MV–SYDIME: A Virtual Patient for Medical Diagnosis Apprenticeship

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***Abstract*—Shortage of medical personnel and the existence of inexperienced ones, are frequently the causes of false diagnosis, and call for a reflection on the methods of training of the later. One of the solutions might be the application of new technologies in the training of medical students, in order to counter the shortage of experts as well as training conditions which are usually inadequate (no patients available for practice). The aim of this paper is to propose a virtual patient, on which an expert can formulate pathology, and hand this patient to a learner for exercises on medical diagnostics.**

***Index Terms*—knowledge base humanoid, medical diagnosis, ontology; virtual patient, VRML, virtual reality.**

I. INTRODUCTION

The teaching of medicine as practiced in most universities is characterized by about three years of teaching basic sciences (biology, chemistry, physiology, etc.). Then the student begins his clinical training in hospitals which follows a series of required courses. Currently, this type of medical education is being re-evaluated in many universities. This re-assessment is rooted in the realization that too often, students are unable to apply and implement the concepts learned when they are faced with a patient. However, the daily activity of the future doctor they will be is diagnosis, to decide how to confirm and explain diagnosis; only a long medical practice can ensure some experience, and thus significantly reduce fatal errors. Unfortunately, the first cases of actual diseases treated by the student doctor are met in clinical cases.

It is therefore necessary to develop an effective training system to transmit the operational skills of experienced physicians (experts) to new generations (students and inexperienced doctors), and allow them to practice as much as possible before their internship. Most existing tools do not offer this virtual patient (human form) they need. To meet these expectations, we offer in this paper a prototype.

The main objective of this work is to develop a system capable of:

- Providing an early solution to the training of qualified practitioners;
- Contributing encountered to reducing the number of false diagnosis found among young doctors;
- Giving to young doctors, the skills needed to address the first real cases of patients with more insight into their decision, and thus enable them to approach more and more the correct diagnosis.

To achieve the objectives mentioned above, we proceeded as follows:

- We have pulled the documentation in medical diagnosis and ontology technologies to gather, define and formalize the various concepts within the definition of a patient and clinical characteristics.
- Then, Case Based Reasoning (CBR) was used to model the process of reasoning and verification steps in the learner diagnosis;
- And at the end of the modelling techniques of virtual human (humanoid) and computer animation birth modelling and animation the virtual patient.

The system we have prototyped allows:

- Experts to return the cases of medical conditions encountered. The goal is not exhaustive, but to provide as much information on clinical situations encountered;
- Teachers of medicine to build virtual patient questionnaires that they will make available to learners;
- Trainees' students to follow a rigorous scientific approach to medical diagnosis and acquire self-learning capabilities through questionnaires designed for this purpose; this on the animated pedagogical agents guide.

This article is divided into four parts:

- The first presents definitions and typologies of medical diagnostics, modelling tools and a few support systems in medical diagnosis;
- The second presents some techniques of modeling virtual humans;
- The third deals with the modelling and implementation of the virtual patient and knowledge base;
- The fourth and final part is devoted to testing the patient's wellbeing. This is done through the design of software that integrates patient called MV-SYDIME.

II. MEDICAL DIAGNOSIS

A. *Definition and typology*

Medical diagnosis is the definition of the nature of a disease. Modern methods of diagnosis consist in establishing the history of the condition of the patient, to clarify the evolution of his illness, and the role of personal and family history, if necessary to perform additional laboratory and radiological tests

Make a diagnosis closer to a pathological situation observed in a patient of similar situations that the physician already knows concretely (personal experience) or theoretically (for the education received or scientific publications), the set of these situations referenced is the "medical knowledge".

There are 2 ways to conduct a diagnosis:

- The overall diagnosis akin to pattern recognition. In these cases, the comparison of all characteristics of an individual with all the characteristics of a disease already known that leads to the diagnosis.
- The step by step diagnostics that applies particularly where there is a very prominent symptom.

Each step of the argument consists of a question that can be given one or more responses that determine the choice and the next question.

Note that there are several types of medical diagnosis [1]:

- Positive diagnosis: to say what the patient is suffering based on the evidence he presents and additional tests he has done;
- Differential diagnosis: identifies conditions that resemble the positive diagnosis and likely to mislead;
- Negative diagnosis: is to identify the cause of the disease mentioned in the positive diagnosis.

B. *Process of medical diagnosis [2, 3]*

Stages of a medical diagnosis are:

- Reason for consultation: what the patient is suffering from?
- History of the disease: when has illness started? What treatment the patient has taken?
- Background: What is the history? The doctor wants to know everything the patient has had like problems in the past;
- Physical examinations: are all body systems working properly?
- Diagnostic hypotheses: based on responses collected in the previous steps, the doctor makes clusters of signs and makes assumptions. To confirm the hypothesis, it is sometimes necessary to make further investigations.

Let's note MC as reason of the consultation, SA1 the answers of stage 2, SA2 the answers of stage 3, EP the elements found to the physical exam and EC the complementary exams. An example of process of diagnosis pose is given by the figure 1.

