Mini-review

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Unsupervised learning to Chip-lets estimating e-Q, and implementing smartphone for dual IR mammograms

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Background

We will concentrate on what shall we do after the Nobel Prize in Physics 2024 bridging collectively & cooperatively the gap among physics, neuroscience, and artificial intelligence, Scientists just like collections of Neurons"

1. John Hopfield as the tip of Pyramid and Geoffrey Hinton were awarded the Nobel/Tuning Prize in Physics for their contributions to artificial intelligence, based on learning of Artificial Neural Nets (ANN) of Neurons (brain Cells) specifically in neurons-like crystal lattice dynamic model like how human brains, computers, robot's, car's, machines learning to recognize patterns and make decisions.. As a matter of fact, all stones and bricks of the pyramid have contributions of colleagues and disciples to the pyramid. We are in ANN community all proud of this award (in spite of that some of us did not receive personally. It proves at least our visions and efforts are in the correct directions. We may say in hindsight that "the Nobel Prize in Physics 2024 celebrates the tip of pyramid in bridging collectively & cooperatively the gap among physics, neuroscience, and artificial intelligence, Scientists just like collections of Neurons".

Figure 1 John Hopfield (91, 15 July 1933 in Chicago) is known for creating the one layer of Hopfield Network, that mimics how the brain associative memory works.

His neural network is motivated from biophysics lattice (magnetic Ising lattice) defined by set of neurons at lattice points:

$$S = (s1, s2, \ldots, sn); \tag{1}$$

with pairwise symmetric interconnect weight matrix output is weighted sun of inputs

$$W_{ij} = W_{ji}; \tag{2}$$

$$X_i = \Sigma S_i W_{ij};\ S_j \geq Sigmoid\ (X_j) \tag{3}$$

The question remains how to train the synaptic weight matrix. For example, Hopfield together with D.W. Tank, an associative neural network in 1982 solved statistically the travelling salesman problem (TSP), i.e. an NP Complete mathematics problem, a type of recurrent content-addressable memory in computer science.

For example Steve Grossberg founder President and Harold Szu (classmate and disciple of George Uhlenbeck of Statistical Mechanics at the Rockefeller University,) as the founding Secretary and Treasurer of International Neural Network Society (INNS); Steve and Gail Carpenter did with two layers Adaptive Resonance Model. Their model showed how neurons (brain cells) can interact with each other to store and retrieve information, much like how memories work. This was a big step toward understanding how artificial intelligence (AI) systems could be designed.

Figure 2 Geoffrey Hinton (77, 6 December 1947 in London) is often called one of the "Godfathers of AI." For example, he and David Rumelhart developed a technique called backpropagation, Backpropagation is essential for training deep multiple-layer neural networks, which are the backbone of many AI technologies today, like facial recognition and modern -day self-driving electric cars.

Terry Sejnowski as well as Paul Werbos to think like human brains which allows AI systems to learn from mistakes and improve over time.. From 2014, Hinton divided his time between Toronto and Google but then resigned from Google in 2023 "to freely speak out about the risks of AI." That might called the attention of the Nobel Foundation about the Industrial Giant using ANN modeling. Together, their work has revolutionized how machines can learn and think, enabling many of the smart technologies we use every day.

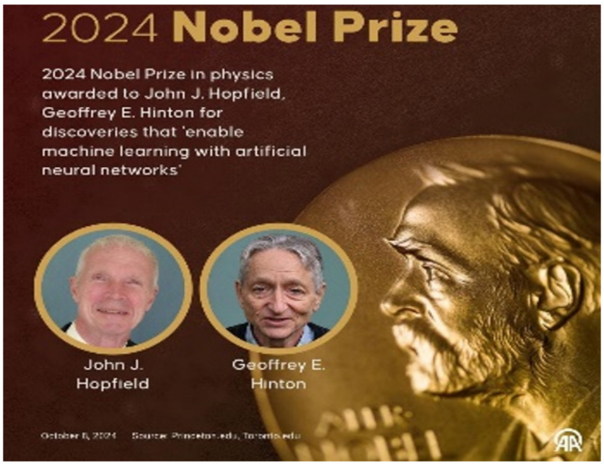

Figure 3 Nobel Prize in Physics 2024 integrating Physics, Neuroscience, Artificial Intelligence.

