Design and Architecture of Intelligent Medical Machines: A Research Paper

Syed V Ahamed

Professor (Emeritus), Computer Science
City University of New York, New York City, New York
Email: profahamed@gmail.com

Abstract— *Commonalities between the engineering rigor and the medical approach were explored to solve problems and present generic platforms to fuse the engineering rigor into the current medical approach to resolve the concerns of medical machine designers. The design methodology stresses the ability to fragment medical problems and their procedures into a series or a combination of minor or even microscopic problems (and their procedures) which are resolved by enforcing one or more actions by intelligent agents (or noun objects) to solve the localized problem. A certain amount of knowledge in the solution process is fed back to customize the specific solution for the specific patient. A series of minuscule of such knowledge modules are appropriately integrated to solve the entire medical problem for the patient. This minuscule's of knowledge become programmable instruction for a medical machine with access to World Wide Web and knowledge bases that can verify and enhance the solution strategy for the fragmented problems.*

The role of knowledge and its programmability become crucial to finding an optimal and efficient solution to solve routine, mid-sized or large medical problems of the patients during routine doctor's visits. It is our contention that the suggested approaches in blending the industry wide practices in the design and manufacture of digital devices and systems can reduce the cost of providing medical services substantially. With reasonable care in selecting the intelligent agents (doctors, staff, instruments, laboratories, and/or medicines), their respective actions and functions in efficient and effective combinations at appropriate instants of time can be a significant step forward in cost reduction and (near) flawless administration of medical procedures.

The paper spans numerous disciplines ranging from mathematics, computer and knowledge science, the science of management including program evaluation and review technique (PERT) and optimization of strategies. The role of these disciplines is incisive and restricted the practice of medicine and the many roles that computer systems that are essential building blocks of medical machines.

Keywords: Medical Machines, Evolution of Medical Processor Units, Intelligent Medical Processor Units.

I. INTRODUCTION

A five step solution strategy listed below is introduced for solving complex engineering problems into the field of medicine. Three distinct solution steps are A, B and C that are iterated (at step E) till a satisfactory solution is found at step D.

(A) The iterative procedure (i.e., solve once with initially guessed (or current) intermediate parameters (based on historical data about the problem), followed by solve again after step (C),

(B) The process of relaxation of the constraints,

(C) Four stepwise sub procedures are:

C.1 {(move forward towards the solution) →

C.2 (gather knowledge gained) →

C.3 (analyze cause-effect relationship(s), if any) →

C.4 (adapt/reject/modify and iterate), and take the next localized step at C.1}

(D) Verify if a satisfactory solution is reached after (C); If so →Stop

(E) Else Iterate back to steps (A), (B), or (C).

The processes (A) and (B) proposed is based on Southwells' relaxation techniques in the numerical solution of engineering problems. The processes and sub processes in (C) are based on the Peter Drucker's suggestions (Plan→Organize→Staff→Implement→Control(←→)Repeat & iterate) for Project Management.

In reality, medical problems are more complex than numerical problems where Southwells' solution methodologies are applicable or project management issues where Drucker management strategies are applicable. In the medical domain, a direct superposition the principle of relaxation atop management strategy or vice versa, is not immediately feasible at a macroscopic level..

However, the fusion of the concepts embedded in these two powerful approaches is possible at a localized, microscopic level. When problem is so finely partitioned/divided and relaxation/strategy is equally well-partitioned/divided, then micro-surgery to the subdivided problem areas with the delicate instruments of relaxation/strategy becomes feasible. A micro step in the solution of the problem is thus achieved. A series of such micro steps are reassembled from the guide lines derived from the AI concepts embedded in Box 3.

To the extent the processes of partitioning/division are feasible, their converses processes of amalgamation/incorporation are also viable; much like differentiation and integration are two distinct mathematical procedures practiced by mathematician in the conceptual space.[1] In localized and microscopic domains, the conceptual linkages are proposed in the medical domains. The appropriate matching of the objects and their functionalities would be impossible without the rules of Artificial Intelligence embedded in Expert Systems, Pattern Matching, Computer Vision, Intelligent Agents and the associated surgical micro instruments of AI.

In an integrated sense, it becomes feasible to perform a type of differential analysis formulation in the finite difference form in the medical field by solving micro medical problems and then performing a type of contour integration to solve the overall medical ailments of the patient(s). The matching and functions of objects and function can be best organized by the PR and ES programs borrowed from the

1 In the practical application, the differential equations (generally Maxwell's or fluid flow equations) are approximated as finite difference equations and integral equations are approximated as corresponding contour integral equations.