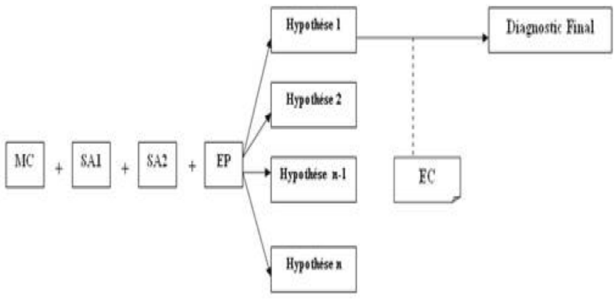

Figure 1. Example of a process of diagnosis

C. *Some assistance systems to medical diagnosis [7]*

Medical diagnosis seems difficult to adapt to the constraints of the computer, if we judge by the small number of programs currently available. This is understandable because:

- The extent of a diagnosis involves not only objective factors, but also subjective data (the emotions of the subject), interpretative and intuitive: is medicine not just an Art?
- There is no one form of a single disease but several, which is called in medical jargon "clinical forms."
- Among the specialized software in assisting the conduct of medical diagnosis, we looked at:
- **ADM** (Help to the Medical Diagnosis) developed for the Laboratory Medical data processing at the Faculty of Medicine of the University of Rennes, and has as objective to help the physicians in diagnosis; and to offer them fast access t to the medical information.
- **VIPS** (Virtual Internet Patient Simulation): is a simulator for medical consultation. It helps to test the operational capacities of the nursing while using an approach similar to the one of the pilots of lines.
- **ADELE** (Agent for Distance Education - Light Edition): It is an educational agent and a 2D animate character implemented under the shape of an applet JAVA. It prepares the presentations of the courses; procures the advice and instructions to guide the learner at the time of training exercise.
- **SYDIME** (Interactive system of help to the pose of Medical Diagnosis) [2, 8, 9]: System developed in LIMSS, in the setting of works on artificial intelligence, training and educational programs; It has as objective to define an ontology, in order to achieve the basis of the knowledge that will be exploited thereafter to describe the cases of illnesses. The present project is the continuation of SYDIME; it comes to complete it, while defining a virtual patient (animated 3D picture). The latter is associated to the cases created by SYDIME and is used for the initiation to the pose of medical diagnosis. It has been named MV-SYDIME.

D. *Discussion*

In spite of their qualities, the tools that we have just presented have numerous limits. It clearly appears that they are specialized in information and help to the decision. They are practically nearly incapable of doing the training; insofar the process of medical diagnosis is not applied by the learner in his training.

Due to the shortcomings of the MV-SYDIME project we propose use the recent technologies of data processing to:

- Represent the knowledge positively while using domain ontology;
- Recover the diagnostic hypotheses associated with a case while using the CBR;
- Represent an emotional virtual patient while using the techniques of emotional data processing, the virtual reality and the agents;
- Construct in a 3D environment, representing the physician's office, so that it looks like the nearest possible of his work environment.

III. THE VIRTUAL PATIENT

A patient is a person suffering from an illness, that has been determined or not. Most of the time this term is used to designate a human being. When a patient is placed at the disposal of a physician or when he receives a medical attention, he becomes then a patient. An interactive virtual patient is therefore a computer program that simulates the real life of a patient's clinical scripts as define above. It has as objective to provide an efficient means to the health professionals' daily practice (to diagnose the illnesses in a suitable virtual environment).

IV. MODELLING AND ANIMATION OF THE HUMAN BODY

In spite of the large number of scientific publications and important technological progress achieved, the modelling of humanoids (that resembles man) remains an extensively open problem. This for two main reasons:

- First because the human body is too familiar; the least detail that we could miss can be detected quickly by our brain;
- Then because the human body is complex; it is composed of several layers in interactions whose effects can be visible at the level of skin.

The simultaneous treatment of all these layers is not an easy thing. The skeleton only accounts 206 bones and about one hundred joints possessing each constraint's specific limits.

The movements of the body are lead by those of the muscle; but in graphic data processing, it is a contrary: the movements of the skeleton rather lead to the distortions of the muscles. That is why; we are only interested in the modeling of the muscle.

In this section we present only the modeling of the muscles.

A. *modelling of the muscle*

We designate by the term skeletal muscles [11] [13], the muscles enabling the bones to move. This definition is necessary for the understanding of the lines that follows.

1) *Mechanical properties*

In literature, we can identify the following two mechanical properties:

- Springiness: capacity of the muscle to come back to its initial position after contraction. Mechanically, when one pulls on a muscle of initial length L, of section cross at area A and of stiffness k with a strength F, an elongation E results from it defined by:

  $E = (F * L * k)/A$ (1)

- Contracility: ability of a muscle to be shortened by a nervous stimulus. If R, is the unit of shrinkage and θ, the angle of rotation of the joint:

  $R = \theta * k$ (2)

2) *Representation and distortion of the muscle*

We used the model of Scheepers and al. and Wilhelms [13]. These latter uses some ellipsoids to represent the muscle (without the tendons). The scheepers models [13] are capable of simulating the isotonic and isometric contractions (See figure 2).

B. *Some techniques of animations of the humanoids [17, 18]*

1) *Interpolation of key shapes*

This technique is more used in facial animation, because it can apply to a mileage without internal skeleton. In this case, the distortions are due to expressions of the face that one tries to reproduce. The user must provide key shapes corresponding to different expressions: sadness, joy, anger, etc.

The problems with this approach are various: First of all, the different key shapes not independent; the artist must draw the shapes that are not in conflict with each other. Then, he must draw a certain number of shapes for different poses. What constitutes a difficult task for the artist?

2) *Distortions in the under-spaces of the skeleton or skin [15]*

The skin or Skeleton Subspace Distortion (SSD) is a technique of animation for which the summits of the surface of an object are displaced in respond to the movement of an internal skeleton. The joints are moved, either in the hand by the animator, or by inverse kinematics, to produce the movement of the bones dragging the summits of the skin. But in this technique, the summits cannot always meet where one would like that they do. This technique is maladjusted for the elbow. In practice, one observes a dish that appears in place of the bone of the elbow. Figure 3 is an illustration of this.

We opt for the technique of skinning because it is closer to reality with the presence of a skeleton.