Since many of us went along through there decades in ANN under Interdisciplinary and international Neural Networks Society (INNS) realize the Award reveal only the tip of the Pyramid John Hopfield received the 2024 Nobel Prize in Physics for his groundbreaking contributions to machine learning, particularly through the development of the "Hopfield network." This artificial neural network, inspired by the human brain, modelled neurons after a lattice set of interacting magnetic poles (Ising model) laid the foundation for many modern machine learning techniques= It is a fully associative architecture with symmetric weights and binary threshold nodes.

Geoffrey Everest Hinton (born 6 December 1947, 77 years old) is a British-Canadian computer scientist, cognitive scientist, cognitive psychologist, when his company DNN acquired by Google, he joined Google known for his work on God Father in AI 2018 Turing Award, often referred to as the "Nobel Prize of Computing", together with Yoshua Bengio and Yann LeCun, for their work on deep learning. While Hinton was a postdoc at UC San Diego, David E. Rumelhart and Hinton and Ronald J. Williams applied the backpropagation algorithm to multi-layer neural networks. Their experiments showed that such networks can learn useful internal representations of data.[13] In a 2018 interview,[50] Hinton said that "David E. Rumelhart came up with the basic idea of backpropagation, so it's his invention". Although this work was important in popularising backpropagation, it was not the first to suggest the approach.[14] Reverse-mode automatic differentiation, of which backpropagation is a special case, was proposed by Seppo Linnainmaa in 1970, and Paul Werbos proposed to use it to train neural networks in 1974.[14]

In 1985, Hinton co-invented Boltzmann machines with David Ackley and Terry Sejnowski.[51] His other contributions to neural network research include distributed representations, time delay neural network, mixtures of experts, Helmholtz machines and product of experts.

2. **Review AI**: Looking back this AI system all the way from Simon 1916 & Turing 1975 with the ability to transform itself through transitions to different states until it stabilizes. The weights between the nodes enforce constraints that influence the outputs of the network.

Figure 4 AI pioneer Herbert A. Simon (June 15, 1916, Milwaukee Wisconsin: February 9, 2001 (aged 84) (Turing Award (1975); Nobel Prize in Economics (1978) wrote in 1965: "machines will be capable, within twenty years, of doing any work a man can do. Alan Tuning (Britain, 1912–1954) logician Alan Turing in the 1930s to advancements at the turn of the 21st century.

