Simulation of da Vinci Surgical Robot Using Mobotsim Program

Marius-Constantin O.S. Popescu Nikos E. Mastorakis

Abstract:-This paper presents a simulated control applications and remote perception, generically called telepresence and teleoperare. In essence, it is transmitted remotely by the IT environment, the signals captured by equipment and controls to the equipment, decided by an operator or an automatic system. In general, sending commands to remote equipment is called teleoperare, who decides whether the control is a human operator or an automatic driving system. An important issue of medical world concerns the creation of systems for online medical parameters monitoring. The solution is to pervade into computing systems which have the capabilities of monitoring, data acquisition and data transfer from medical devices. We describe in this paper the use of integrated planning and simulation for robotic surgery.

***Keywords*:**-Applications of telepresence, Biological parameters, Computing systems, Simulation, Mobotsim software.

I. INTRODUCTION

According to Webster's encyclopaedia, a robot is "an automatic device that performs functions normally assigned to men, or a machine with human resemblance". Another definition was given by the Robotics Institute of America in 1979. Under this definition, a robot is "a reprogrammable machine, multifunctional designed to move materials, pieces, tools or specialized devices through various programmed motions for achieving a large variety of tasks. A short and widely accepted definition today is: a robot is an intelligent system that interacts with the physical environment through sensors and effects.

We can distinguish different types of robots [7]: androids, robots built to mimic human behaviour and appearance; static robots, robots used in various factories and laboratories such as robot arms; mobile robots, robots moving in an environment without human intervention and targets achieved; autonomous robots, robots perform their tasks without intervention by a human operator and obtain their energy needed for the functioning of the environment; tele-robots, robots that are guided by remote control devices by a human operator.

What is a mobile robot? A mobile robot could be described as a robot that must move in a certain environment, without a human operator, and to perform certain tasks given by him. So its main feature is mobility.

What is teleoperating? Sending commands to a remote device is called teleoperare, who decides whether the controls are a human operator or an automatic driving system. Scope:

a) Detection of landmines (Fig.1). One of the serious humanitarian problems facing modern civilization is an antipersonnel mine. Only in 2008 have been destroyed 100,000 mines, but another 2.5 million were placed (particularly in South East Asia). Destruction of these mines is a dangerous and costly operation [5], [10].

Fig. 1: Example of robot used in the detection of landmines.

b) Inspection of nuclear contaminated areas (Fig. 2). Following a nuclear accident should be inspected and evaluated the accident damage. Because usually the core status is unknown, the possible consequences of radiation or sending a mobile robot is preferred for assessment of damage [1].

Fig. 2: Example of robot used in the inspection of nuclear contaminated areas.

c) Intervention for bomb threat (Fig.3). In civil protection, mobile robots are used to occur in crowded places

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(airports, railway stations, markets, etc.). To detect and neutralize some explosive devices trap (packages, briefcases, etc.).

Fig. 3: Example of robot used in intervention for bomb threats.

d) In space research (Fig.4). Since the '60s space research institutes have investigated the possibility of applying technology teleoperare of mobile robots in space research [6].

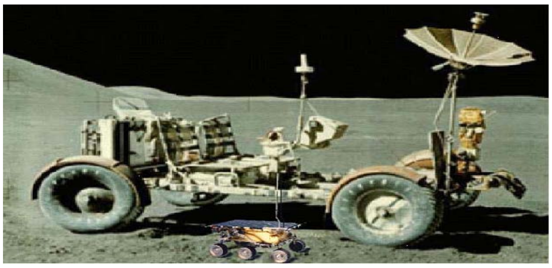


Fig. 4: Example of robot used in space research.

e) Pipe inspection (Fig.5). Pipe inspection systems usually consist of several parts: mobile robot platform that provides movement, a typical video camera mounted on a device that allows you to rotate and tilt it and the tools necessary to perform other tests or repairs.

Fig. 5: Example of robot used in pipe inspection.

f) Field underwater (Fig.6). They usually operate at relatively large depths of up to 7000-8000 m depth. Some common applications include: mapping, detection of shipwrecks, return to the surface of various objects, inspection Wreck (Magellan 725 was used several years ago in an investigation related to the sinking of a cargo vessel as it is shown that the vessel was deliberately sunk collection of insurance premium).

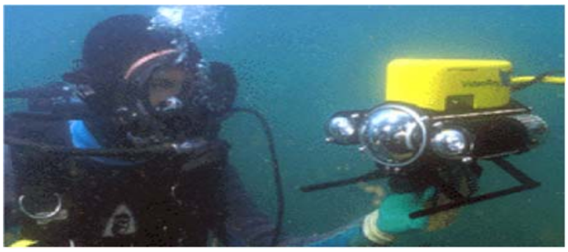


Fig. 6: Example of robot used in the underwater.

g) The military (Fig.7). In military, using the mobile robots brings many benefits. It can carry out reconnaissance, espionage without risking the loss of troops (or to divulge information to their capture), logistic support (transportation of ammunition, medicines, fuel), medical evacuation of wounded soldiers, search and rescue operations, etc.