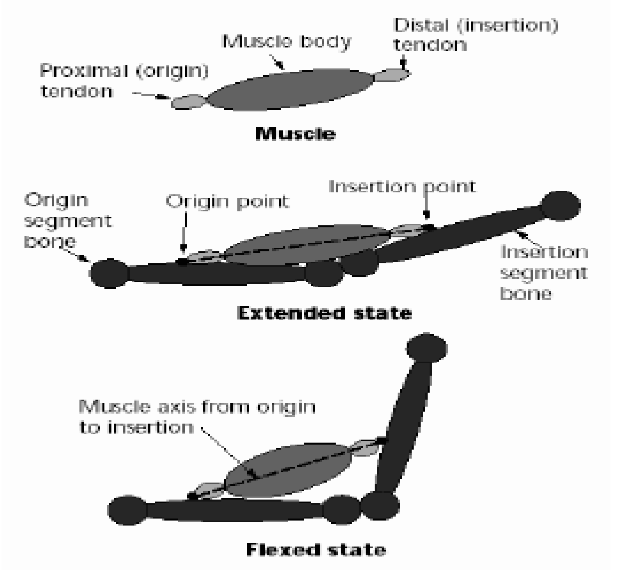

Figure 2. Illustration of the contraction on the model of Wilhelms muscle [14]

Figure 3. a) Aplatissement to the level of the elbow; (b) Thinning to the level of the joint because the arm is pierced

In the section above, we presented a brief statement on the work in modelling of humanoids. In the following section, it is question of using the tools and techniques adopted to design and model the virtual patient.

V. DESIGN OF THE VIRTUAL PATIENT

This section starts with the specification of a virtual patient, through the necessary data for its implementation and for the development of the tools or systems which will make use of it. ¶In continuation we specify and model the visual aspect of the patient, and we will finish this section by animation.¶

In what follows, a short presentation and classification of the data of the virtual patient are carried out.¶

A. *Specification interns of the patient* ¶

It consists in counting and formalizing the significant data for the representation and implementation of the virtual patient (given demographic and clinical data). Others share necessary data for the follow-up and the evaluation of learning. We use a representation which respects XML format for this purpose.¶

1) *Data of the virtual patient*

a) *Demographic data*

These data are of three types: the demographic data (concern the human identity of the patient: name, age, sex, and of demographic features of a patient, as the race, the temperature, the weight, tension, etc.), the clinical data (for clinical management and gotten by direct observation of the patient) and the complementary data (pictures, song, video or all other multimedia objects, representing a particular component of the virtual patient, used to return enough realistic and attractive training environment).

b) *The clinical data*

Some data cannot be formalised, a descriptive text would be necessary for these data. It is the case of the narration giving the complaint of the patient or anamnesis (history of the illness, social context, medical antecedents, etc.).

The identified data that can be formalised are the following:

- **Medication or treatment**: describes the correct treatment that must be prescribed to the patient by a learner.
- **Symptom**: represent one of the demonstrations subjective of an illness or a pathological process, as expressed by the patient.
- **Illness**: change of the functions or the health of our organism. Entity characterized by reasons, of the symptoms, an evolution and the clean therapeutic possibilities.
- **Exam:** Procedure of diagnosis achieved for motives of health: to diagnose the illnesses, to measure the progression or the recovery of the illnesses, to confirm the absence or the presence of an illness.
- **Diagnosis:** defines the data on the patient's complete diagnosis: differential, positive and etiologic.

All these data constitute the knowledge base of our system. This base is an XML file. Each of the data presented over here, is represented therefore by a XML element, having sub elements and attributes.

The figure 4 presents an excerpt of this XML file that shows for example how a diagnosis is stocked.

```
<Diagnostic id="diag3" estauteur="oui">
  <Différentiel>
    <Valeur> paludisme </Valeur>
    <Valeur> typhoïde </Valeur>
    <Valeur> fièvre jaune </Valeur>
  </Différentiel>
  <Positif> typhoïde </Positif>
  <Etiologique>  consommation  des  eau  non  potable :  eau
pluies, des puis</ Etiologique >
</Diagnostic>
```

Figure 4. An excerpt of the knowledge base showing an "diagnosis element"

A diagnosis as stocked in the knowledge base and presented on this figure is composed of the elements follow:

- An Identifier (note Id on the figure): allowing the other components of the virtual patient to make reference to a very precise diagnosis;
- est_Auteur: it is one Boolean sub element that determines if the present diagnosis has been specified by a practiced user in medicine as being a correct final diagnosis, and that serves reference to the learners who consult the patient;
- Différentiel: defines a set of names of potential illnesses. it has one sub element note "valeur";
- Positif : give the name of the illness of which stands the patient;
- Etiologique: it is a descriptive text giving the reasons of the patient's pain.

2) *Data for the management of the interventions of the learners*

The patient specified through the data presented at V.A.1 used in the training of the student physicians. The data for management of the interventions of the learners are the following: name of the learner, date of consultation of the patient, diagnosis made, trace of the dialogue between the patient and the learner.

These data offer a triple favour:

- **The assessments of the learners**: it consists of making a check-up of interventions done by the learners on the virtual patients to insure that they respected the process of diagnosis and that to the tip the calm diagnoses are the good as well as everything that can come with a diagnosis.
- **The management of appointments:** the learners must feel as real consultation, that is the stages that they are will meet later in clinic must be simulated; this is the management of appointments of the patients.
- **The follow-up of the patient's medical file:** we recall that the patient's medical file is a notebook in which the physician mentions his interviews with the patient (diagnosed illness, exam to do, treatment to follow, etc.). A patient can be followed successively by several practitioners. Each physician should have the possibility to see the results of the consultations made by his colleagues in the patient's file.

The specified data will be represented following the XML norm (that appears us more suitable), seen the hierarchy of the patient's elements.