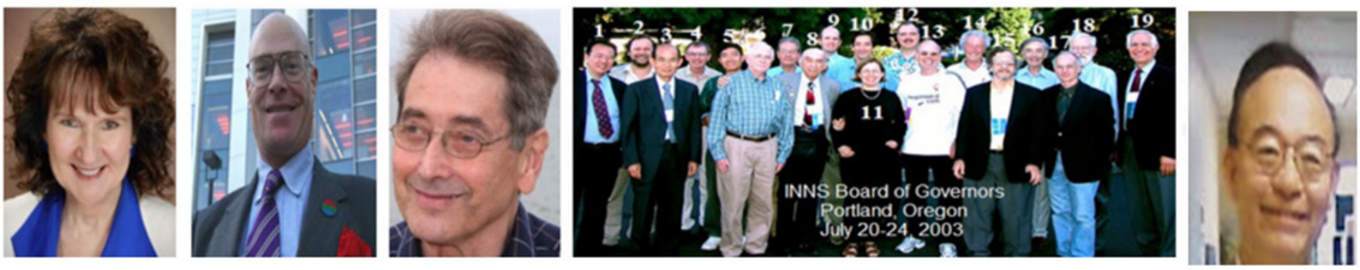

Figure 5 Helena Wisniewski , Bob & Steve Grossberg as well as attendances The First INNS & IEEE joint workshop led by Steve Grossberg and colleagues including currently Life Fellow of IEEE Harold Szu, Founding Secretary and Treasurer of International Neural Network Society with 17 Governors Members with colleague of Harold Szu (from the Rockefeller Univ) President Steve Grossberg of Boston Univ. developed Adaptive Resonance Model with Gail Carpenter Networks (ICNN) in 1987 and played a key role in organizing the first INNS annual meeting in 1988, H. Szu has served as the Founding Secretary and Treasurer of INNS where Dr. Robert Hecht-Nielsen (ASU in math) with the financial support of DARPA Dr. Helena Wisniewski in 1987 he co-founded the International Joint Conference on Neural Networks (IJCNN).

New AI era begins and is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

3. What's next? Unsupervised Learning implementing emotion e-Q [5] Chip-lets, on Big Data Analysis (BDA) on Mammogram minimizing False Negative Rate (FNR) based on Ludwig Boltzmann Head Stone is his entropy Law S=k log W Solving e-Q based on image skeletons &/or sounds Chip-lets representing emotional responses.

Figure 6 CHATGPT invented by India/Albanian born Mira Murati studied at MIT Artificial General Intelligence working at Tesla 2013 developed Autopilot and advocates ethicists at OpenAI. Proposed by Alan Turing in his 1950 paper "Computing Machinery and Intelligence," this test involves a human judge engaging in natural language conversations as well as a picture says thousand words manifesting i-Q & e-Q with both a human and a machine designed to generate human-like i-Q & e-Q responses.

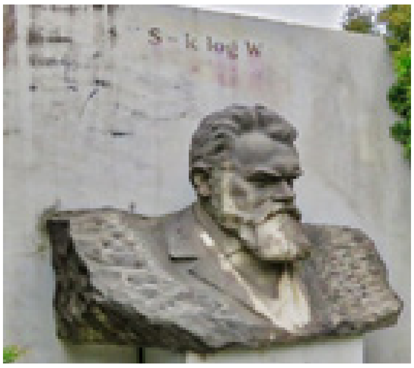

Figure 7 Collectively we believe that AI Going Beyond Homo Sapiens must be unsupervised learning from Big Data Analysis taking the advantage of speed of computers and available controlled data basis in National Library of Medicine, revealing the hidden disease and cancer prevention and treatment. After we are proud of the collective accomplishment of conquering Homo Sapiens ionic i-Q, as there remains much challenging in homo sapiens Chemical hormone intelligence so-called e-Q.

We propose e-Q must be inferred from a set of cartoon picture "chip-lets" e.g. Appendix B for happy joy, sad, tearing etc. images processing by minimizing the system's Herman Helmholtz H free (internal) energy E at the maximum Boltzmann entropy S at the Kelvin absolute Temperature T_o

$$H = E - T_o S \tag{4}$$

A concept rooted in physics at irreversible thermodynamics. This innovation enables the network to retrieve stored patterns even from noisy or incomplete data, making it a key tool in fields like image recognition extracting emotional e-Q. Hopfield's work, which began in the 1980s, a half century ago played a crucial role in the development of artificial neural networks, allowing for the processing of complex information through interconnected nodes, much like neurons in the brain. His contributions helped pave the way for today's advanced AI systems. He shared the Nobel Prize with Geoffrey Hinton, who built on Hopfield's network to create the Boltzmann machine, further enhancing machine learning capabilities.