Fig. 7: Example of robot used in military field.

f) Healthcare. They occur in surgical operations [8]. To reduce hospital expendure sometimes it is reasonable to monitor patients at home rather than in hospital [1]. This study overviews the necessity of patients or elderly people to monitor constantly some biomedical parameters. A reason of use for automated data capture systems is a patient being monitored from home where they will be able to transfer their reading online without involving medical professionals. The medical measurement devices which are realized on basis of optoelectronics and microwave, and the adaptation and use of these devices or sensors in instrumentation systems and tele-communications are taken into account in this paper [2], [3]. To monitor patients at home it could be a sustainable and practical solution [1], by utilising existing medical devices and by using their connectivity together with appropriate software modules. It means that the developed software modules will allow building flexible systems for medical devices which are monitoring, measuring, recording, storing, processing and transmitting different human biological parameters [4], such as: blood pressure, oxygen saturation, body temperature, cardiac rhythm, respiratory rhythm, pH data, ECG channel, fetal heart rate and uterine contractions of labor. With already over 210 devices in use throughout the United States, Europe, and Japan, Intuitive Surgical is the leading company in the field of digital surgery with its da Vinci Surgical System.

Approved in 2000 to perform advanced surgical techniques such as cutting and suturing, this system is the first operative surgical robotic system to be cleared by the FDA, giving it a first-mover advantage over its competitors. Though Intuitive Surgical has had to overcome many obstacles in order to dominate the digital surgery field, it is now a multimillion-dollar business that continues to grow.

II. SYSTEM OVERVIEW

Making a one-centimeter keyhole incision to perform the operation, the surgeon is able to engage in minimally invasive surgery through this system (Fig. 8). According to Ben Gong, Intuitive Surgical's vice president of finance, da Vinci reduces the average 2-3% infection probability to nearly zero. There are four main components to da Vinci: the surgeon console, patient-side cart, EndoWrist Instruments, and Insite Vision System with high resolution 3D End-oscope and Image Processing Equipment (Fig. 9).

Fig. 8: System Owerview.

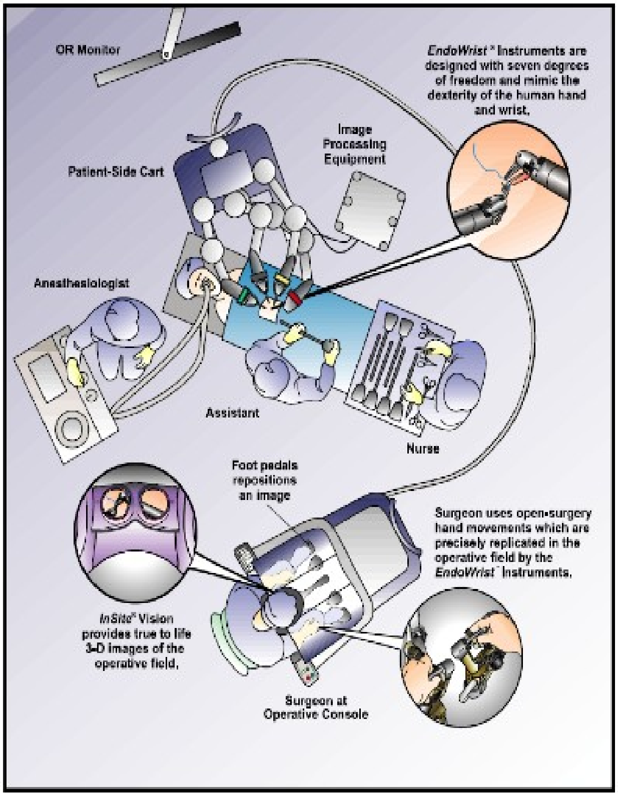


Fig. 9: da Vinci Surgical system in a general procedure setting.

Surgeon Console. The surgeon is situated at this console several feet away from the patient operating table. The surgeon has his head tilted forward and his hands inside the system's master interface. The surgeon sits viewing a magnified three- dimensional image of the surgical field with a real-time progression of the instruments as he operates. The instrument controls enable the surgeon to move within a one cubic foot area of workspace (Fig. 10).

Patient-side Cart. This component of the system contains the robotic arms that directly contact the patient. It consists of two or three instrument arms and one endoscope arm. The feedback as of today is limited to sensing tool-on-tool collision, so the surgeon needs to rely almost solely on the visual field when suturing or contacting soft tissue.

Fig. 10: Surgeon Console.

As of 2003, Intuitive launched a fourth arm, costing $175,000, as a part of a new system installation or as an upgrade to an existing unit. It provides the advantages of being able to manipulate another instrument for complex procedures and removes the need for one operating room nurse (Fig. 11).

Fig. 11: Patient-side Cart.

Detachable Instruments. The Endowrist detachable instruments allow the robotic arms to maneuver in ways that simulate fine human movements. Each instrument has its own function from suturing to clamping, and is switched from one to the other using quick-release levers on each robotic arm. The device memorizes the position of the robotic arm before the instrument is replaced so that the second one can be reset to the exact same position as the first. The instruments' abilities to rotate in full circles provide an advantage over non-robotic arms (Fig. 12).

