

Technology Cooperation Office of the Presidency



International Department

By introducing the Bulletins of “Iran Technological Potential” provided by Technology Cooperation Office of the Presidency (TCO), we intend to encourage international cooperation aiming at sharing technological resources with others. We would put forward more publications of such bulletins in different arenas of science and technology in near future.

As a matter of fact, science and technology has a global nature rather than local or even national, so geographic boundaries has been crossed and as a result, exchanging ideas and maintaining joint research activities has become crucial to many scientists and researchers all over the world. In addition, developments of electronic communication tools as well as IT advances facilitate this process as never before.

The main objective of these bulletins is to improve the international community’s knowledge about recent advances of Iran capacities and capabilities in Science and Technology and to facilitate technological collaborations with other countries.

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## ***What is laparoscopic surgery?***

Laparoscopic surgery refers to a special technique by which the surgeon performs the surgery through several small holes in the abdomen with the aid of a camera. It is also known as “minimally invasive surgery”. These incisions are much smaller than would have been required using traditional surgical techniques. Generally the operation that is performed is still the same operation, even though the incisions are much smaller. In this operation, presence of surgeon assistance is essential for laparoscopic conduction and support. This person could be replaced with a robotic arm in exhausted situation..

## ***What advantages does laparoscopic surgery have over conventional surgery?***

Laparoscopic surgery usually results in reduced hospital stays, fewer wound infections, less pain, and a faster recovery time. From a surgeon’s perspective, laparoscopic surgery may allow for easier dissection of abdominal scar tissue (adhesions), less surgical trauma, and improved outcomes in certain groups like the elderly and extremely overweight individuals.

*In experienced hands, laparoscopic surgery is a safe alternative to open surgery for the treatment of most gynaecological conditions.*

## ***Laparoscopic Surgery Robotic Assistant***

During last years, a new field has gained the interest of robotic researchers. Minimally invasive techniques, such as laparoscopy, have grown as a very suitable domain for robotic systems. In these procedures, the surgeon only uses the visual feedback information provided by a camera attached to the endoscope. Thus, the surgeon manoeuvres the laparoscope and video camera within the abdominal cavity to explore the anatomical structures and their pathologies. Since these procedures can last up to two (or even more) hours, the camera image can suffer a significant loss of stability. The centering on the point of interest can be worse, as well. In this scenery, a robotic aid, able of moving the laparoscopic camera according to surgeon’s voice commands (allowing him or her to use both hands in the surgical procedure itself), would become a very helpful tool in the operating room.

Laparoscopic techniques involve the use of long stem instruments through small incisions in the abdominal wall of the patient. A special camera, whose optic penetrates as well into the abdomen, helps the surgeon to manoeuvre the instruments in order to complete the procedure (Satava, 1998). Thus, we have two possibilities to develop a robotic aid: moving the instruments or moving the camera. Every one of these options follow a different target: robotized instruments can help us to achieve telesurgery, moving the surgeon from the operating room to a distant site; a robotic camera, however, can improve coordination and efficiency, and free a second surgeon (the one

who moves the camera) to help the main surgeon, or to carry out another procedure in a different operating room.

## ***Robolens:***

“ROBOLENS” helps the surgeon by holding and moving the laparoscopic lens (camera) under his/her supervision during the surgical operation. It can be controlled by Voice commands of the surgeon or by a smart foot switch system under his/her foot.

The project is accomplished and the robot has passed technical and clinical tests at the Imam Khomeini Hospital Complex.

Robolens is a New Design for Laparoscopic Surgery Robotic Assistant by Alireza Mirbagheri under supervision of Dr. Farzam Farahmand, and Dr. Ali Meghdari at Robotic Surgery Lab with cooperation of Sharif University of Technology- Mechanical Eng. Dept. & Tehran University of Medical Science- Research Center for Science and Technology in Medicine.

Robotic systems have been proved to be very useful in laparoscopic surgery; they are



more stable with no fatigue and inattention and reduce the supernumerary staff required, provide excellent geometrical accuracy and improved personal control for the surgeon over the procedure, remove the risks of ionizing radiation, enable the data integration

# Robolens

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from multiple numerical and sensor sources, etc. The available robots for handling and control of laparoscopic lens include at least 4 actuators to fulfill the surgeon's requirements. The purpose of this project was to develop a novel design for the laparoscope robotic arm in which while the systems controllability (moving up/down, left/right and zooming in/out) is maintained its active degrees of freedom are reduced.