Get an overview of unsupervised learning, which looks for patterns in datasets that don't have labeled responses. You'd use this technique when you want to explore your data but don't yet have a specific goal, or you're not sure what information the data contains. For example, breast cancer. Except you wish to minimize the false negative rate (FNR). It's also a good way to reduce the dimensionality of your data. The analog basis of unsupervised learning is the following increase of Boltzmann Entropy S defined as on his graveyard head stone

$$S = k_B \, Log \, W \tag{5}$$

i.e. Phase space volume $W = \exp\ (S / k_B)$

Since the irreversible thermodynamics said that a closed system always evolves to the equilibrium at maximum entropy for uniformity.[1] This is our basis of unsupervised learning.

4. **Thermodynamic theory of unsupervised learning:** We consider the exemplar of mammogram cases for nulliparous nuns taking the energy ΔE from the isothermal Kelvin absolute temperature T_o as the reservoir entropy change S_r :

$$\Delta S_r = -\Delta E / T_o$$

Then the total entropy change is

$$\Delta S_t = \Delta S_r + \Delta S = -\frac{\Delta E - T_o \Delta S}{T_o} \equiv -\Delta H / T_o$$

As such we define at the total (Herman) Helmholtz free (usable) energy H will be minimized at the maximum entropy level

$$H = E - T_o S$$

The irreversible thermodynamics of the Entropy S predicted by,

$$\frac{ÄH}{Ät}$$

Proof:

Let total entropy be denoted as reservoir + system S

$$S_t = S_r + S$$

Then the change is likewise as follows:

$$\Delta S_t = \Delta S_r + \Delta S$$

$$\Delta S_t = -\frac{\Delta E - T_o \Delta S_r}{T_o} + \Delta S \equiv -\frac{\Delta H}{T_o} + \Delta S$$

Where $\Delta H \equiv \Delta E - T_o \Delta S_r$

Although an early malignant tumor must be small in size, the abnormal cells reveal themselves physiologically by emitting spontaneously thermal radiation due to the rapid cell growth, the so-called angiogenesis effect. We consider a biomedical engineering application the underlying principle of Thermal Infrared (TIR) imaging in breast cancer study. Thermal breast scanning has been employed for a number of years, which however is limited to a single infrared band. Also, the camera has not built on Smartphone. In this research, we deploy two satellite-grade dual-color (at middle wavelength IR (3 − 5µm) and long wavelength IR (8−12µm)) IR imaging cameras equipped with smart subpixel automatic target detection algorithms. According to physics, the radiation of high/low temperature bodies will shift toward a shorter/longer IR wavelength band. Thus, the measured vector data x per pixel can be used to invert the matrix-vector equation x=As pixel-by-pixel independently, known as a single pixel blind sources separation (BSS). We impose the universal constraint of equilibrium physics governing the blackbody Planck radiation distribution, i.e., the minimum Helmholtz free energy, H = E − ToS. To stabilize the solution of Lagrange constrained neural network (LCNN) proposed by Szu et al., we incorporate the second order approximation of free energy, which corresponds to the second order constraint in the method of multipliers. For the subpixel target, we assume the constant ground state energy Eo that can be determined by those normal neighborhood tissue, and then the excited state can be computed by means of Taylor series expansion in terms of the pixel I/O data. We propose an adaptive method to determine the neighborhood to find the free energy locally. The proposed methods enhance both the sensitivity and the accuracy of traditional breast cancer diagnosis techniques. It can be used as a first line supplement to traditional mammography to reduce the unwanted X-rays during the chemotherapy recovery. More important, the single pixel BSS method renders information on the tumor stage and tumor degree during the recovery process, which is not available using the popular independent component analysis (ICA) techniques. Change of Helmholtz free energy of the breast tissue system.