B. *Specifications and modelling of the patient's visual aspect [12, 17]*

A human being is complex to be modelled or controlled in his entirety. The animation of a humanoid (virtual object having a human shape) proposes a simplified representation of the reality that preserves the essential features necessary to correct movement restitution

The specification declines itself in three levels:

- The constituent elements of the virtual human that will be represented by ontology.
- The skeleton of the virtual human: the bones must be represented by segments joined by nodes that represent the joints.
- Skin and the muscle: it is about the geometric shapes that regain the skeleton

1) *Definition of the ontology of the virtual human*

The development of ontology begins usually by defining its domain and its extent. The ontology proposed for the virtual human is given by the figure 5:

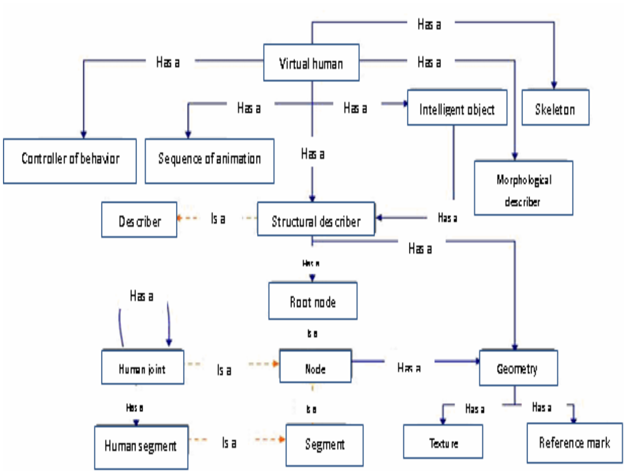

Figure 5. Ontology of the virtual human

Legend of the concepts used

- **Root node**: it is the element root of the virtual patient; it is the humanoid root;
- **Controller of behaviour**: software component, that implement the functions defining the behavior of the virtual human;
- **Skeleton**: software component defining the skeleton of the virtual human;
- **Node**: represent the other node of connections between the objects constituting the virtual human;
- **Human join**: these are the objects that describe the position of the joints and are organized hierarchically from the root.
- **Segments:** representing geometry and the appearance of his different parts;
- **Geometry:** software component permitting to define the shapes geometric that one can recover on the parts of the human body. (Cylinders, spheres, ellipsoids and truncated cones)

2) *Virtual human construction*

The modelling of the human body is divided into 2: the head and the body. To respect the VRML (Virtual Reality Markup Language), we leaned on the H-Anim standard (Humanoid Animation).

This standard inspired us for the definition of the skeleton of the figure 6. Every point is a joint.

While being inspired by the [12, 3] diagram, an approximation of the body has been made with 15 primitive strong: cylinders, spheres, ellipsoids and truncated cones. The figure 7 presents the resulting model.

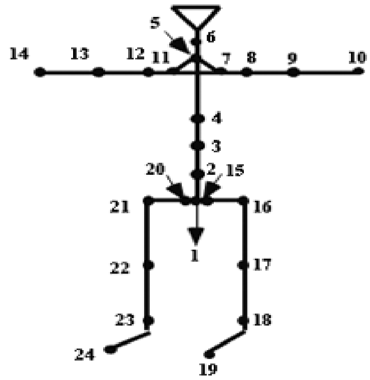

Figure 6. A Simplified skeleton and definition of the different joints [16]

TABLE I.
DEFINITION OF DIFFERENTS JOINTS

names	numbers	angles
Sacrum	1	F
Vertebra 1,2,3,4,5	2,3,4,5,6	FTP
left and right collarbone	7,11	FP
left and right shoulder	8,12	FTP
left and right elbow	9,13	FT
left and right wrist	10,14	FP
left and right hip	15,20	F
left and right thigh	16,21	FTP
left and right knee	17,22	F
left and right ankle	18,23	F
Left and right heel	19,24	F

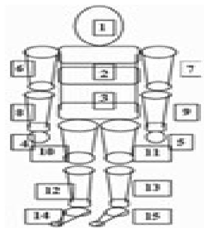

Figure 7. Model representing the patient's musculature [17]

TABLE II.
DEFINITION OF DIFFERENTS NUMBERS

Numbers	Names	Type of shape
1	head and neck	ellipsoid
2,3	top and low of the torso	cylinder
4,5	hands	sphere
6 to 15	arm, before arm, thigh, legs and feet	cone

C. Animation of the virtual patient

In general, the animation of the body rests mainly on degrees of liberty (angles) while the facial animation is above all of muscular nature. As we specified above, the animation is divided into two parts: the body and the face.

1) Distortion of the body

To enliven the body of the humanoid, the adopted technique consisted in defining within the character's envelope (on the skeleton) a set of key points, having to act as reference mark for the distortion of the body. A diagram of [12] served as basis, and we added these key points there as you can be seen on the figure 8.

We draw these key points as wire inside the body, and then we make the character coincide with the points.

This operation is in general long enough because, must be very precise. It is however very necessary, because all the animation is calculated from this on line standard personage. Indeed, a software will be able to distort the personage thereafter, according to the angles necessary to the animation, without any other human intervention.

The principle used consists in dissociating the envelopment of the body of the skeleton. The lines in figure 9 show the algorithm of distortion.

2) Face Animation

Contrary to the animation of the body that essentially rests on the variation of the joint angles (Knee, elbow, shoulder etc.), the one of the face has as basis the muscle. So a smile is only the consequence of muscular distortions. The technique used for the animation of the face is the one of the pseudo muscles of Waters [25]. The idea is to avoid the complexity that is inherent in physical modelling of the face.

To the term of this section, the virtual patient is ready to use. But the goal is to help in the training of young physicians, we judged imperative to achieve a system that should use aforesaid patient effectively to fill this mission. It is the object of this last section.

VI. APPLICATION: THE MV-SYDIME SYSTEM

We are going to achieve a survey of the needs of the users that will clear on the census of the actors and their main use of the system. Then, will follow the modeling of the knowledge base. We will finish by the implementation of the different components.