Fig. 12: Endowrist Instruments and Intuitive Masters.

The seven degrees of freedom (meaning the number of independent movements the robot can perform) offers considerable choice in rotation and pivoting. Moreover, the surgeon is also able to control the amount of force applied, which varies from a fraction of an ounce to several pounds. The Intuitive Masters technology also has the ability to filter out hand tremors and scale movements. As a result, the surgeon's large hand movements can be translated into smaller ones by the robotic device. Carbon dioxide is usually pumped into the body cavity to make more room for the robotic arms to maneuver.

3-D Vision System. The camera unit or endoscope arm provides enhanced three-dimensional images. This high-resolution real-time magnification showing the inside the patient allows the surgeon to have a considerable advantage over regular surgery. The system provides over a thousand frames of the instrument position per second and filters each image through a video processor that eliminates background noise (Fig. 13).

Fig. 13: Insite Vision and Navigator Camera Control.

The endoscope is programmed to regulate the temperature of the endoscope tip automatically to prevent fogging during the operation. Unlike The Navigator Control, it also enables the surgeon to quickly switch views through the use of a simple foot pedal.

III. MARKET INFORMATION OF THE ROBOT SURGICAL SYSTEMS

Just a few years ago, Intuitive Surgical was in the midst of a fierce legal battle with its competitor, Computer Motion. The series of events was offset by a lawsuit filed by Computer Motion for nine patent infringements. Intuitive Surgical then filed three lawsuits of its own and made a final blow by teaming with IBM to sue its competitor for infringing on its voice-recognition technology. Computer Motion lost the case for this integral component of all its devices including Zeus, its version of da Vinci. It faced a major problem since it would have to stop selling in the event that it could not receive a proper license from its competitor. On March 2003, Intuitive Surgical merged with its main competitor, ending a four-year legal power struggle that detracted from product advancement and funds. Intuitive Surgical paid $150 million for Computer Motions and laid off around 90% of its employees following the merger. Intuitive now owns and will market Computer Motion's products (Zeus Surgical System, Hermes Control Center, Aesop Robotic Endoscope Positioner, and Socrates Telecollaboration System).

Tab. 1: Former computer motion systems that are now owned by intuitive surgical [7].

Equipment	Costs	Company	Equipment Descriptions
da Vinci Surgical System	$1 million	Intuitive Surgical	Robot-assistant, with arms to connect surgical instruments
Zeus Robot Surgical System	$975,000	Computer Motion	Robot-assistant, with arms to connect surgical instruments
Aesop 3000	$80,000	Computer Motion	Voice-controlled endoscope-positioning robot
Hermes Control Center	Request price quota	Computer Motion	Centralized system used to network an intelligent OR
Socrates Robotic Telecollaboration System	Request price quota	Computer Motion	Allows shared control of Aesop 3000 from different locations

Advantages and Disadvantages. The da Vinci Surgical System reduces hospital stays by about half, reducing hospital cost by about 33%. These fewer days in the intensive care unit are a result of less pain and quicker recovery. Though the size of the device is still not small enough for heart procedures in children, the minimally invasive nature of da Vinci does not leave a large surgical scar and still has some limited applications in children for the time being. Moreover, according to Intuitive Surgical, only 80,000 out of 230,000 new cases of prostate cancer undergo surgery because of the high risk invasive surgery carries, implying that more people may undergo surgery with this evolving technology. The main drawbacks to this technology are the steep learning curve and high cost of the device. Though Intuitive Surgical does provide a training program, it took surgeons about 12-18 patients before they felt comfortable performing the procedure. One of the greatest challenges facing surgeons who were training on this device was that they felt hindered by the loss of tactile, or haptic, sensation (ability to “feel” the tissue). The large floor-mounted patient-side cart limits the assistant surgeon’s access to the patient. However, there are also many who are unable to access the da Vinci based on the steep price. In a paper published by The American Journal of Surgery, 75% of surgeons claimed that they felt financially limited by any system that cost more than $500,000. As of now, surgery with the da Vinci Surgical System takes 40-50 minutes longer, but the FDA considered this a learning curve variable and expects time to improve with more use of the system.

Costs. Though Intuitive Surgical has faced some setbacks during its legal battles with Computer Motion, it has recovered quickly and has been growing at an unprecedented rate since the merger. The total sale for the first year of 2004 was $138.8 million (a 51% increase from the previous year) with a total of $60 million in revenue. This includes recurring revenue from instruments, disposable accessories, and services, which have also increased accordingly in response to the larger number of systems installed and greater usage in hospitals. In 2004 alone, 76 da Vinci Systems, each costing about $1.5 million, were sold [9].

Tab. 2: Estimate of initial investment and cost savings per heart-valve surgery for da Vinci market price [8].