The design constraints and variables of the system were studied in detail. A major ki-



nematic constraint arises from the fact that the abdominal wall should be considered as a pivoting point for the laparoscope; the arm is only allowed to provide spherical movements for laparoscope, i.e., 2 rotations around the incision point and an axial translation into the abdomen. Moreover, while the lens of the laparoscope might be able to rotate along its longitudinal axis, the rotation of the camera should be fixed in order to save the view orientation. Two different approaches for design of the robot were studied. In the first approach goniometers, chain drives, parallel 6-bar linkages, etc. are used to decouple the instrument motions about an isocenter defined at the entry portal. In the second approach the robot's wrist has one or two un-actuated, but encoded, rotary axes proximal to the laparoscope holder and relies on passive compliance to ensure that the movement of laparoscope satisfies the entry portal constraint. For each approach two novel mechanisms were introduced. The isocenter mechanisms included 3 rotary and 1 linear actuators with concentric axes at the incision point. The first passive wrist mechanism included 3 rotary and 1 linear actuators with 2 passive- encoded rotary joints at the end of the robot wrist. In the second passive wrist mechanism 1 linear and 2 rotary actuators and 1 passive- encoded rotary joint were serially configured. The advantages and disadvantages of the designs were then evaluated. It was found that the last mechanism can well fulfill the functional requirements of the system by means of only 3 actuators (instead of 4); this is a major advantage considering the cost and maintenance issues of the system when employed in clinical practice. The size synthesis and manipulability measurement of the robot also provided satisfactory results. At the present time, an operational sample of Robolens has been used in Imam Khomeini Hospital. Robolens is usable in Iran hospitals because of its low manufacture expenditure and high efficiency. Also, it has congruency with surgery room environment and objective situation of laparoscopic surgeries.

### *Advantages of using Robolens instead of assistant person*

- 1) Reduction of surgery time
- 2) Elimination of movement errors, picture vibration, and lens smudge through unwanted contacts with inner viscera
- 3) Reduction of technicians and increase of space for surgeon
- 4) Hold and moving laparoscopic lens with order of surgeon (Voice orders: up/down, right/left, zooming in/out)

### *Advantages in comparing with similar robots*

- 1) View Fixation and no rotation of right angle
- 2) Using of minimum active degrees of freedom
- 3) Simple action
- 4) Smooth movement of lens with constant speed in any situation
- 5) Moving on spherical surfaces
- 6) High movement safety and automatic stop in contact with inner viscera
- 7) Setting of robot head upper than surgeon head
- 8) No contact with other surgery devices and surgeon's hands
- 9) Moving of lens under surgeon left or right hand
- 10) Preparing to start surgery in less than 30 seconds

Robolens design has started in the late 1382 and entered into surgery room in the late 1385.

### ***Production Stages***

After termination of research stage, conceptual design of four preferable mechanisms was done in simulation environment. Following surgeons agreement comment, experimental and functional sample of Robolens was made. After that the sample was evaluated by Sharif university experts and after confirms of necessary standards, it was entered at surgery room.

### ***Equipments and Technologies in Production***

Modular components with high quality and safety were used in this robot. Although these components are expensive, but they could provide possibility of modification or change of the designed robot. Also these components afford simple and fast construction of Robolens. These components have unique and great qualities for research projects and most of the institutes use these components for different robots research samples.

### ***Scientific and Economic Significance of Robolens***

Use of advanced technologies including of robotic surgery is growing in different fields of surgery especially in minimally invasive surgeries. One of the most common is use of surgeon assistant robot for laparoscope holding and conducting in Laparoscopic Surgery. According to the reports, this robot affords accuracy and speed increase in operations, and decreases the problems of assistant's non-cooperation with surgeons and any other human factors. Also it decreases the surgery room technicians, surgeon and assistant fatigue and view vibration...

### ***Export of Robolens***

Our purpose is entering to global markets and this product has been constructed with competitive quality in global markets. For this purpose, German components and motors has been used in this robot. We expect to export of this product to the Persian Golf Countries. Five papers about this project have been presented in International Congresses and publications especially in Annual Congress of the American Society of Mechanical Engineering (ASME) in the field of Frontiers in Biomedical Devices.

### ***Future of this Design***

We would like to continue this design in industrial production and research section. We expect to eliminate some of the laparoscopic surgeon problems and develop using of new technologies in our country. Robolens intellectual function and its automatic movement will be evaluated in research stage. This function will be done through the Image Processing of the abdomen internal view and prediction of surgeon required movement.

### ***Opportunities for Cooperation***

Although this machine has some unique and high capabilities, but it can be improved and upgraded to meet market demands. So, we are looking forward to cooperating with all interested companies about upgrading and mass production strategies of this machine.

It is necessary to note that its current features provide convenient means to do joint marketing activities with other parties and we welcome of any cooperation in the field of joint marketing in this issue.