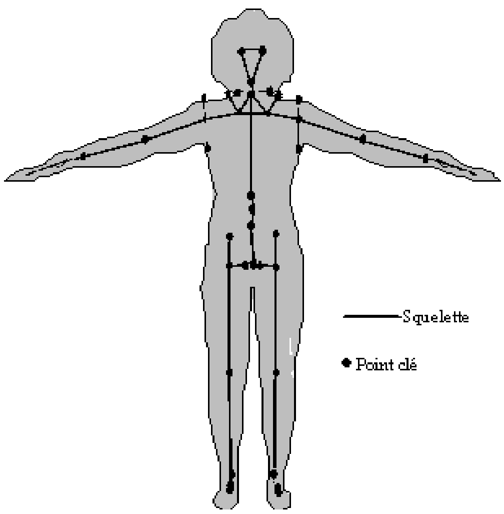

Figure 8. Representation of the human body for the distortion

*For each segment **S** of the skeleton*
*For each point **P** of the corresponding body in **S***
*Associate **P** to the extremity the more close to the segment **S***
Select an operator for the type of animation
*Give the movement of **P** to **S***
End for
End for

Figure 9. Excerpt of the knowledge base showing an element diagnosis

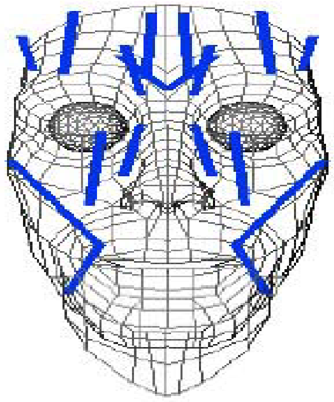

Figure 10. Disposition of the pseudo muscles (large strip in blue) in the model of Waters[18]

A. Main functionalities waited of the systems

From the needs expressed by the experts and the teachers, we identified the following functionalities:

- To offer two types of use to the learners: training and the assessment;
- To present a picture 3D representative of the patient on which the diagnosis will be done;
- To provide to the expert an interface where he can bring the cases of illness already met ;
- To provide to the teacher an interface where he can create a virtual patient and assign it to the learners;
- To provide to the learner an interface where he can acquire new knowledge while answering composed questionnaires beforehand by a teacher, under the tutelage of an emotional educational agent;
- To permit the diagnosis on the virtual patient: the system must provide to the learner an interface where he can practice the pose of diagnosis on virtual patients;
- To guide the learner in case of false diagnosis, if this last is the training type;
- To allow the teachers to recover and to correct the diagnoses put by the learners.

B. Approaches adopted for the realization of MV-SYDIME

It rests on the representation of the knowledge by the ontologies, the use of the CBR (Case Base Reasoning) for research in diagnostic hypotheses of a case and the use of agents for the realization of the intelligent tutor.

C. Global working diagram

Figure 11 presents the different components of the system and the interactions between them.

D. *Analysis and design of the system*

1) *Analysis of the functional requirements*

They are gotten while identifying all actors who are going to interact with the system, as well as the different uses of each of them. We identified the following actors:

- The expert: He is in charge of managing the knowledge (all relative information to an illness: symptoms, treatments, exams, etc.) and to manage the cases: case of pathologies existing in the knowledge base.
- The teacher: He is in charge of the virtual patient and to assign it to a learner, and to propose cases of the illnesses.
- The learner: He is in charge of acquiring some knowledge; to choose some themes (a functional system, for example the respiratory system), to see themselves asking some questions and getting answers; to consult a virtual patient.
- The administrator: He is in charge of creating, to suppress some users and to maintain the system.

These different uses of the system are summarized by the diagram of case of uses of the figure 12:

2) *Knowledge base modelling*

It is represented by an ontology of the studied domain (medicine), restricted to the only concepts permitting representation of a pathology case. The diagram below represents the conceptual model of the ontology of MV-SYDIME:

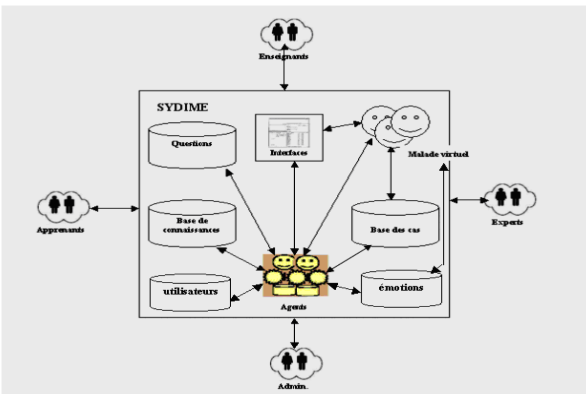

Figure 11. global working Diagram of MV-SYIDIME

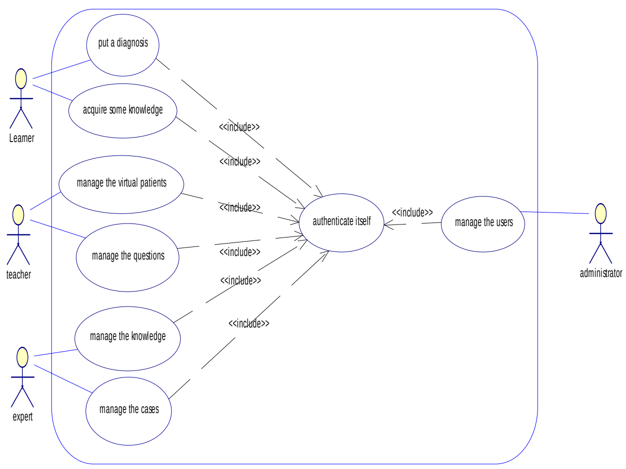

Figure 12. Diagram of use case of MV-SYDIME

3) *Reasoning modelling*

The objective of the reasoning model is to determine the diagnosis for a case of a given patient (target case) according to the diagnosis already done on other patients (case sources). The reasoning passes via four phases: research, reuse, the revision and the training. One of the main difficulties of the application of the CBR to a particular domain is to determine the good criteria of this domain, the criteria that allows a fine and sure selection. The picture (figure 14) below presents a research of a case of diagnosis.

4) *Identification of the different agents of the system*

The system is conceived to be a multi agent system.