The second law of thermodynamics stating that an equilibrium open system possesses minimum Helmholtz free energy. The Helmholtz free energy is a state function of a thermodynamic system, which is defined by

$$H = E - T_o S$$

Unsupervised learning with mini free energy.[2,3]

$$T_o > 0; if\ and\ only\ if\ \frac{\Delta E}{\Delta t} = -\frac{\Delta H}{\Delta E}; \frac{\Delta E}{\Delta t} = -\frac{\Delta H}{\Delta t}.\text{E.D.}$$

Use is made of A.M. Lyapunov control theory as the monotonic decay e.g. beach white sands have more entropy than mountain top rocks (having the paleology information.Actual BDA with e-Q will be followed with co-authors. Lidan Miao and Hairong Qi:[2]

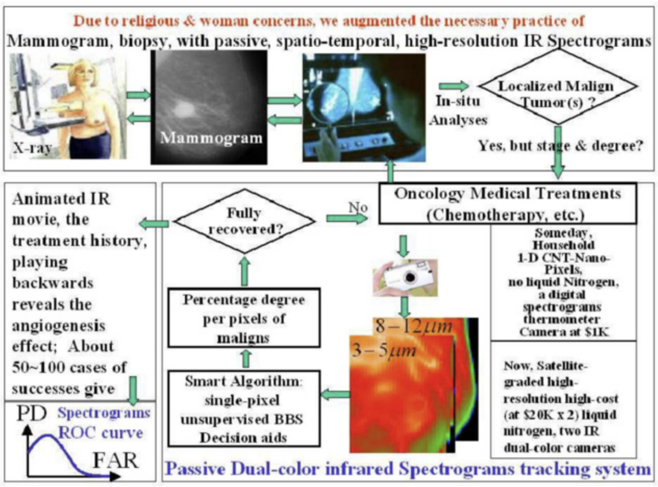

Figure 8 Private Smartphone dual IR lens images based on thermodynamic free-energy minimization for unsupervised: exemplified by the fusion of dual-color infrared breast images.

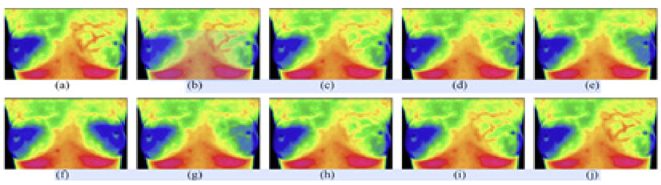

Figure 9 Selected frames from the animated movie. The first column is the five frames in recovery and the second column shows the process of developing into tumor.

This smartphone setup could be used practically for household applications and some additional details on making the setup effective.

1. Creating the DIY IR filter for smartphones

a) Materials: To create an IR filter, you'll need a material that blocks visible light but allows IR wavelengths (3-5 μm and 8-12 μm) to pass through. Specially treated carton or plastic with this filtering capability can be found in certain optical stores or DIY kits.

b) Attachment method: Cut a small piece of this IR-filtering material to fit over your smartphone's camera lens. You can attach it using a simple adhesive, making sure it's secure but easily removable.

c) Dual layering for dual spectral range: If possible, design the filter with two sections or layers, each optimized for one of the spectral ranges. Alternatively, you could swap out filters for specific measurements if capturing both ranges simultaneously proves challenging.

2. Practical applications of dual IR imaging at home

a) Health monitoring: IR imaging is non-invasive and can be used for basic health assessments:

b) Fever and inflammation detection: Using the IR filter, you can track body heat patterns to detect hot spots, which may indicate fever or localized inflammation.

c) Circulation observation: IR imaging can help visualize circulation issues. Poor circulation often results in cooler areas on the skin, which can be visible in IR images, helping to identify potential circulatory concerns.

d) Moisture detection in skin: IR bands are sensitive to different material properties, and moisture in the skin can alter IR absorption. This could allow household users to track hydration levels on skin surfaces or detect dryness, useful for skincare routines.

e) Identifying physical stress or discomfort: For athletes or those who engage in physical work, the IR camera could help track muscle strain by detecting unusual temperature changes in specific muscle groups.

3. Environmental and household applications

a) Home temperature mapping: This setup can be useful for detecting heat leaks or cold drafts in the home, helping with energy efficiency by identifying areas of insulation weakness.

b) Moisture and leak detection in walls: Since different materials and moisture levels reflect IR light differently, the setup can help locate moisture accumulation in walls or ceilings, which may indicate leaks.

c) Pet health check: For pet owners, dual IR imaging could help track temperature changes on pets, potentially detecting signs of illness without causing stress.

