Da vinci robotic surgery

The Society of Manufacturing Engineers described a “ robot” as a reprogrammable task-driven machine which is designed for specific or multifunctional purposes (Rehg, 1985). The term “ robot” was derived from a Czech word “ robota” which denotes forced labor and coined by Karel Capek, in his play “ Rossom’s Universal Robots” (Lanfranco, Castellanos, and Desai, 2004). From then, this term has evolved from a representation of a simple task-driven machine into anthropomorphic robots with artificial intelligence as popularized by the media.

Today, robotic technology has gone a great leap; robots can now perform tasks that can hardly or impossibly be done by humans (Lanfranco, Castellanos, and Desai, 2004). Robots are now ubiquitous in the industrial processing plants, deep-sea exploration, and in perilous fields such as in military wars and in nuclear power plants (Lanfranco, Castellanos, and Desai, 2004). Hence, it is not surprising that robots have reached the medical endeavor. Robotic surgery, nowadays, is a fast-growing technological trend in surgical profession.

Robotic telesurgical machines are now viable for transcontinental cholecystectomy while voice-activated robotic arms are now used in the manipulation of endoscopic cameras (Lanfranco, Castellanos, and Desai, 2004). Also, the Food and Drug Administration of the United States has approved the masters-slave-robotic systems for commercial use (Lanfranco, Castellanos, and Desai, 2004). Presently, as this technology largely depends on market demands, medical institutions have been using robot-assisted operation to impress clients and gain prestige in minimally invasive surgery (Lanfranco, Castellanos, and Desai, 2004).

Thus, the utilization of robotic technology in the field of medicine presently served as a marketing strategy. Brief History of Robotic Technology The beginning of robotic surgery can be traced way back in 1985 when Kwoh, Hou, Jonckheere, and Hayati successfully used “ Puma 560” in neurosurgical biopsies (Lanfranco, Castellanos, and Desai, 2004). After three years, with the use of the same robot, Davies performed prostate transurethral resection (Lanfranco, Castellanos, and Desai, 2004).

This event led to the design of “ PROBOT”, a robot specific for such operation. During the “ PROBOT” development, “ ROBODOC”, a robot for hip replacement surgery was successfully designed by the Integrated Surgical Supplies Ltd. in California (Lanfranco, Castellanos, and Desai, 2004). Meanwhile, the Ames Research Center in the National Air and Space Administration or NASA of the United States became interested in the development of the telepresence surgery (Lanfranco, Castellanos, and Desai, 2004).

Thus, in 1990s some scientists of this research institution collaborated with the Stanford Research Institute or SRI which led to the development of the design for telemanipulator for hand surgical operations (Lanfranco, Castellanos, and Desai, 2004). The success of this collaboration has made other surgeons and medical experts to realize the potential of improving the conventional minimally invasive surgery.

As robotic technology sets on the stage, the United States Army conceived the possibility of telepresence in reducing the war death tolls by treating wounded soldiers through robotic surgical instrument operated by an expert in a Mobile Advanced Surgical Hospital or MASH (Lanfranco, Castellanos, and

Desai, 2004). This project has been successful in animal subjects but has never been tested in the real casualties of war. Later on, the group of experts who worked for the army robotic projects led the commercialization of robot technology.

In connection to this, the Computer Motion, Inc. in California who designed the surgeon-voice command robotic arm called Automated Endoscopic System for Optimal Positioning of AESOP, under the financial support of the United States Army, introduced the AESOP technology in the civilian community (Lanfranco, Castellanos, and Desai, 2004). After this, the former Integrated Surgical Systems in California patented the Green Telepresence Surgery System of the SRI which was known as the da Vinci surgical system after intensive enhancements (Lanfranco, Castellanos, and Desai, 2004).

In response to this, Computer Motion introduced the Zeus system in the market (Lanfranco, Castellanos, and Desai, 2004). At present, several research institutions are continuously conducting intensive studies for further development of robotic technology. For instance, in Eberhard Karls University, Schurr, Buess, Neisius, and Voges designed a master-slave, ARTEMIS, for laparoscopic surgery while Dario, Corrozza, and Peitrabissa of MiTech laboratory in Italy specifically designed robotic system for computerized colonoscopy (Lanfranco, Castellanos, and Desai, 2004).

da Vinci Robotic System The da Vinci robotic system has a console, three-dimensional optical vision tower, and surgical cart (Nishanian and Mets, 2004). The three mechanical arms of the cart are controlled by the surgeon through a real-time computerized manipulation. The two arms of the system hold instrument while the other one has an endoscopic camera (Nishanian and Mets, 2004). In addition, the system was designed with a six-degree motion which is identical to human wrist articulation and incorporated with a frequency filter for tremor elimination.

Also, motion scaling was provided in order to reduce the hand motion of the surgeon into miniature scale (Nishanian and Mets, 2004). Meanwhile, the console projects three-dimensional surgical field image as the endoscope provides dual and independent optical view; thus the surgeon in real-time looks at independent camera views simultaneously leading to the formation of three-dimensional images (Nishanian and Mets, 2004). These images are regulated then by two light sources in the vision tower as the surgeon manipulates the robotic and telescope arms at the console (Nishanian and Mets, 2004).

In controlling the robotic arm manipulator, the instrument has masters or levers with index and thumb-finger attachments for both hands while the movements of the wrist are transmitted through each end of the robotic arms (Nishanian and Mets, 2004). In relation to this, foot pedals were provided in the console for the control of robotic system like endoscopic camera adjustment, cauterization energy, and robotic motions (Nishanian and Mets, 2004). However, due to the close distance of the patient with the side cart, unnecessary contact with the robotic arms motion should be avoided.