The agents are identified from the roles that must be adopted by these. The roles belonging to a same sphere of operation will be allocated to a same agent. The identified agents are the next one:

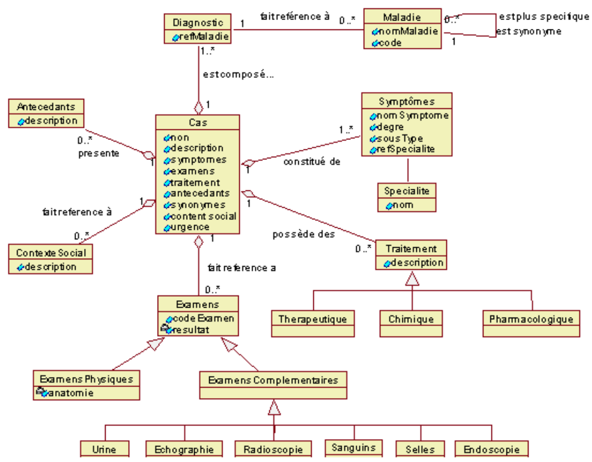

Figure 13. Conceptual diagram of the ontology of MV-SYDIME

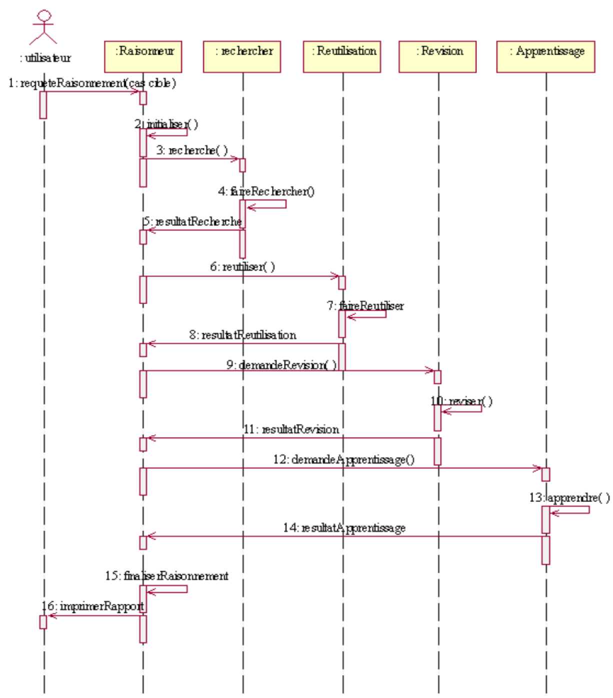

Figure 14. Sequence of reasoning

- Agent “***LearnMate***": it will receive the role of interface management for the learner. It will also receive the virtual patient administrator role in order to manage the learner's waiting room that is constituted of virtual patients. This agent's responsibility is the management of the waiting room and the services that it offers are: allow the access to the patients, permit the patient's consultation, enable to put the hypotheses and to ask for verification;
- Agent "***AutorMate***": this agent will receive the roles of interface administrator for the author, of administrator of the questions and administrator of virtual patients. This agent's responsibilities are: management of the questions and virtual patients. The services that it offers are: to display, to create or to modify the questions, the questionnaires and the virtual patients;
- Agent "***ExpertMate***": it will receive the role of interface administrator for the expert, of administrator of cases and knowledge. The services that it offers are: displaying, creation or modification of the questions and the virtual patients;
- Agent “***Interactor***": this agent will receive the virtual patient consultant role. Its main responsibility it is to provide the interface of dialogue between the virtual patient and the learner. The services that it offers are: display the patient's answers and conduct the execution of the actions defined by the learner;
- Agent "***Operator***": this agent will receive the role of diagnosis tester. It is responsible to verify the diagnosis put by a learner. The services that it offers are: verify the diagnosis, display the findings of a verification, send some messages to the consulted patient;
- Agent "***Reasoner***": it is going to receive the role of reasoning administrator. It is responsible for the application of the CBR to a new case in order to find its diagnostic hypotheses. The services that it offers are: reason for a given case, display the report of reasoning;
- Agent "***Sydime-tutor***": it is an emotional pedagogic agent that will receive the role of training guardian. It is charge of commenting the learner's answers when he is acquiring the knowledge. It maintains a permanent dialogue with the learner and motivates him when he is working, by congratulations when has found the good answers to the questions. It can use the gestures, the facial expressions, the stances to guide the learner. The services that it offers are: display the recommendations, explain the displayed recommendations, send the messages and move.

5) *The different components of the system*

MV-SYDIME is constituted of a set of software components. We have the following components:

- IHM: This package regroups the components of the interface man, plots the system, even named object mirrors;
- Agent: it encapsulates the agents of the domain;
- Entity: it regroups the objects professions of the application, the different modules lower implemented;
- Persistence: it encapsulates all functions, as well as all services of consultation and modification of the data.

Figure 15 presents the components diagram of the system.

VII. SYSTEM IMPLEMENTATION

A. *Choice of tools*

To develop the modeled system, we used the following tools.

B. *The knowledge base*

The knowledge base is implemented as XML files, this is to make it usable on various platforms, without any difficulty. The ontology developed and modelled, was done in protege2000 version 3.2; that allows the generation of knowledge base schema, a XSD file, then the XML file. Figure 16 present an excerpt of the ontology under protége2000.

