

# **A Low Cost Robotic Assisted Surgery System Using, Artificial Intelligence and Augmented Reality in Medical Technologies**

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## **Abstract**

Duluth Medical is developing a robotic arm that will lower the cost and improve the outcome of surgical procedures.

Duluth will transform and disrupt the practice and operation of the surgical robotic systems that have been used during the last two decades. Duluth's system is a combination of technological advancements that integrate both artificial intelligence (AI) and augmented reality (AR) in robotic surgery.

The current robotic surgery systems cost over one million dollars and take many hours of training on the surgeon's part, while also requiring special operating rooms that only large, well-capitalized hospitals can afford.

Duluth's robotic system is expected to cost about 90% less than the current systems and is developed to assist surgeons in their existing operating room, with their current surgical training experience., Unique advantages are: precision, speed, and agility, all for the fraction of the cost of existing robotic systems.

Pertinent to the current situation, robot assisted surgery (RAS) may also help reduce hospital stay, protect health care staff from infection and strenuous physical work while dealing with COVID-19 patients. Remote robots or cobots are the upcoming opportunity which are designed to work autonomously with safety assured by isolation from human contact

Duluth filed for several patents to protect its intellectual property.

## **Introduction**

Generally, the use of surgical robots provides a number of benefits, one that is most important to the patients and surgeons is the use of minimally invasive procedure. In this regard, patients lose less blood, experience less pain, recover quicker, and leave hospital sooner. As a result, it has a number of health and cost benefits. The robotic surgery is assisted with Augmented Reality which allows surgeons to see in close detail in 3D-magnified images. It provides the benefit of high definition viewing while controlling greater range of movements. This offers surgeons a three-dimensional, high-definition view inside a patient's body.

The notion that Robots will replace the work of surgeon is wrong conclusion. RAS is not autonomous; it is controlled by the surgeons at all times. It is a smart tool that provides a significant support to the surgeon's surgical procedure. Also, the Surgical arm has many of the needed instruments attached. These attachments are used at the surgeon's discretion.

## **Duluth seizing a market opportunity to launch a low cost, affordable robotic arm**

Technology has made a huge leap over the last two decades. Especially the use of robots in commercial market. i.e. automotive, construction, defense, transportations and many other sectors of businesses, however; it takes much time and deliberation when it comes to develop and market for medical industry. Our team at Duluth understands the nuances of this industry really well. The distinction of introducing robots in medical industry is clearly measured by the stringent safety regulations, adoption by the health care experts and then the cost of development and operations.

The experts in this field must be trained and assembled from a multidisciplinary background. As in example, we must use the expertise of electronics, mechanical, computer science engineering, clinical, regulations as well as different classes of clean rooms and laboratories. The Duluth team's years of the medical industry experience is the paramount benefit recognizing these challenges, where we can stream line the process and be able to go to market expeditiously.

For almost two decades, the Da Vinci system has received praise from many practitioners but has also faced criticism for its expense.

The “Si” version of the system costs just under \$2 million, plus several hundred thousand dollars in maintenance fees every year.

As of September 2017, there were 4271 Da Vinci Surgical System units installed around the world. Of those, 2,770 are in the United States and 719 are in Europe. (Ref.1)

In the United States, the Food and Drug Administration (FDA) approved the system for use in 2000, and the robots are now used around the country.

This particular data provides an amazing opportunity to bring the transformation that Duluth is targeting. We know that these systems are based on 20 years old technology. We see today that robots, with a smaller size and lower cost perform superior to their predecessors.

### **Assisting the surgeons**

The robot is assisting the surgeons, it will not replace and cannot work autonomously. In this regard it can lead to better performance than what surgeons can do by themselves.

Augmented reality superposes information on the live view. It provides useful contextual information to the user, which provides the ability to see more details. The camera is moved and directly controlled by the surgeon. The instruments can rotate several times over, which is much more than a human wrist can do. The instrument motion can be scaled down to remove a natural tremor or to go in extremely slow motion if desired. The instruments can be paused in any position or action to provide a steady, unmoving point of stability or retraction.