4. Optimizing image quality and analysis

a) Enhancing smartphone performance: Smartphone cameras may have limited sensitivity to IR, so here are a few tips to enhance image quality:

b) Increase exposure time: Most smartphones have adjustable exposure settings. Increasing exposure time can help capture more IR light, enhancing the details in the image.

c) Use an IR-compatible app: Some apps are designed to interpret IR data, especially if you connect an external IR sensor. Even without an external sensor, these apps might improve the processing and display of IR images.

d) Image analysis and comparison: To make the best use of dual-band IR imaging, you can capture images over time and use a simple photo-editing app to compare temperature or brightness levels, allowing for trend analysis.

5. Educational and experimental uses

a) Science projects for kids and students: This setup offers an excellent tool for educational purposes. Students can explore how different materials absorb and emit IR radiation, conducting experiments around heat transfer and thermodynamics.

b) Art and photography: IR imaging can create unique visual effects, capturing scenes and portraits in a way visible light doesn't. This artistic application can make dual IR imaging an engaging experience for hobby photographers.

6. Future developments and extensions

a) Integrating a tracking app for health metrics: An app specifically designed for this setup could automatically process IR images to detect anomalies, such as unusual temperature spikes, moisture levels, or structural weaknesses, turning the smartphone into a more powerful diagnostic tool.

b) Collaborating with health or tech experts: For users interested in advancing this technology, collaborating with health experts or tech developers could lead to more refined applications, especially in preventive health or smart home technology.

This approach could empower households to monitor both health and environmental factors without needing expensive equipment or hospital visits. Let me know if there's a specific area you'd like to explore further or if you need help with instructions on setting up the filter or app suggestions![4–6]

Appendix B image carton Chip-lets illustration might help.

Appendix A theory sigmoid logic & learning rule for all ANN apps

Since 1987 Leesburg Xerox for organizing INNS formation 1988 in Boston, Dr. Harold Szu has derived from Boltzmann Entropy S (a measure of large S for large degree of homogeneity, e.g., mountain rocks S_{in} is smaller than beach sands S_{out}), then likewise the minimization of (Helmholtz) free energy of brain at $37^o_C = 310^o_K \cong \frac{1}{37} eV$ yields unsupervised Learning.

$$S = k_B \, Log \; W$$

$$W = \exp\left(\frac{T_o S_{out} + T_o S_{in}}{k_B T_o}\right) = \exp\left(-\frac{E_{in} - T_o S_{in}}{k_B T_o}\right) = \exp\left(\frac{-H_{in}}{k_B T_o}\right)$$

$$\because E_{in} + T_0 S_{out} = 0 \therefore T_0 S_{out} = -E_{in} \downarrow H_{in} \equiv E_{in} - T_0 S_{in}$$

$$\hat{y}_{pairs}(t) = \left[W_{ji}(t)\right] \vec{X}_{pairs}(t)$$

$$new\,\vec{X}' = \sigma(\hat{Y})$$

$$\hat{y}_{pairs}(t) = \left[W_{ji}(t)\right] \vec{X}_{pairs}(t)$$

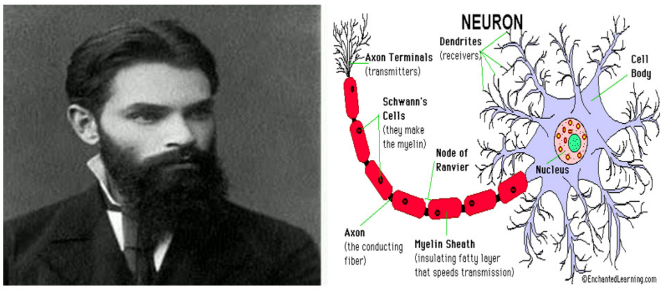

Figure 10 Alex Lyapunov; Neuron representation.