TABLE III.
LIST OF DIFFERENTS TOOLS USED

tools	**use**
Borland JBuilder 2006 (IDE Java 2)	for the development of the application
Protege2000 version 3.2	modelling of the ontology and generation of the knowledge base as XML file
Adobe Photoshop	design of pictures, logos and icons
Rational Rose	for the drawing of the different diagrams
VRML	for the realization of the virtual patient and its environment
Script python	integration of the VRML animations in the Java code
Cortona VRML Client	interpretation of the VRML code in the navigator

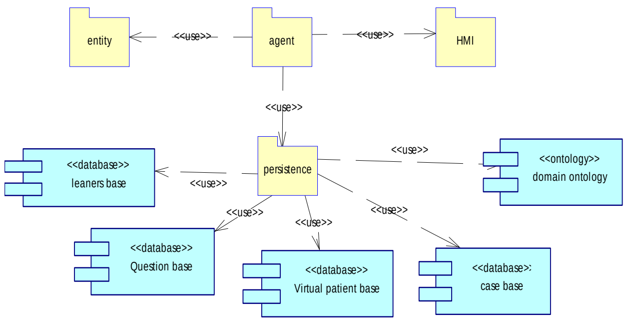

Figure 15. Software architecture of MV - SYDIME

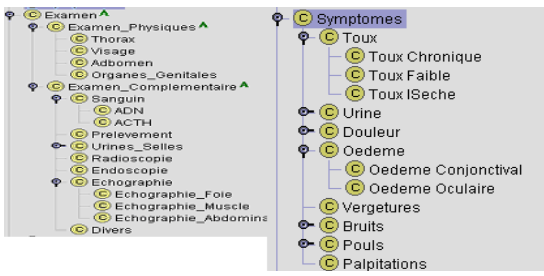

Figure 16. Excerpt of the ontology implemented under protege2000

C. Implementation of the other modules

Each knowledge (illness, diagnosis, social context, symptoms, etc.) constitingt the base was implemented as a Java class, which permits easy composition of a pathology case from the illness objects, symptom, examination, etc. The working of the system asks from time to time for one or several access to the BC (XML file), that is made through the parser of file, XML JDOM.

VIII. RESULTS

A. Implementation virtual patient with VRML

1) The skeleton

The implementation of this skeleton consists of defining every joint like an object joint, of the H-Anim standard. In the VRML language, we got the skeleton of figure 17.

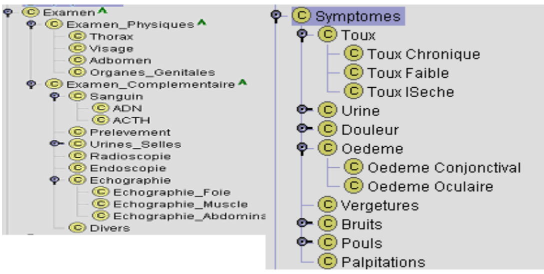

Figure 17. skeleton of the patient: 1 - in face view 2 - in tilted view

2) Dressing of the skeleton

It was question to cover the previous skeleton of a layer simulating the skin (figure 18)

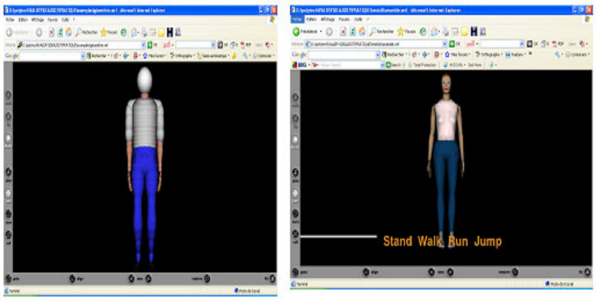

Figure 18. a) Musculature of the patient b) result after dressing with a layer of skin

B. A few scenario of use of the system

1) Expert

a) Expert's welcome interface

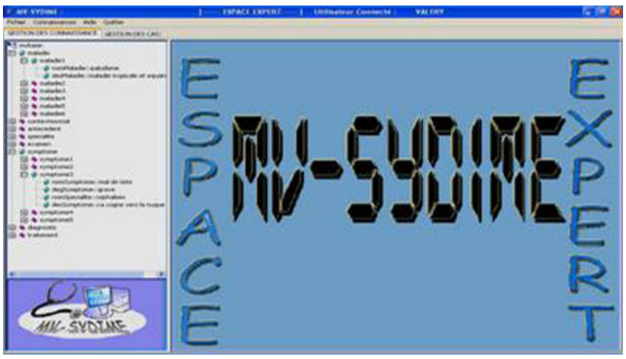

Figure 19. Space of the expert

b) Scenario of case composition

The expert first of all creates the different knowledge bases which he will need: example the registration of a symptom (figure 20).

Figure 20. Registration of a symptom

He can compose a case of pathology with the different knowledge bases. From it, he goes to the tab management of the cases and to be informed on the new case to create. He validates and gets the screen according to what suits him then makes a right click on a concept to take "add to the case" in the contextual menu (illustration on figure 21);

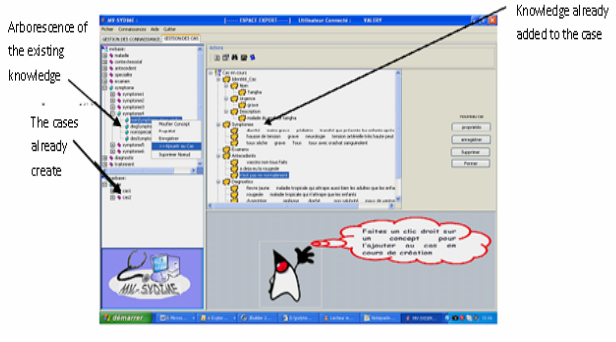

Figure 21. Composition of a case

2) Teacher

Creation of question: an example with Multiple Choice Question (MCQ)

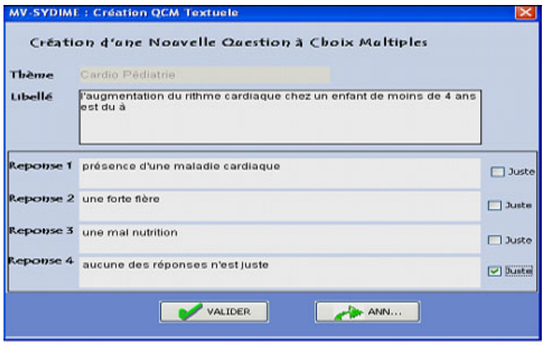

Figure 22. Interface of creation of a QMC by the teacher

3) Learner

The main usage of the system by the learner is for consultation: we have below, a session for consultation. On the right we have the questions of the learner and the answers given by the patient. The picture below presents an example of dialogue between the learner and a patient, during a consultation.