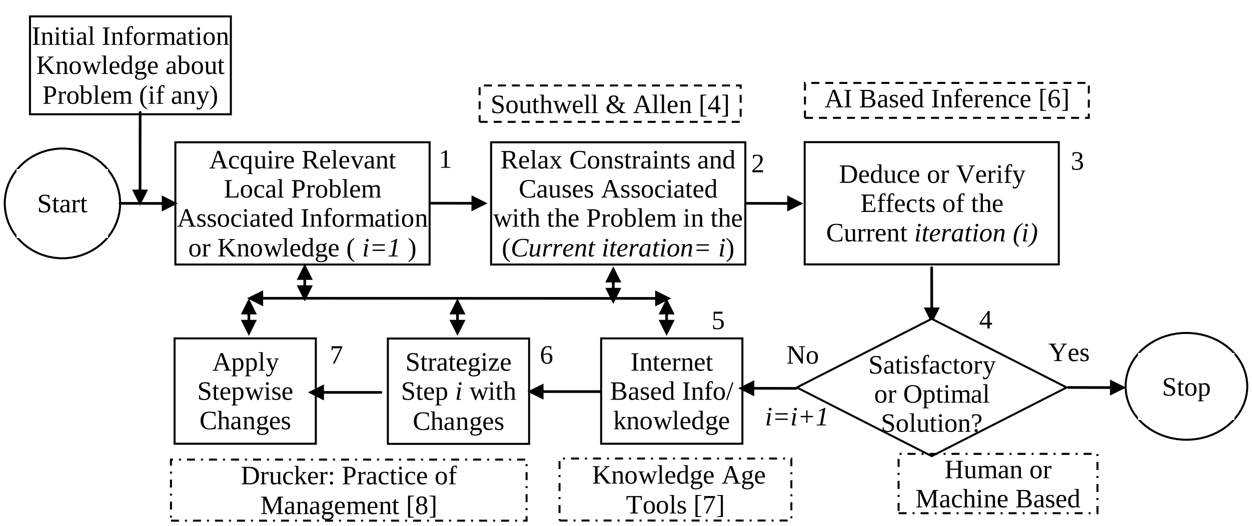
Science if Artificial Intelligence. Very competent doctors perform these rather diverse functions quite coherently in their minds from the knowledge(s) acquired from their education, training, internship, experience and interpersonal skills. Yet every doctor is not as disciplines as a "virtual doctor" who practices "perfect" forms of these doctorial education, training, internship, experience and interpersonal skills. The Image of this "virtual doctor" is hypothesized by intelligent network computers that scan the Internet constantly for the cure every possible ailment on a collective and on an individual basis.

Artificial intelligence in medicine has prevailed since the seminal contribution MYCIN[1] type of computer-based medical consultations programs that could be implemented on early computers of the 1970s and 1980s era. Rule based expert systems have evolved as heuristic programming projects initiated at Stanford University in 1984[2] and entered in the realm of cognitive sciences.[3] These seminal contributions have become the cornerstones in scientific research since the 1990s. The present paper is founded on the principles well established in most of computer science books and the AI books of the 21st century.

II. COMPUTATIONAL FRAMEWORK FOR THE PROPOSED METHODOLOGY

The steps A through E are depicted in Figure 1. The mapping of the software to track the methodology is by superposing the steps into Boxes 1 through 7. The Universal of concepts from Southwell's and Allen's[4,5] are blended with the modern AI techniques[6] in Box 3 and with the Knowledge Age tools and networking topologies[7] in Box 5. Peter Druckers'[8] contributions in mixing and merging of relaxation procedures with the AI techniques are deployed to making the process smooth and error free to a great extent. In a sense, all the processes in Figure 1 can be construed as Southwells' and Allens' relaxation techniques but with the more recent inclusions of AI based Inference Engines, Expert Systems[6] and with modern intelligent Internet knowledge machines and their networks.[7] The entire process requires the Internet access, support and switching support[7] represented in Box 5 of Figure 1.

Figure 1
Schematic for the Solution of Major Problems in Engineering or Medicine based on a Knowledge Platform. (The symbol *i* represent the current iteration for the solution)



The iterations in the closed loops in Figure 1 are indicative of the "trial and error" approach in the solution of human problems in the social domain long before 1940's when relaxation techniques were introduced. The classic contributions of Southwell and Allen imported the wisdom of "trial and error" methodology into mathematics and the numerical solution of engineering problems.

2.1 Blending Engineering Approach with Medical Functions

The treatment of patients is a scientific process in a great majority of the cases. Intuition of doctors, though not completely scientific, should be considered as what a machine can with endless search on the Internet. After all machines, however scientific cannot compete with an expert human, even though they can verify, build upon or even reject an intuitive decision. In a generic sense, numerous objects (such as doctors, medical staff, patients, patient family, treatments, medicines, medical tools, etc.) all play specific roles. These roles are indeed functions that influence the goal of resolving the patients' needs. Specifically, such functions can be a prescribing treatments, medications, procedures, etc., that are in the doctor's domain; functions such as taking blood samples, blood pressure readings, injecting medications, etc., that are in the medical staff domain; billing, accounting, collections, etc., that are in the clerical domain; etc. Further, each of the functions is specific to the patient, the medical condition, the stage of treatment, the prior experience, etc. Hence, an elaborate linking and collaborating becomes necessary for every object to accomplish the specific function in a chain of functions that lead to the accomplishment of the overall goal. Such linking and collaboration can be called a "Convolution" between any object(s) and function(s) and conversely between any function(s) and the associated object(s).

Such objects, functions and convolutions exist in engineering projects as well. For example, building a house, manufacturing a car, driving a car, etc., all have (major and minor) objects, (major and minor) functions, and (simple and complex) convolutions to accomplish their respective goal(s). The methodology that is generic and standardized in the engineering field (such as computer aided design, computer aided manufacture, inventory control and accounting, etc.) can be imported in the medical field with due consideration the most objects in the medical domain are human and subject to a behavioral mode rather than a mechanistic or mathematical mode. Such consideration(s) make the computerization and optimization medical processes more complex rather than impossible. Hence it is our contention that the medical field can be only partially computerized.

2.2 Integrating Engineering with Medical Science

In perspective, it becomes feasible to perform a type of differential analysis formulation in the finite difference form in the medical field by solving localized micro medical problems and then performing a type of contour integration to solve the overall medical ailments of the patient(s). The matching and functions of objects (doctors and medical staff) and (their positive healing and coordinating) function can be best organized by the PR and ES programs borrowed from the Science if Artificial Intelligence. Very competent doctors perform these rather diverse functions quite coherently in their mind from the knowledge(s) acquired from their education, training, internship, experience and interpersonal skills. Yet every doctor is not as disciplined as a "virtual doctor" who practices "perfect" forms of these doctorial education, training, internship, experience and interpersonal skills.