Maintenance/year Physician Training	$1 million $100,000 $250,000
Cost of one inpatient hospital day	$2,000
Reduced inpatient hospital days for heart procedures	4.5 days
Cost saving per heart procedure due to reduced hospital stay	$9,000 per heart valve
Extra procedure cost	$2000 more per operation
Surgical assistance	$175,000 for fourth arm (Compared to $80,610 per year for extra OR nurse)

Medical reimbursement by insurance companies is specific to each respective company. However, Medicare reimbursement is available for laparoscopic and thoracoscopic procedures since the da Vinci Surgical System has been FDA approved for commercial distribution in the United States.

Tab. 3: FDA Approval [10].

Date	Procedure
April 2005	Gynecological Laparoscopic Procedures
January 2003	Totally Endoscopic Atrial Septal Defect (ASD)
November 2002	Mitral valve repair surgery
November 2002	Thoracoscopically-Assisted Cardiotomy Procedures, K022574
July 2000	General Laparoscopic Surgery (gallbladder, gastroesophageal reflux and gynecologic surgery), K990144
March 2001	Thoracoscopic Surgery (IMA Harvesting for Coronary Artery Bypass and Lung surgery), K002489
May 2001	Laparoscopic Radical Prostatectomy, K011002
July 1997	Surgical Assistance, K965001

Safety concerns remain the center of focus for Intuitive Surgical. To start the procedure, the surgeon’s head must be placed in the viewer. Otherwise, the system will lock and remain motionless until it detects the presence of the surgeon’s head once again. During the procedure, a zero-point movement system prevents the robotic arms from pivoting above or at the one-inch entry incision, which could otherwise be unintentionally torn. Included in the power source is a backup battery that allows the system to run for twenty minutes, giving the hospital enough time to reestablish power. Each instrument contains a chip that prevents the use of any instrument other than those made by Intuitive Surgical. These chips also store information about each instrument for more precise control and keep track of instrument usage to determine when it must be replaced. Besides the cost, the da Vinci Surgical System still has many obstacles that it must overcome before it can be fully integrated into the existing healthcare system. From the lack of tactile feedback to the large size, the current da Vinci Surgical System is merely a rough preview of what is to come. More improvements in size, tactile sensation, cost, and telesurgery are expected for the future.

IV. MATERIALS AND METHODS

The chain requires cooperation between the radiologist, cardiologist, surgeons and researchers in robotics, and computer images [15]. The first step is to provide a model of the patient and the robot suitable for computer use. Then, in an interactive manner, the surgeon will describe these models on the aims of the intervention in order to translate them into mathematical criteria. Finally, an optimization of these criteria will lead to the location "ideal" points of incision and the position of the robot. These results, provided and verified automatically, are validated by the surgeon in virtually repeating the intervention. All stages of the approach detailed below are integrated into one system, accessible through a single interface [5]. The first step is to represent the working environment, since the positioning of the robot, and therefore the success of the intervention, depend on it. This is to provide geometric models (which are suitable for computer use) of the organs of the patient and the robot, and their geometric relationship to the operating theater.

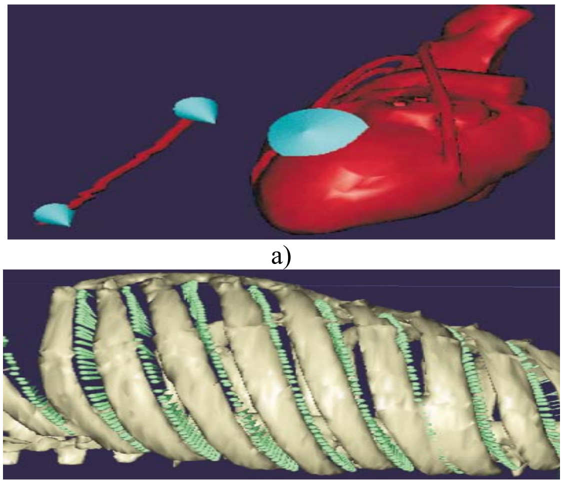
Patient data. An acquisition scanner with injection of a contrast product, synchronized with the electrocardiogram, provides a comprehensive view of the chest of the patient. The data are processed with methods of image analysis to extract surface models corresponding to different anatomical entities involved: heart, chest, left mammary artery. Together, the left coronary tree can be modeled in 3D from a consideration of coronary angiography and may be subsequently merged with the surface model of the heart to enrich the procedure [10].

Modeling of the robot. A sufficiently realistic reproduction of the movements of the robot is obtained using the geometric model of the support and tools added some features, like the joints of the robot stops. In addition, an algorithm for detecting collisions provides contact between the manipulator arms.

In order to optimize the location of incisions, the surgeon says on anatomical models reconstructed on patient the areas over which it wishes to operate, and a preferred direction. These target areas are represented in the simulator by cones indicating the direction and surface operating privileged as shown in Fig.14a. They then delineate the parts on which cuts can be made. In the case of CABG, this area is limited to the intercostal spaces (see Fig. 7b), where each point is calculated normal to the surface of the skin.

Location of incisions. Among the points of Fig.14b, some will be selected as candidates for an incision, they are called *admissible points*. These items should check the following properties:

- the distance between the point of entry and target point (d in Fig.15a) must be understood within a typical manipulator arm;


a)

b)

Fig.14: a) The surgeon selected the areas where he wants to intervene with a suitable interface; b) the intercostal spaces are the potential entry points of the instruments.