Figure 23. A session of consultation of a patient by a learner

IX. CONCLUSION

The survey presented in the state of the art evidenced by the necessity to develop a virtual patient to integrate it in the systems to come. It must pass by through modelling and a human's implementation (humanoid). But a human being is a lot too complex to be modelled in its entirety. The problem consisted then in representing, according to the aimed application (here the training), what is necessary. Indeed, although the human body can be divided in three layers: the skeleton, the muscles and skin; the skeleton himself is composed 206 bones besides. The introduction of levels of details was then an obligatory passage in the human's representation. A stake of our work was therefore, to propose a simplified representation of the reality, that preserves nevertheless the essential features necessary for a correct restitution of the human movement.

We use techniques of Virtual Reality that gave us the possibility to represent a humanoid with the VRML language.

Finally, this work permits to realize the complexity, and the multiple challenges covered with the problematic of help to physician's training, this through the patient's modelling for their practice. We hope to have brought our contribution to the realization of this challenge:

- The first is the survey of the human modeling, that, it is necessary to mention asked it a lot of courage: because it requires some notions of anatomy, biomechanics, anthropology, mathematics, survey compartment of the human beings, etc.;
- The second is the modeling of the muscles of the face, thanks to the method of the 3D pseudo muscles, for the management of the patient's emotions,;
- The third is the implementation and the patient's animation (humanoid) in an environment, making the training a little realistic,;
- The fourth is the design and the implementation of a system for the patient's test (MV-SYDIME); who reminds it, is not finished completely, but that permits already to test the patient's reactivity.

X. PERSPECTIVES

This work remains open to new perspectives:

- finalize the management of the patient's emotions, and implement several other actions, for example asking him to lie down on a table for consultation, or to present any part of its body;
- currently, the questions that the learners ask the patients during the consultation, were meadow recorded in the knowledge base, it would be interesting to let the learners the possibility of typing questions, and therefore we must implement a module of the natural or pseudo natural language processing;
- finalize the implementation of the emotional educational agents, that will monitor learners all along their training;
- design and implement a virtual, complete enough environment, representing the physician's office, and containing the tools used such as the thermometer, the high-blood pressure meter, the stethoscope, a table of consultation,;
- Finally, we think about to adapt the system so that it turns on one platform web, and becomes therefore deployable in an intranet.

REFERENCES

[1] Microsoft. diagnostic médical, encyclopédie encarta edition, 2006.

[2] C. Tangha, F. Tietche, B. Batchakui, R. Yatchou. Educational agent for the medical diagnosis. Acts of the SIGE symposium, pages 195 to 208, of the 22 to October 25, 2001. (Ed Pr Tchuente).

[3] Valery MONTHE. Modelling of a virtual patient for the medical diagnosis apprenticeship. faculty of the sciences, University of Yaounde 1, Master's thesis in Computer science, 2010. 77 pp

[4] J. Ferber. The multi-agents systems, toward a collective intelligence. InterEditions, 1995.

[5] C.K Reisbeck and R.C. Schank. Inside Case-Based Reasoning, 1989.

[6] Alexander TOPOL. Vrml, survey, implemented and application. Master's thesis, CNAM, July 2001. 163 p.

[7] Zeinabou LABARANG. Specification and realization of an interactive system of help to the pose of the medical diagnosis. National Hight School Polytechnic of Yaoundé, Master's thesis in Computer science, 2005. 65 pp

[8] R. Nkambou, F. Tietche, R. Yatchou, C. Tangha. Emotional agent for the medical diagnosis. Convention of the French-speaking association for the Knowledge, ACFAS2004, 10 to May 14, 2004. UQAM, Montreal, Canada.

[9] Garg A. and P.S.Walker. Prediction of total knee motion using a 3d computer graphics model. Journal of Biomechanics, 23(1) :45 à 58, 1990

[10] Matt Cordner J. P. Lewis and Nickson Fong. Pose space deformation: A unified approach to shape interpolation and skeleton-driven deformation. Proceedings of SIGGRAPH. 00, ACM Computer Graphics, pages 165 à 172, July 2000. ACM Press/Addison-Wesley Publishing Co.

[11] Luciana Porcher Nedel. Anatomic Modeling of Human Bodies Using Physically-Based Muscle Simulation. PhD thesis, EPFL Lausanne, 1998.

[12] Luciana Porcher Nedel and Daniel Thalmann. Anatomic modeling of deformable human bodies. The Visual Computer, pages 306 à 321, 2000.

[13] Jane Wilhelms and Allen Van Gelder. In proceedings of the 24th annual conference on computer graphics and interactive techniques. In ACM Press/Addison-Wesley Publishing Co., editor, Anatomically based modeling, pages 173 à 180, August 1997.

[14] N. Ying and W. Kim. Bioengineering conference proceedings. In Summer Snowbird, Utah, editor, Use of dual euler angles to describe general spatial movements of human joints, pages 273 à 274. volume 50, 2001.

[15] Daniel Thalmann. Animation par ordinateur. Technical report, EPFL Suisse, support de cours d.infographie, Master II, Juin 2002. 52 pp.

[16] S. Akkouche and Al. The virtual human. theme 1: modelling. December 2004. LIRIS-UCB Lyons.

[17] C. Stone K.Waters. A muscle model for animating three-dimensional facial expression. Computer Graphics (Siggraph proceedings), vol. 21 :17 à 24, 1987.

[18] Valeri Ficet-Cluchard. Realization of a help system to the design of applications of Treatment of pictures: an approach based on the Reasoning from Case. PhD thesis, University of Caen, Phd Thesis, January 1999.

[19] http:// www.statistiques-mondiales.com/medecins.html, Janvier 2010

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