The image of this "virtual doctor" is hypothesized by intelligent network computers (see Box 5 in Figure 1) that scan the Internet constantly for the cure every possible ailment on a collective and on an individual basis. Perhaps it is one of the responsibilities of the world health organizations and world class universities is to contribute to the "personality" or the (grandiose knowledge base(s)) of this virtual doctor. Dedicated computers that scan the tax returns of millions of citizens perform such functions by scanning for cheaters hiding behind their tax returns. A positive and humanitarian network is the proposed network of intelligent medical computers that will attempt to solve or resolve problems that are to classified as insolvable. The methodology proposed is generic for numerous problems that arise in global, social, medical and international domains.

2.3 The Role of Knowledge in the Medical Field

Two distinct types of knowledge become eminent; (a) knowledge based on medical sciences and (b) knowledge associated with the patient and problem. When type (a) knowledge is carefully convolved with type (b) knowledge, then certain incremental or eventual step can be achieved in reaching the goal, but only with a certain probability since the behavioral mode can only be assessed on a statistical basis.

In this paper we propose to extend the two approaches into the medical field by streaming the doctor-patient interaction by solving the medical problem(s) of the patients by the doctor in the three AI procedures covering the (a) Diagnosis cycle, the (b) Prognosis cycle and the (c) Treatment cycle. The convergence of these three cycles is interactive and inter-dependent as the doctor-patient interaction emerges and leads to a near "perfect" solution.

The structure of knowledge plays an important role. If a solution is reached in (re)solving a microscopic medical problem, then a micro-element of knowledge (μk) is gained, that ties (convolutes; convolution is symbolized as *), a certain micro-object (μno) performing a micro-function (μvf) at a certain instant of time (or circumstances) or over a duration δt. Stated alternatively, the generic form of this "event" over a period δt is written as:

$$(\mu k) \leftarrow (\mu no * \mu vf).\ \delta t$$

$$((\mu k)_{t+\delta t}) / \delta t \leftarrow (\mu no * \mu vf)_{t+\delta t/2}$$

Energy spent in accomplishing the function μvf is expended in the environment by one or more of the noun objects[2]. More precisely the later equation should be written as

$$\oint_{t1}^{t2} (\mu no(t) * \mu vf\ (t))\ .\ dt \rightarrow \{ (\mu k)_{t+\delta t} - (\mu k)_t \}$$

And interpreted to read that the gain in an increment of knowledge over a period (t_2 *minus* t_1) is due an integrated effect (*) of the event encompassing an action (*vf* by a noun object *no*, or *vf* upon a noun object) between *(μno and μvf), (μvf and μno)* or a chain of such events. This representation makes it

[2] These equations imply the flow of knowledge power and knowledge energy. Knowledge power should be considered as the "power" of impact of (*no*vf*). If this power of impact is integrated over finite time or circumstances then a certain quantity of knowledge energy accrues. In practice, the knowledge energy is only gained or lost. It is indeed the change of the state of knowledge since we do not have a state of zero-knowledge. Hence a certain amount of caution is necessary to interpret the equation in a strictly mathematical format, but it is possible to estimate the change (Δk) in a computational framework.

possible for the events during a series of δt periods can be represented as a series of equations on paper or a series of executable commands to a computer system. Medical programming becomes feasible as a series of executable statements on a medical computer or machine. Such medical programs can be constituted, grouped, chained or cascaded like macros and/or subroutines in computer software.

Much like any systems programming projects, major medical events are amenable to PERT and CPM tools in Management systems.[9] The ambiguity behind the medical treatments is thus resolved by management tools and engineering optimization techniques. The unification of the two major disciplines is likely to save the medical costs to the patients and insurance companies by at least 50 percent.

Programming the micro and macro noun objects ($\mu no's\ and\ large\ NO's$) and their corresponding micro and macro verb function ($\mu vf\ and\ large\ VF's$) to act coherently in coordination (*'s) at predefined instants of time (t_1, t_2, t_3, ... etc.) will facilitate major medical events (such as (heart, kidney, bone marrow, etc.) transplants and or other surgical events become (almost) error free.

III. SUPERPOSITION OF KNOWLEDGE SCIENCE ON THE AI FRAMEWORK

Knowledge science methodology that could be implemented by computer architectures was conceived and presented[10] as far back as 1993 and 1994. Knowledge science as a scientific discipline was presented in 2006[11] and further expanded in 2014[12] based on the theory of knowledge.[13] The convergence of knowledge science, computational programming and its machine implementation as they can be implemented in the Science of Medicine was presented in 2013.[14]

3.1 Medical Science as a Part of Knowledge Science

Knowledge is computational entity that can be processed as numerical, logical, and/or informational entities in computers and networks[11] The command languages and processing architectures for knowledge systems become progressively more intricate, elaborate and structured [see Chapters 5, 6 and 7 in Reference 11]. Though more complex knowledge processing systems can be construed and built dependably as the knowledge bases and knowledge management systems now distributed throughout the World Wide Web (WWW) sites. Even though such knowledge systems do not function as precisely, accurately and dependably as the more established computer systems, they perform more precisely, more accurately and more dependably than the human counterparts who also process knowledge in finding one or more solutions to the real problems in life and society.