- the angle between the line joining a point target candidate and the normal to the target (α in Fig.15a) is as small as possible to facilitate the surgical gesture;
- the angle between the line joining a point target candidate and the normal to the skin (in Fig. 15a) must be small enough not to damage the ribs.
- no obstacle should impede access to the targets, as is the case in Fig.15b. The method used to detect collisions based on the reference [8].

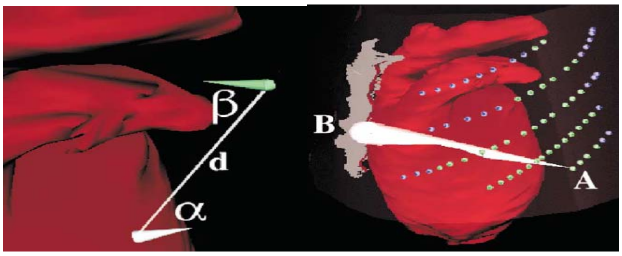


Fig. 15: a) Different measures used to define points eligible; b) one of the tests of eligibility.

Among the eligible, the triplet of points that offer the best dexterity and comfort to the surgeon is sought. This triplet should under no circumstances lead to a crash or lock up. To do this, each eligible item is assigned a measure of dexterity, which corresponds to the angle α in Fig. 15a, valid for both tools and for manipulating the endoscope. The optimum location of the endoscope is first determined on this basis. The triplet is then completed by the pair of points allowable better dexterity that respects the symmetry of right and left arms of the surgeon.

Positioning of the robot. The problem of positioning of the robot is to find an initial configuration of the manipulator arms that can reach all the targets and to perform all the necessary paths to the operating performance of the gesture, without causing collisions (in the arms or with another anatomical entity such as the shoulder). This position of course should match the location of the previous section. To do so, these constraints are formalized and associated with a cost function, the cost of a collision is infinite. Some constraints are harder to express than others, for instance, collisions with the operating environment, which varies depending on the rooms. Then, this function is applied to randomly selected configurations in the space of configurations of the robot. A gradient algorithm is used for hidden refine the selection of configurations and lead to minimizing the cost function and therefore corresponds to the highest position of the robot depending on the data. This method is described in more detail in [6].

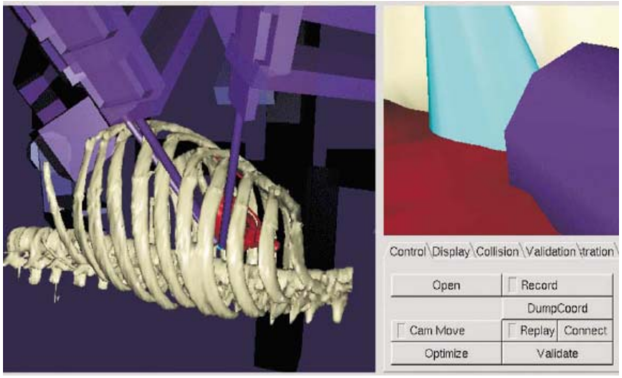


Fig. 16: The interface in simulation mode, the illustration shows the external view and the endoscopic view, only available during the intervention.

The ultimate validation of the proposed positioning is obtained by simulation (see Fig.16). With a navigation device in three dimensional (3D mouse or master console connected to the robot simulator), the user can move the virtual robot in the anatomical models of the patient. During this phase, the surgeon may also experiment with different operating strategies and "repeat" his gesture is familiar with the anatomy of the patient and the robotic tools. This feature will also be very useful for learning gesture. At surgery, the robot must be positioned relative to the patient as suggested by the results of planning. This registration is done by matching points identified on the patient and in the simulator. With an interface for connecting to the robot, we can use the robot to point these areas and determine their exact position (see [6]). We can place the patient in relation to the robot and the position in accordance with planned results. The accuracy of this shift is equal to the precision of position sensors of the robot. Consider a margin of error when planning allows to proceed safely. In addition, the statement is recorded and can be replayed later in the simulator. This recording is used for evaluation and archiving of the intervention. All steps described above are integrated into one system with a single user interface, which will be used by both the radiologist, the cardiologist and the surgeon [2]. This unification of tools simplifies their use and gives more rigorous approach.

V. RESULTS AND DISCUSSION

Our approach has been tested on a plastic phantom torso and heart, previously scanned, with the coronary arteries and mammary represented by a radio-opaque material. Types of locations were chosen on the heart and breast to identify targets of intervention and get the best positioning of the robot. This position was automatically checked and validated successfully in simulation. Then the key stages of the intervention, the dissection of the mammary artery and the coronary bypass, were performed by the surgeon from the master console on the plastic model. The evaluation of positioning by the surgeon was very satisfactory, and no collision or other problems were observed. The Figs. 17 and 18 show the location of incisions and the corresponding positioning of the robot in virtual mode and the ghost.

Fig. 17: Result of the port location and positioning of the robot.

