article reports that the tendons that control the finger joints act "like ***a switching function of a logic gate***…" The authors state, "Moreover, this form of information processing at the macroscopic scale is a new instance of the emerging principle of non-neural 'somatic logic'…"

VOICE: Body logic, "logic circuits" in the body.

PROF.: That means the tendons connecting muscles to our fingers perform "logic computations" that control the amount of tension in fingers. The *Journal of Neurophysiology* says controlling the tension that way provides "a rich repertoire of finger joint [movement] not possible with simpler tendon paths." In other words, it can ***adapt*** to a wide variety of conditions and needs.

"A rich repertoire" of finger joint movement.

VOICE: I've heard people mention the "opposable thumb." But I don't fully understand it.

PROF.: The thumb is "opposable" in the sense of moving in the opposite direction from the other digits. [4] This *opposition* provides the ability to squeeze, such as between the thumb and fingers or thumb and palm.

Imagine yourself trying to pick up objects without a thumb. You can do it, but it's awkward and clumsy. But an opposable thumb enables the hand to pick up objects and manipulate them with precision and finesse.

Julius Caesar recognized the importance of the thumb. He reportedly ordered the thumbs of captured prisoners to be cut off. [5] That would give his opponents a major handicap.

As Sir Isaac Newton said, "In the absence of any other proof, the thumb alone would convince me of God's existence."

VOICE: What did Newton mean when he said that even if there were no other proof, "…the ***thumb*** alone would convince me of God's existence"?

PROF.: I haven't been able to find the context of that statement. But Dr. Randy Guliuzza of the Institute for Creation Research gives evidence that Newton's point was valid. He writes, "…the human thumb is extraordinary. This is due to a forearm muscle called the *flexor pollicis longus*, whose tendon independently bends the thumb's tip… The human brain employs exquisite muscle motor commands over [that muscle]..." Individual muscle fibers can be activated by very low rates of nerve stimulation to generate a finely graded thumb-tip force of only 7/100 of an ounce."

VOICE: Less than 2 grams!

And the threshold for touch in the forearm is 33 grams per square millimeter. For the fingertip, it is ***2.*** What a difference!

PROF.: Drs. Taylor and Schwarz conclude their article, "The Anatomy and Mechanics of the Human Hand" by saying, "…normal hand function is the result not only of a highly complex and versatile **structural arrangement,** but also of an equally elaborate and fully automatic system of **controls**."

VOICE: So the skill of the hand is not just in its "hardware." It needs the brain and nervous system "software" to make it work so precisely.

PROF.: The article continues, "It communicates thoughts that words would conceal… [W]e only half-know velvet, fur, sculpture, [or] sand…if we can't feel them. There are no other hands in nature quite like ours, though the number of bones is nearly identical."

VOICE: The best that human inventors can achieve, can't duplicate the hands we were born with. So let's give our hands a hand.

PROF.: Or does the applause really belong to ***the God who made our hands?***

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4 Digits are fingers and thumbs.

5 Desert Hand Therapy, "18 Amazing Facts about Human Hands."

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