Much even more, when the instruments handled by the robotic arms are still in contact with the patient’s body, any changes in the patient’ position must be allowed (Nishanian and Mets, 2004). Unintentional motion is prevented for it may cause operational failure during the process. Thus, for the replacement of any instrument in the robotic arms, trocars or access ports were purposively designed for clutching functions (Nishanian and Mets, 2004). The computer equipment for the dual optical channel integration is located at the optical tower (Nishanian and Mets, 2004).

The integration of dual optical channels creates stereoscopic view which in turn facilitates the control of the robotic arms. Meanwhile, the movement of the hands of the surgeon in the robotic arm control is transmitted by the computer software into digital code that directs the movement of the system under the surgeon’s control (Nishanian and Mets, 2004). Since each instrument positioned at the cart’s arm has its own function, it also necessitates specific scaling and computer processing (Nishanian and Mets, 2004).

Also, the surgeon needs a medical staff for attaching and replacing instruments in the cart’s arm. Nonetheless, in order for all medical staff involved in the surgical operation to observe the operative procedure, monitors are in the top of the tower (Nishanian and Mets, 2004). Clinical Applications Robotic surgery is envisioned to improve the capacity of human surgeons in different medical operations (Lanfranco, Castellanos, and Desai, 2004). In 1987, robotic technology was first applied in laparoscopic cholecystectomy (Lanfranco, Castellanos, and Desai, 2004).

As technology advances and the medical skills of the surgeons are continuously improving, laparoscopic surgery also progresses. In fact, da Vinci and Zeus robotic systems have been employed for different laparoscopic endeavor such as kidney transplants, mitral valve repairs, tubal ligation reversal, nephrectomy, cholecystectomy, and gastrointestinal operations (Lanfranco, Castellanos, and Desai, 2004). For these surgical operations, robotic technology promises small incision, less pain and threat of infection, and reduced number of days in the hospital and even recovery period (Lanfranco, Castellanos, and Desai, 2004).

Increasing data on robot-assisted surgical operation, which proved the efficacy of robot surgery, has been assessed. Notably, Cadiere, Himpens, Germay, Izizaw, Degueldre, Vandromme, Capelluto and Bryuns studied 146 cases of minimally invasive surgery done through da Vinci robotic system including cholecystectomy, gastropalty, antireflux procedure, hysterectomy, tubal reanastomoses, gastropalty, and other internal-organ related surgeries (Lanfranco, Castellanos, and Desai, 2004).

Similarly, the studies conducted by Falcon, Goldberg, Margossian, and Stevens as well as Abbou, Hoznek, Salomon, Olsson, Lobontiu, Saint, Cicco, Antiphon, and Chopin have conclusive proofs on the efficacy of robot-assisted surgical operations (Lanfranco, Castellanos, and Desai, 2004). However, forebodings still frighten the mind of the public because of the perceived technological limitations.

Thus, intensive trainings on the part of the surgeons with respect to the technical robotic system control and operations should be conducted, along with more accurate clinical trials concerning actual surgical procedures (Lanfranco, Castellanos, and Desai, 2004). Technological Limitations Amidst the aforementioned great promises of robotic surgery, limitations due to the mechanical attributes of the equipment are still at hand.

Since the operation is done by a machine manipulated by the surgeon, technical issues like lack of dexterity, inefficient hand-eye coordination, and loss of haptic feedback are still points of concern (Lanfranco, Castellanos, and Desai, 2004). During the operation, the medical expert performs the surgery through a two-dimensional monitor as his or her hands direct the movement of the laparoscopic instrument (Lanfranco, Castellanos, and Desai, 2004).

As such, the surgeon needs some vision adjustment for the movement of instrument as the image seen in the monitor is in the reverse direction of the target part. In addition, while the hands have a seven-degree motion, the instrument has only a four-degree motion (Lanfranco, Castellanos, and Desai, 2004). In the same manner, since the surgery is performed through a machine, tactile sensing is affected (Nishanian and Mets, 2004). The force applied by the surgeon by means of robotic controls is minimized by the scaling computer program.

Thus, the forced applied on the target part is always less than the actual force applied by the surgeon (Nishanian and Mets, 2004). The surgeon then must vigilant enough on the visual cues seen on the monitor for a precise estimation on the actual pressure he or she generates on the target tissue (Nishanian and Mets, 2004). Moreover, due to dependency on video monitor, every hand movement of the surgeon is transmitted into the patient with the rigidity of the instrument.

This entails difficulty of incision and anastomoses (Lanfranco, Castellanos, and Desai, 2004). In addressing these limitations, researches on the development of surgical robot for minimally invasive surgery are still in progress. Conclusion Robotic surgery will continue to progress as medical institutions acquire and promote the products of robotic technology. For example, due to the limitations of laparoscopic surgery, robotic system on endoscopic coronary artery grafting was developed (Lanfranco, Castellanos, and Desai, 2004).

Event though data on robotic surgery has already proven the feasibility of robotic technology in medicinal endeavor, issues on malpractice, technical skills in robot system control and operation, and other ethical and legal considerations should be properly addressed (Lanfranco, Castellanos, and Desai, 2004). Furthermore, accurate clinical data on robotic surgery should be presented to ease public hesitations and robotic surgery will finally take full root (Lanfranco, Castellanos, and Desai, 2004).