A frame work of measuring, quantifying and predicting knowledge in any particular direction defined by the Dewey Decimal Systems or the Library of Congress classification is presented in Reference '12'. Knowledge centric objects (KCOs) can indeed be constructed in the memory systems of computers. These KCOs have volatile and dynamic boundaries that couple with the human mind/ psyche or with other KCOs to image the reality of the physical space. The attributes and bondage of the KCOs are altered by the knowledge systems much as the numerical values and their dependencies are altered by the CPUs and programs of computers.

3.2 Expansion of Knowledge Science into the Medical Discipline

The concepts from references '10 and 11' are explored and expanded further in Reference '13' and correlated to the basic human needs that offer the raw motivational energy to drive the actions that manipulate the KCOs. These altered stated of KCOs gratify the human needs that prompted the action. A state of temporary equilibrium is reached for that particular need till the next deficit need prompts similar action. The cycle continues and the focus of lives of all organism moves from one instant to the next. Machines can indeed track such movements and optimize the strategy for efficient and meaningful life of the user of such mini-machines. For more complex and deeper problems, the machine architectures and the processing of the KCOs can be conceived, designed and built from the VLSI chips[14] that image the social and cultural environments of human setting.

3.3 Medical Knowledge and Doctor Patient Relations

Based on the science of organizing, arranging and architecting of knowledge, a fundamental theory of knowledge is constituted.[15] The general theory of knowledge is based the truism that any action that is associated with an object changes its status. It is also because actions cause change. An action that does cause any change in the entropy anywhere in the system is no action at all. Since there is no object that does not undergo change, there is some action or a set of actions inherently and inadvertently acting upon every object. An object without one or more verbs to act upon it is a non entity and a verb without a corresponding noun to be acted upon is virtual. These truisms are applicable in the medical field as well; to the extent a medical process (or any process) can cause a change in the status or condition of a patient. We map the medical functions of the doctors to the corresponding effect (both positive and negative) on the status (medical condition) of the patient. Objects in nature and their inevitable changes are the basis of theory of knowledge in every discipline including the medical field. Changes occur over measurable and discernible parameters. Changes that cannot be perceived over a predefined duration should be considered as no change or deductively, the action that was to have caused the change is ineffective.

In the real world, the innate forces of nature/environment and the rate of change that lead to the cause and intensity of such forces. In social settings, the hierarchical needs based on Maslow’s Motivational theory of needs of humans that exert such forces. On a broader scope, the physical laws (e.g., gravitation, electromagnetic and electrostatic, etc.), quantify such forces. Indeed, the natural processes become the theme to construct the theory of cause and effect relation in medical sciences. The validation of the normal, the usual equations relating the measurable parameters (such as, mass and momentum, force and movement, torque and rotation, energy and inertia, etc.) becomes necessary. As the real objects fill the physical space; hypotheses, concepts, and notions fill the intellectual space; humans, their needs, and their innovations fill the social space. One of the objectives of the theory is to extend the domain of (statistical and probabilistic) computation coupled with the inference and directionality offered by AI techniques to extend the frontiers of knowledge and to derive notions leading on to concepts and axioms leading on the wisdom and practice of the medical sciences.

IV. EVOLVING ENHANCED MEDICAL MACHINE ARCHITECTURES

A series of Figures 2 through 5 illustrates the migration of architectures of simple computers from their configuration (Figure 2) to those of an enhanced medical computer (Figure 5). The step-wise migration enhancement of the functions is embedded in the functions of the CPU (central processor unit), the KPU (the knowledge processor unit), the MPU (medical processor unit) and the EMPU (enhanced MPU). The two additional stages become necessary: a knowledge based computer that performs the operational code (*opc*) for the microcode to accomplish a verb function (i.e., equivalent of a knowledge operation code *kopc*) between a noun object (i.e., *no*) and its verb function (i.e., *vf*) in an appropriate syntax (i.e., * that precedes or follows any typical *no* or a typical *vf*).

No convolution can exist without a driving noun or source of energy and its corresponding action or function. By the same token, each and every action or function causes the change of status of noun object(s) and a corresponding convolution or * is associated. Correspondingly, a * before or after an action of verb function(s) indicated the modality of the verb. These contextual relationships between verb function(s) and noun object(s) are part of the executable code of all computers and machines for optimal accomplishment of the goal of the entire and overall program.

4.1 The Plain Old Computer Architecture

The bus architecture and the CPUs architectures of the simpler computer have evolved dramatically over the last few decades. Both architectures are portrayed in Figure 2 and 2A respectively. The bus architecture of Figure 2 is able to accommodate the CPU in Figure 2A for an early inexpensive machine.

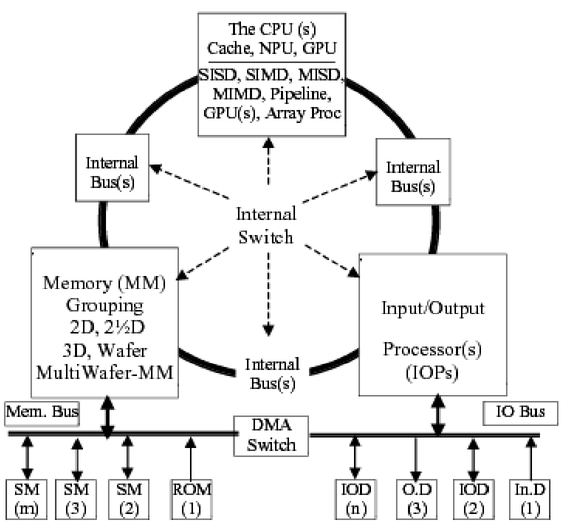


Figure 2. The Architecture of a typical computer where the CPU performs the routine processing functions including those of the Arithmetic-logic unit (ALU), the indexing, memory access and Input/output (I/O) functions.