These results are very close to those obtained by an empirical investment made by the surgeon. However, we must not forget that in the case of this experiment, the surgeon is working on a ghost transparent and pliable, which he could test and adapt the positioning of the robot. This is not the case with a patient, because the goal will be to do that three incisions. We must therefore ensure that the procedure will be possible through these incisions without the robot is in collision or stop.

Fig. 18: Application of the results of planning ghost.

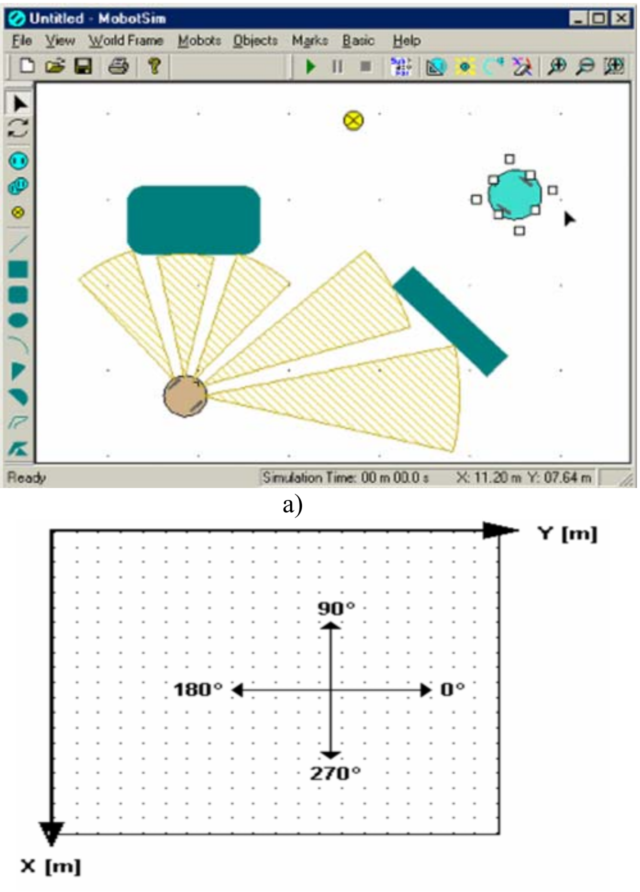
Although dexterity obtained is very encouraging, it should be noted that this experiment was performed on a simple phantom (chest or shoulder without diaphragm). It remains to be complexify the ghost to take into account possible limitations in the choice of eligible points, which makes optimization more difficult. The ghost is being improved to become more realistic, allowing for more complete validation of our approach. It is also important to note that the shift remains to refine and simplify [12-14].

VI. SIMULATION OF MOBILE ROBOT

Two simulations were done in a special program designed for applications with mobile robots called Mobotsim conducted Mobotsoft Company. Programming language used is Visual Basic for compatible applications and includes a set of specific functions for programming robots, such as for example [11], [17], [18]: `SetTimeStep(…)`, `SetWheelPosition(…)` etc. Thus, in addition to the basic instructions that you use Visual Basic's (`If...Then...Else, For...Next,` etc..) Was extended "with an adequate language to be dealing with simulated robots (`SetMobotPosition (...),(...) MeasureRange etc).`

Main Screen. The main screen at Mobotsim show the box (the) main (World Frame) that can add elements such as robots, objects, signs, etc. Main box (Fig. 19), is a two dimensional region and is working environments for robots (operating space itself). First time to run, start with a Box Main Mobotsim default, with size of 20x20 m, but we can resize later with the new desired values for the document. Main box uses a standard Cartesian coordinate system in meters and degrees, and the origin is upper left corner as shown in Fig. 19b.

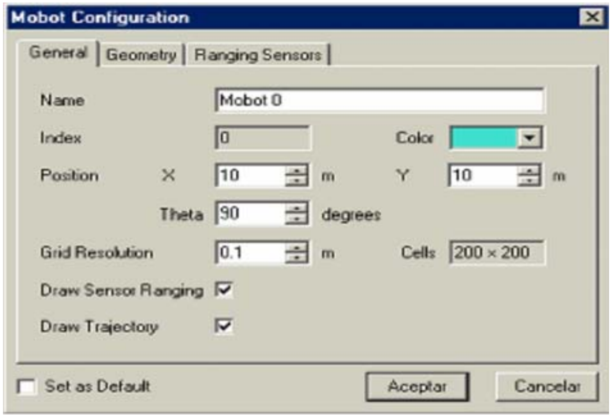
Configuring robots. Configuration window allow robots to edit all properties of a robot. These properties are grouped into three categories: General, Geometry and Ranging Sensors as shown in Fig. 20.



a)

b)

Fig. 19: Example of robot used in military field.