$$\frac{dH}{dt} = \frac{\partial H}{\partial [W]} \frac{d[W]}{dt} = \frac{\partial H}{\partial [W]} \left(-\frac{\partial H}{\partial [W]}\right) = -\left(\frac{\partial H}{\partial [W]}\right)^2 \le 0$$

Appendix B Emotion IQ by image matched filter of emotional Chip-lets

Estimating Emotional IQ using an image-based method, such as a matched filter technique with "chip-lets" (small segments or sub regions of an image), is theoretically possible but quite complex and not commonly used for this purpose. Let me break down how this might work:

1. Matched filter concept: In image processing, matched filters are used to detect patterns within an image by matching specific small templates (or "chip-lets") to parts of a larger image. When applied to facial recognition or emotion detection, chip-lets might be small segments of key facial areas, such as the eyes, mouth, or other regions that convey emotional expressions.

2. Detecting emotions: Facial expressions are strongly associated with emotions, and machine learning models trained on image data can detect these. Chip-let-based methods could theoretically identify emotional cues by matching specific patterns (like smiling, frowning, or squinting) to known templates of emotions. This would involve breaking down a face into chip-lets, analyzing each for emotional signals, and combining the results to infer an emotional state.

3. Challenges for emotional IQ estimation:

a) Complexity of emotions: Emotions are complex and vary greatly between individuals and cultures, so estimating Emotional IQ (a measure of one's ability to perceive, use, understand, and manage emotions) goes beyond simple expression detection.

b) Temporal dynamics: Emotional intelligence includes understanding changes over time, as emotional responses are not static. A single image or even a sequence might not capture these nuances.

c) Non-visual cues: Emotional IQ also involves interpreting non-visual cues (like tone of voice and context) and understanding emotions in oneself and others, which chip-let-based image analysis alone cannot capture.

4. Practical applications: While chip-lets could potentially enhance emotional detection in images or video streams, estimating Emotional IQ with high accuracy would likely require a multi-modal approach. This could combine image analysis (like matched filter methods) with audio, text analysis, and even contextual data.

Citation: Szu HH, Miao L, Haitong QI. Unsupervised learning to Chip-lets estimating e-Q, and implementing smartphone for dual IR mammograms. *MOJ App Bio Biomech.* 2024;8(1):90–95. DOI: 10.15406/mojabb.2024.08.00215

In summary, using chip-let-based matched filtering might help identify emotional expressions visually but is limited for full Emotional IQ estimation due to the need for broader contextual and psychological insights.

Some of the challenges involved:

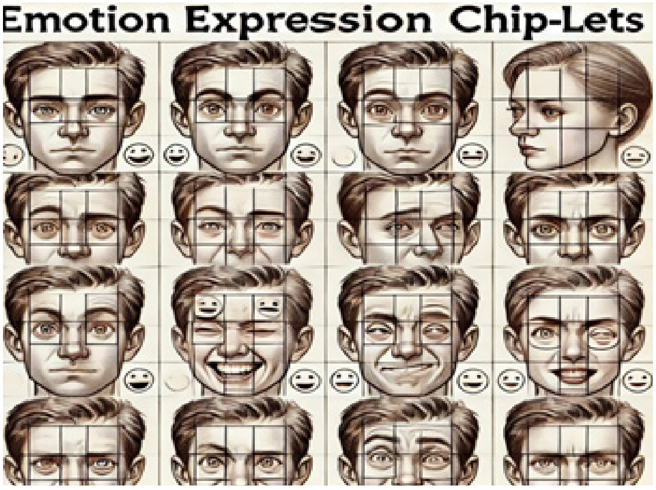

Figure 11 Exemplar of emotion e-Q Chip-lets (Nov 4 2024).

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Conflict of interest

Author declares that there are no conflicts of interest.

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6. Ever felt an emotion that you haven't been able to find the right words for?