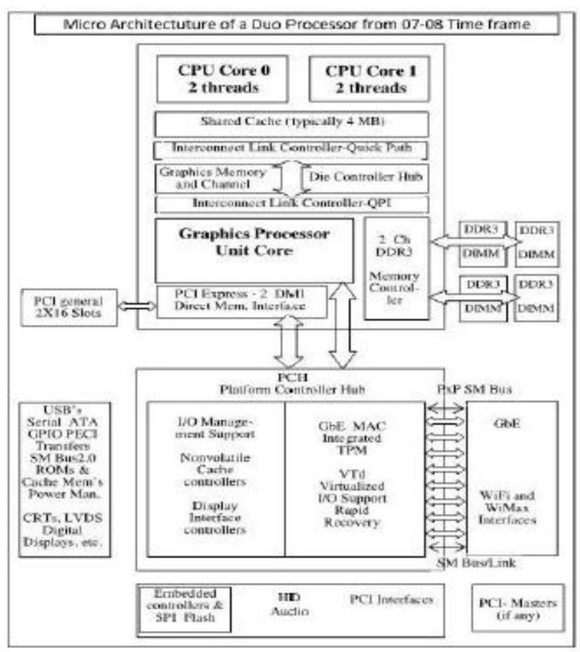


Figure 2A Microarchitecture of a duo processor from the 07-08 period. Two CPUs are integrated with a GPU and two channel Direct Memory Interface for faster Graphical displays.

4.2 The Knowledge Machine Architecture

The architectural arrangement of a knowledge machine is shown in Figure 3. The KPU (enhanced from a CPU) executes *kpoc* assembly level instructions on *nos* and *vfs* much as a typical CPU executes an *opc* instructions on its appropriate operands. The associated functions (such as fetching the operands, store the result, indirect addressing, indexing, etc.) become more detailed and cumbersome but orderly and programmable. Such functions are feasible in HW or micro-code as they are feasible in hardwired CPUs or in micro memories in the VLSI design of micro-programmable CPUs.

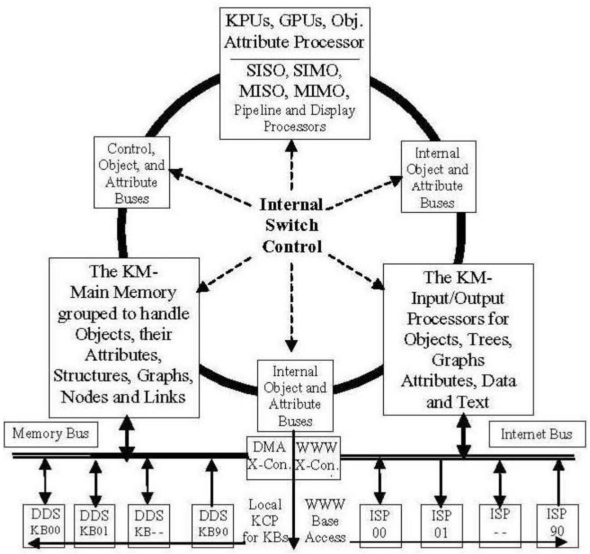
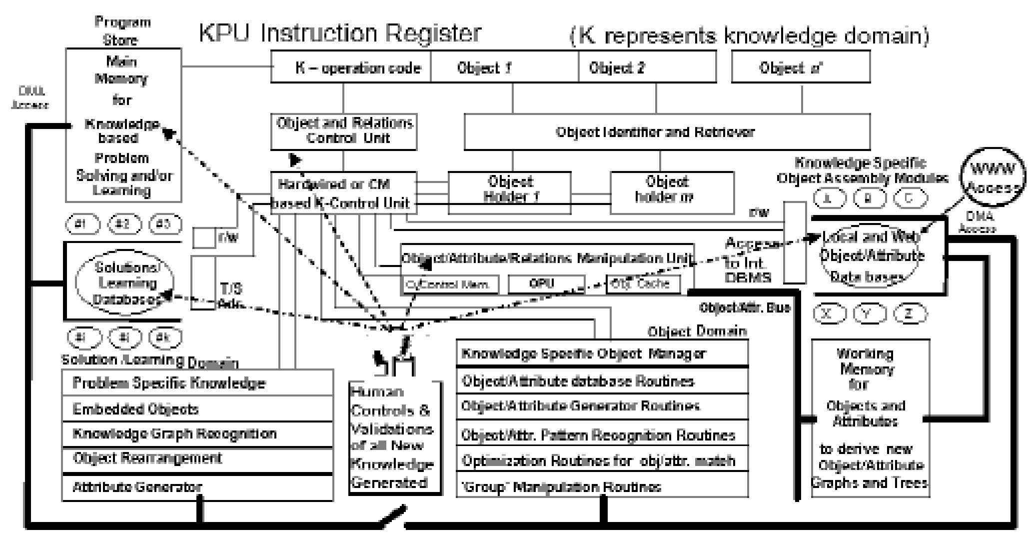


Figure 3. (Left) The Architecture of Knowledge Machine (KM) where the KPU performs the Knowledge Functions in addition to the functions of the CPU. Multiple CPUs may also be distributed throughout the KM for specific CPU functions germane to the knowledge functions (such as computing the probability distributions, or confidence within a decision making process.

Figure 3A (Below) Switch S-1, Open for Execution Mode for Knowledge Domain Problem Solving; Closed for Learning Mode. The Learning programs 'process' the existing solutions and are able to extract objects, groups, relationships, opcodes, group operators, modules, strategies, optimization methodologies from existing solutions and store them in object and corresponding databases. The architecture permits the KPU to catalog a new object in relation to existing objects and generate/modify existing pointers to and from new objects.