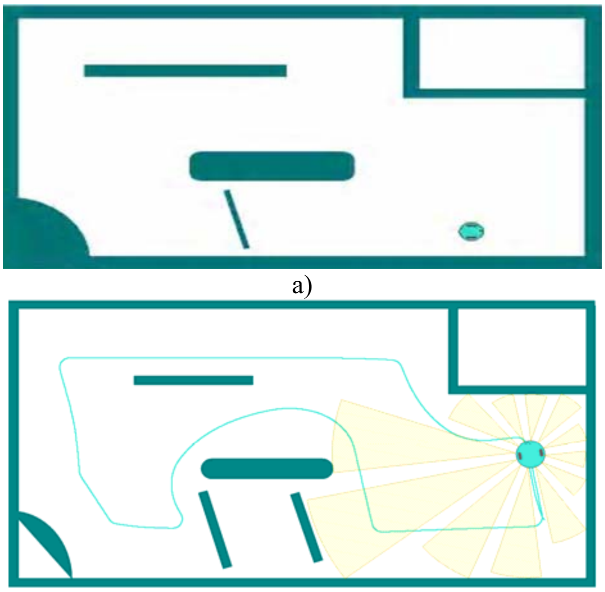


Name Mobot 0
Index 0 Color
Position X 10 m Y 10 m
Theta 90 degrees
Grid Resolution 0.1 m Cells 200 × 200
Draw Sensor Ranging ☑
Draw Trajectory ☑
☐ Set as Default Aceptar Cancelar

Fig. 20: Window for configuring robots.

Name: Each robot has a unique name, a string of maximum 30 characters. In setting the new robots are called: Mobot 0, Mobot 1, 2 ..., but their names can be changed at any time.
Index: Integer is a number unique to each mobot and is designated by Mobotsim dynamically added or deleted when robots and can not be changed by the user.
Position: Robot platform allows choosing colour, determines the colour of the robot trajectory.
X, Y, *Theta Position*: Determines the position and orientation of the robot in Main box, X and Y are given in meters, and Theta in degrees.
Draw Sensor Ranging: If checked, reading sensors milestones is drawn while running. Also they will be drawing as a reference while editing the Main box.
Draw Trajectory: If checked, the robot trajectory is drawn while moving.
Platform Diameter: Allows you to change the circular platform of the robot, which is given in meters.
Distance between wheels: Allows you to change the distance between wheels, from centre to centre along the axis.
Wheels diameter: Allows you to change the wheel diameter, which is given in meters.
Radiation Cone: Radiation sensors benchmarking is approximated by a cone. This value is the angle sector is represented by that con-dimensional.
Range from-to: Sets minimum and maximum distance that a sensor can read.

First simulation. In the following we make a simulation in which a robot will follow exactly the route drew new walls will stake through the obstacles, and its final aim is to establish a route. The first step we will do is to build a kind of 'map' in the box we mainly used forms are available in Toolbox (Fig.21a). After we made this map we have no choice but to realize our program to enable our robot to perform “mission” [16]. To write our program we have to open the Basic editor. The first thing the robot needs to follow exactly the wall is to take knowledge about the working environment. Thus we will use sensors benchmarking or division (ranging sensors) to measure the distance from the obstacles they encountered. In this simple algorithm we use only one sensor, namely sensor number 4. For this we use the following instructions: `s=MeasureRange(0,4,0)`
The first parameter,, 0 "is the name of the robot, the second parameter,, 4" is the number of sensor that we used, and the third parameter is 0 "when no one wants to implement due to grid method”. Before reading the sensor is convenient to place the robot in a position enabling it to detect a wall.



a)

b)

Fig. 14: a) The map was built in the Main box; b) The trail that leds to the robot.

According to the picture we created the environment to place the robot 0 ex: coordinates X=13, Y=12.5, and orientation angle=0 degrees, with instruction `SetMobotPozition:SetMobotPosition(0,13,12.5,0).`

The code written in Basic Editor has the following form:

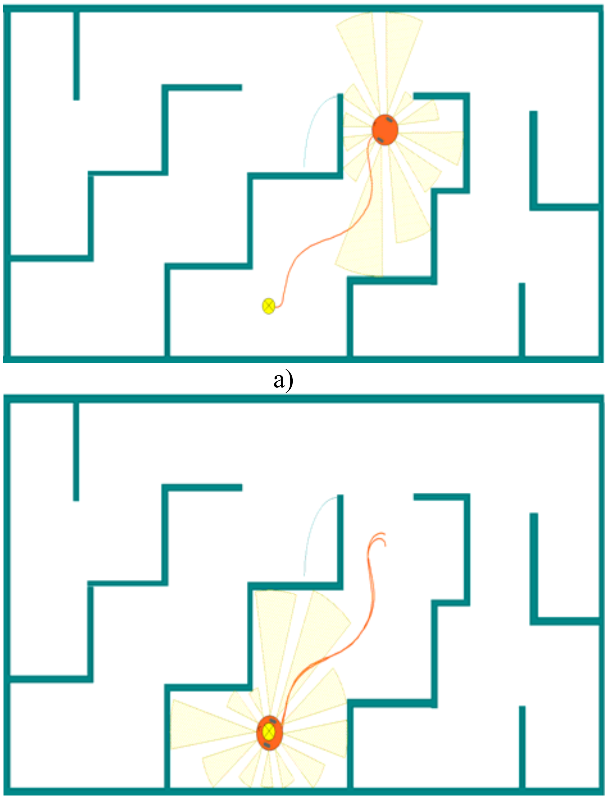
```
Sub Main
  SetMobotPosition(0,13,12.5,0);
  s=MeasureRange(0,4,0)
End Sub
```