4.3 The Medical Machine Architecture

The architectural arrangement of a simple medical machine is shown in Figure 4. The MPU (enhanced from a KPU with additional CPUs) executes *mpoc* assembly level instructions on medical *nos* (medical noun objects) and *mvfs* (medical codes and/or much medical verb functions) as a typical KPU executes a *kopc* instructions on its appropriate medical operands that will receive the effect(s) of the *mpoc(s)*. Functions associated with MPUs become at least an order of magnitude more complex than those of the KPUs and even two orders of magnitude more complex than those of the CPUs. It becomes logical to support the MPU(s) with slave KPUs and slaves of MPUs and KPUs. With the rapidly diminished costs of the VLSI circuit components in the 21st century, the cost of an MPU gets comparable to the cost of a typical mid-sized CPU during the late 1960s.

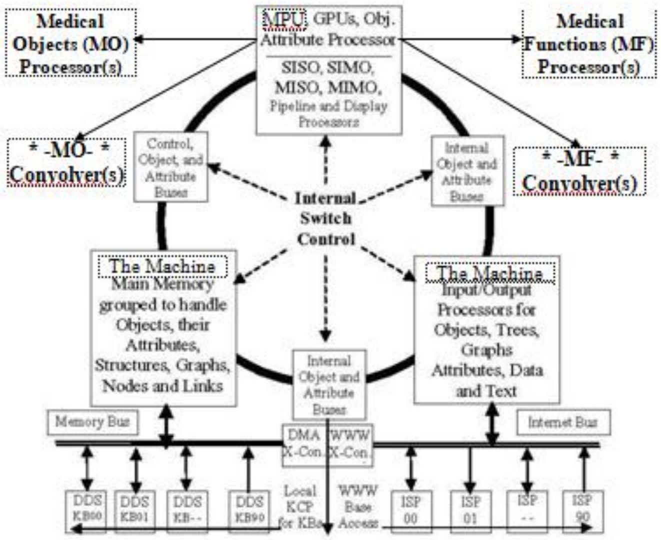


Figure 4 The Architecture of Medical Machine (MM) where the MPU performs the Medical Functions in addition to the functions of the KPU and the CPU. Multiple KPUs and CPUs may also be distributed throughout the MM for specific medical functions germane to the medical environments (such as computing the optimal use of a certain specific drug or treatment, or confidence within a medical decision making process, such as the deployment of transplant process, etc.).

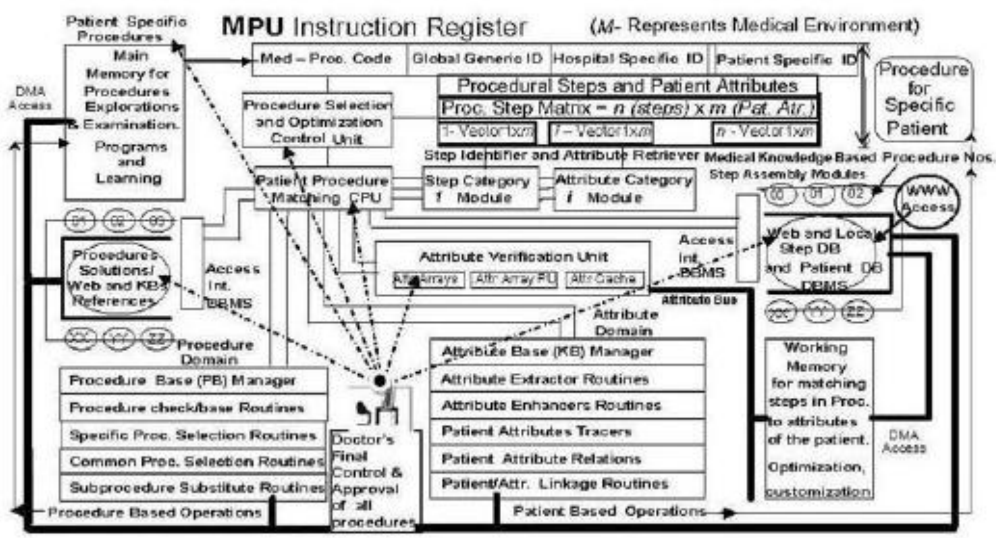


Figure 4A Architecture of a medical processor unit (MPU). DMA = direct memory access, DBMS = Data, base management system that holds procedure, patient and/or attribute base(s), procedure management system(s), patient specific characteristics, and medical resources of the hospital, KB = knowledge base(s). The medical procedure code is the *'mopc'* that forces the MPU to execute a micro or nano medical function.

4.4 The Enhanced Medical Machine Architecture

The architectural arrangement of enhanced, elaborate and extended medical machines is shown in Figure 5. The EMPU (enhanced from a MPU with additional KPUs, and CPUs) executes *mpoc* assembly level *macro* instructions on medical hierarchical *hnos* (complex medical noun objects) and/or hierarchical *hmvfs* (complex medical codes and/or hierarchical medical verb functions) as a typical MPU executes *mopc* instructions on its appropriate medical operands that will receive the effect(s) of the *hmpoc(s)*. The presence of the complex medical codes and complex verb function is made feasible by assigning a tree/graph structure to each of the *hmnos* and *hmvfs*. It is still to be evaluated if the *m*'s* also need a tree/graph structure. These medical machines will facilitate the work of physicians as much as computer aided designs will facilitate the detailed design of automobile engineers.

Machines offer more quicker and accurate solutions to patient problems. Such solutions will aid the diagnostic, the identification and treatment of ailments based on the knowledge and expertise stored in the Internet bases but with three inter twined, interrelated and interdependent AI procedures. These procedures also get customized to the medical history of the patient and the doctors own preferences. In a sense, the AI processes also facilitate the doctors to sharpen their skills in diagnostic, problem identification and treatment. Adequate reasoning is provided if the AI based medical system offers procedures over and beyond any proposed institutive solution by the doctor. As a secondary use, the system will also prove itself as an efficient computer aided training facility for medical students and trainees. Much as an autopilot or self driving cars improves the logistic caliber of pilots and drivers, the triadic medical system can improve the caliber of medical practitioners. A self learning system can also suggest treatments based on local hospitals and treatment centers and select possible procedures, dates and schedules for patients, doctors, medical staff, and hospital resources.

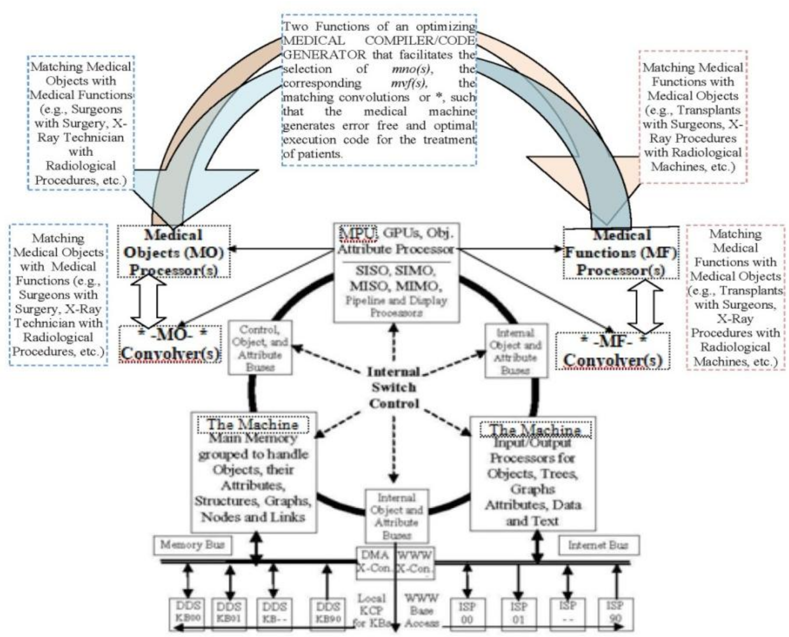


Figure 5. The architectural overview of a medical machine with extended medical processor to generate the error free and optimal execution code for the matching of medical noun objects or *mnos*, medical verb functions or *mvfs*, with the appropriate convolutions (*'s). The code is optimized to the hospital resources, medical profiles of the patient, the medical staff, scheduling and their availability.

4.5 Knowledge Science Approach in the Field of Medicine

When the medical processes are arranged logically, systematically and optimally, the patient can receive heightened benefits by the excellent treatment of symptoms. The approach is borrowed from the science of medicine and programmed into the medical operations of a robot to perform actual physical steps or in the medical programs can offer the discrete steps of the medical treatment for the doctors and robots alike to maximize the benefits of the logical and follow up steps in the treatment and procedures. The result could possibly be the optimal depending on the patient history, status, and extent of local and Internet knowledge available and the expertise of the doctor. Extraneous factors and environmental effects are incorporated in the medical procedures suggested by the medical machines in this paper.

4.6 Trends in the Evolution of Medical Machines

It is evident that the medical community is oblivious to the vast options that have been provided by the pathways of recent computer scientists over the last three decades. This type of inaction was also evident when the communication technologists who did not explore the computational pathways provided by early computer architects of early computational systems such as the von Neumann hardwired machines and IBM 360/370 general purpose and micro-coded machines. It was left for the Bell Labs scientists to contribute the C-language that emphasized the communications aspects in ESS machines as a distinct science apart from the computing aspects in computers of the mid 1960 era. The two aspects (communication for world wide connectivity and computing for traffic pattern analysis and billing) are harmoniously integrated in the modern switching systems of the 21^{st} century.

The role of medical intelligence (distinct from artificial intelligence and embedded microcode in the control memories of second and third generation computers) becomes essential for the accuracy and dependability of medical machines. The design of medical supercomputers also becomes essential to trail the intricacies of the human body and mind, their ailments and abnormalities.

The top level of these medical supercomputers still have to be built with a cluster of MMI-MMO, MMI-MMV and MMI-MM* architectures[3] as MIMD have built, optimized and tailored to the particular VLSI design of the chipset that execute the CPU functions of plain old computers. Each multiprocessor controls series of multiple co-processors, thus achieving the extremely high floating-point operations per second (flops). Six orders of computing power become feasible by this three level hierarchical design of the supercomputers. These supercomputers can vary radically with respect to the number of multiprocessors per cluster, the number of processors per multiprocessor, the number of simultaneous instructions per SIMD processor, and the type and number of co-processors. Based on the specialized (yet simple) MIMD and SISD configurations, the supercomputer speeds can reach the many tens of petaflops processing power. These clusters are interconnected by high-speed very well connected data-highways within the supercomputer.

2 The MMI represents Multiple Medical Instruction, MMO represents Multiple Medical Objects, MMV represents Multiple Medical Verbs of Verb functions and MM* represents Multiple Medical Convolutions. For the plain old computers MIMD represents Multiple instruction Multiple data instruction format of an executable assembly level instruction. SIMD represents the Single Instruction Multiple Data instruction format, etc.