Now the robot can „see” working environment. A simple algorithm could be the following: if the robot is too close to the wall, then turns to the left; if the robot is too far from the wall, then turns right; otherwise, go forward, translated in Visual Basic this shows thus:

```
If s<0.7 Then SetWheelSpeed(0,0,10)
ElseIf s>0.9 Then SetWheelSpeed(0,10,0)
Else SetWheelSpeed(0,10,10) EndIf
```

Simulation of the robot is now ready, all that remains is we'll test it to see him conduct by pressing „play” for simulation (Fig.21b).

Second simulation. In the following, we will draw a different map for our robot, so we'll write another program to enable besides establish a specific path to reach a specific target (a sign). So his mission is to avoid what he runs into obstacles and reach, the target point (Fig. 22).



a)

b)

Fig. 22: a) The route followed by the robot; b) The robot is reaching the goal pursued.

The program in Visual Basic is:

```
Sub Main
DimPI,Fcr,Fct,X_target,Y_target,X,Y As
Single;
Dim X_grid,Y_grid,i,j,C As Integer
Dim Frx,Fry,d,dist_targ,rot,Fx,Fy As
Single; Dim Fcx,Fcy,Rx,Ry As Single
PI=3.1415927;Fcr=1`Force constant
Fct=1`Force constant(attraction)
X_target=GetMarkX(0)
`Target coordinates(mark 0);
 Y_target=GetMarkY(0)
End Sub
SetCellSize(0,0.1)'Set cell size 10x10cm
SetTimeStep(0.1)
'Set simulation time step of 0.1 s
Do 'Start main loop
X=GetMobotX(0);Y=GetMobotY(0)
'Present mobot coordinates
X_grid=CoordToGrid(0,X);
Y_grid=CoordToGrid(0,Y)
'indexes of cells where the mobot center is
'MeasureRange(0,-1,3)
'Perform a range scan and update the
'Certainty Grid (max. cell value=3)
Frx=0;Fry=0 'Repulsive Force (x comp and y)
'Each occupied cell inside the windows of
'33x33 cells applies a repulsive force
For i=X_grid-16 To X_grid+16
For j=Y_grid-16ToY_grid+16 C=GetCell(0,i,j)
If C<>0Then d=Sqr((X_grid-i)^2+(Y_grid-j)^2
If d<>0 Then Frx=Frx+Fcr*C/d^2*(X_grid-i)/d
Fry=Fry+Fcr*C/d^2*(Y_grid-j)/d
End if
      End if
      Next
      Next
dist_targ=Sqr((X-X_target)^2+(Y-
Y_target)^2)
'The target generates a constant-magnitud
'attracting force
Fcx=Fct*(X_target-X)/dist_targ;
Fcy=Fct*(Y_target-Y)/dist_targ
Rx=Frx+Fcx; Ry=Fry+Fcy
'Resultant Force Vector
Rot=RotationalDiff(0,X+Rx,Y+Ry)
'shortest rotational difference between
'current direction of travel and direction
of vector R
SetSteering(0,0.5,3*rot) 'mobot turns into
'the direction of R at constant speed and
'steering rate proportional to the
'rotational difference
StepForward
'Dynamics simulation progresses time step
Loop Until dist_targ<0.1
'Loop until mobot reaches the target
End Sub
```

VII. CONCLUSIONS

The present paper addresses a topic of interest in present: teleoperate respectively telepresence. In general at present trend is towards distributed systems, for globalization applications. This is possible due to the development of computer technology, computer networks, etc. The primary objective of this study is to realize a link between Computer Science and Medical Equipments, in order to establish a reliable health care environment. The main purpose is to make possible to connect the medical measurement and monitoring devices to any type of personal computer and retrieve the measurements directly from devices.

The main distinguishing aspects of the device are a combination of self-training and mentoring strengthened introduction of a course of long-term - during the patient's education and training, consisting of modules for distance education easy opening a training system by issuing modules Independent. Three other objectives are covered through this distance learning: the strengthening of educational exchange within the network R2A by pooling various modules, the creation of partnership school / company around research and development projects carried by enterprises, development of the offer continuing education in Medicine Faculties. The method described is part of robotic surgical procedures minimally invasive. Today, these interventions are applied only the most adapted to the structure of the robot and the skills of surgeons. Our method offers a systematization of planning, integrating expertise multidisciplinary radiology, cardiology, surgery, robotics and image-vision. It also allows the simulation and the archiving of interventions and serves as a learning tool and validation preoperatively. We hope that this work will ultimately generalize the system to be more sensitive and reduce the rate of conversion to conventional surgery procedures that are blocked because of a bad investment or a collision. This integrated system should also allow to test new types of procedures. This work can be further developed and applied in different areas where human activity is difficult and sometimes impossible.

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