Each cluster generally runs under its own operating system. The core clusters share the tasks in a balanced fashion thus giving rise to Symmetric Multi-Processing or SMP environment. They share the memory with non-uniform memory access or NUMA and each of the cores may be from one to many thousands of multi-core processors. The co-processors can themselves be the new breed of general purpose graphics processor unit or GPGPU that are very powerful in their own right with their own FPUs, ALUs and integer processors and coprocessors. The computing power is thus pushed from a few million flops (10^6) to several tens of petaflops (10^{15}). Interconnection, bus switching, operating systems, and multi-threading of task are the toughest but not insurmountable issues in the design of the modern supercomputers. Currently, social sciences and medical problem solving are not on the list of the application of either of the two supercomputers and Sequoia being built by IBM.

The use of super computers in medical applications is limited, partly because the VLSI and software designers have not visualized the medical application as being profitable to them. This scenario was prevalent in the automobile industry about two or three decades back, but over time, almost all aspects of automobile industry is computer, communications and graphics oriented. The dependability, precision and the speed that sophisticated digital systems can bring into the medical field are yet to be harnessed.

Full-fledged medical computer systems need architectural, firmware and software enhancements. In this Chapter, we have eluded to the changes that will be desirable and necessary. The design of the MPU can also become radically different from the design of ultra large-scale integrated circuits.

V. CONCLUSIONS

In this article the design of medical machines and associated processors were outlined. It is still to be seen when the medical machine designers will optimize the medical processor unit (MPU) designs and the medical machine (MM) architectures. Most medical functions and the information and knowledge between a typical doctor and a patient during a doctors consultation and the subsequent analysis and treatments can be greatly facilitated by advanced their design and deployment. The goal is to train a medical community to perform the necessary interactive modules based on MI (medical intelligence) principles to seek the necessary and desirable step to act intelligently in network cloud (LAN, WAN and/or the Internet) environments. Typical AI systems have been successfully designed and deployed for most business transactions on the Internet. Such systems update local data/knowledge bases after each transaction and receive the necessary information from Internet data/knowledge bases.

A perfect doctor would work infallibly (without any errors) during all phases of the steps involved in patient information gathering, prognosis, diagnosis and treatment. The role of numerical computations will become vital given the nature of the uncertainties of the nature of patients' ailments, conditions, dependability of the treatments and procedures. However, it is to be expected that the medical machine would perform better than most average doctors but not as well as a human expert doctor for the particular medical expertise. In the routine instances, the duel of life and death is thus played out by the super learner medical machines for a wide variety of patients in a wide variety of ailments. The cost savings is implicit and the patient service will improve.

CONFLICT OF INTEREST

None declared till now.

REFERENCES

[1]. Shortcliffe, EH., MYCIN: Computer-Based Medical Consultations, American Elsevier, New York, 1976.

[2]. Buchanan BG and Shortcliffe EH, Rule-Based Expert System: The Mycin Experiment at Stanford Heuristic Programming Project, Addison Wesley, Boston, 1984.

[3]. W. Kintsch et al., About NeoMycin, Methods and Tactics in Cognitive Science, Lawrence Erlbaum, Mahwah, NJ, 1984

[4]. http://rsta.royalsocietypublishing.org, D. N. d e G. Allen, B.A., L. Fox, D .Ph il., a n d R. V. Southwell, F.R.S., Relaxation Methods Applied to Engineering Problems, VIID. Stress Distributions in Elastic Solids of Revolution, [Received 23 December 1942).

[5]. Allen, D. N. de G., Fox, L., Motz, H. & Southwell, R. V. 1945 "Relaxation methods applied to engineering problems. Part VIIC.", Phil Trans. A, 239, 488-500.

[6]. Henrik Brink and Joseph Richards, Real-World Machine Learning, Manning Publication, 2016.

[7]. Ahamed, S. V., Intelligent Internet Knowledge Networks, Wiley Interscience, Hoboken, New Jersey, 2006. and Next generation knowledge machines. Waltham, MA: Elsevier Insights Book; 2014.

[8]. Drucker, PF The Practice of Management, HarperBusiness, Reissue, 2006

[9]. https://**en.wikipedia.org**/wiki/**Program_Evaluation_and_Review_Technique**

[10]. Ahamed SV, "Architecture for a Computer System used for Processing Knowledge," US Patent Number 5,465,316, November 7, 1995. Also see, European Patent # 9437848.5- "Knowledge Machine Methods and Apparatus", European Patent Number 146248, US/05.11.93, Denmark, France, Great Britain, Italy. Issue date 29/12/94

[11]. Ahamed SV., Intelligent Internet Knowledge Networks, Wiley Interscience, Hoboken, New Jersey, 2006

[12]. Ahamed SV., Next generation knowledge machines. Waltham, MA: Elsevier Insights Book; 2014

[13]. Ahamed SV., Computational Framework for Knowledge. Hoboken, NJ: John Wiley and Sons, Inc; 2009

[14]. Ahamed SV., Computational Framework for Knowledge. Hoboken, NJ: John Wiley and Sons, Inc; 2009 - Chapters 8 and Figures 8.11 to 8.25

[15]. Ahamed SV., Computational Framework for Knowledge. Hoboken, NJ: John Wiley and Sons, Inc; 2009 - Chapter 3, "General Theory of Knowledge"

[16]. Ahamed SV., Evolution of Knowledge Science: Myth to Medicine, Intelligent-Internet Based Humanist Machines, Morgan Kaufmann, 2016

[17]. Ahamed SV., Recent Approaches and Applications in Medical Systems, Chapter 2, Intelligent Networks; Elsevier Insights, 2013

[18]. Ahamed SV., The Art of Scientific Innovation, Prentice Hall, 2006