This is achieved by having the robotic arm is mounted to the surgical bed, providing stability and guidance during the procedure. The robot facilitates proper positioning of the surgical instruments as guided by the physician through the procedure. The virtual reality eyewear integrates with the eyewear the surgeon currently uses to provide guidance of the procedure

progress toward the final implant position and installation. Artificial intelligence is integrated into the system to optimize procedural technique based on training algorithms.

Similarly, there is some physical health benefits to the surgeons, while conducting the operation in compare to conventional surgical procedures. Without the support of Robotic arms, the surgery can be physically demanding and lead to neck, shoulder, or back problems. Having to make a smaller incision compared to conventional procedure, noticeably results in faster recovery. Also, its much less cumbersome to surgeons.

As we usher in a new decade, we are positioned to take advantage of the most innovative medical technologies yet.

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### **Robots in many segments of medical surgeries**

The Duluth **AI** based robot's initial target is the development of Orthopedic related surgeries. However; there are many opportunities in several other types of surgeries, that are being dabbled by major as well as startup companies.

Here is example of the areas that robots are making significant advancements

Types of procedures

Gallbladder removal, Kidney removal, Hip Joint replacement, Mitral valve Surgery, Robotic Surgery for Lung Cancer– Ear, Nose, and Throat, cardiovascular surgery, head and neck surgery, abdominal, colon and rectal surgery and urologic surgery

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## **Medical research and machine learning**

Duluth's differentiated advantage is the use of the emergence and integration of AI in the robotic system. AI evolution is at its beginning phases, and it will advance with edifice and collection of large size of data base. The success of AI In the medical application, very much depends on focusing on one indication at a time, and also on collecting quality data, meaning, (precise, specific and with small tolerance of specificity matters)

Following Mayo's vision, health care researchers and founders try to make life longer by battling aging and making rehabilitation smoother. Medical research on aging is growing rapidly, compared with research on the leading causes of death in the U.S. It is also one of the fastest accelerating research areas in the past six years.

Studying the academic and funding dimensions of the medical AI ecosystem, we see that the movement towards Mayo's vision is taking place. *Prediction and prevention, wellness and rehabilitation, amelioration* of aging, and technological augmentation of doctors are all noticeable themes.

*Prediction and prevention* are well-known concepts for health care professionals. Now they appear to be revitalized and reinforced by machine learning. A dive into PubMed databases demonstrates that the pace of research activity for ML-powered prediction and prevention is currently higher than the research activity associated with these concepts without involving ML.

The examples given above suggest that tech is moving medicine toward preventing diseases from happening. This can be done by tweaking genes, detecting early signs of diseases, and altering human behavior for health benefits. Currently AI tech penetrates just a part of the list of dangerous diseases.

Studying 35 companies that employ computer vision in health care, one may conclude, that their primary approach is to augment professionals, rather than to replace them. For example, BayLabs "develops technology to simplify the process of recording, editing and sharing of video," while Mindshare Medical aims "to empower clinicians and health care providers" by

utilizing medical imaging. Oxford Heartbeat “helps clinicians accurately plan and rehearse stent placements inside blood vessels”.

Our inquiry suggests that the vision of medicine coined by Mayo is closer to life than we think, thanks to AI. Cognitive technologies fit nicely with the popular research themes explored above. Moreover, at the current stage, where diseases are not eliminated entirely, tech empowers rather than displaces health professionals. Therefore, we expect to see more exciting AI health tech to emerge and suggest entrepreneurs consider opportunities in this space.

The next big thing in health care is also anticipated by investors, who have increased their bets on the segment. Venture capital investment in cutting-edge, AI-driven medical technologies like computer vision, machine learning (ML), and robotics has skyrocketed from \$30 million in 2012 to \$892 million in 2016.

Wellness applications may use almost unlimited data from healthy populations, the collection of which is accelerated by new devices entering the market. The more data from healthy patients is available, the more insight one can get. Traditional health care uses data, that is limited by the number of cases and more severe sampling requirements.

Prevention and prediction segments start from research into cells and genetics, aiming to eliminate the underlying causes of dangerous diseases. Machine learning drives these research topics as well.

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## **Medical robotic market is a growing exponentially**

Market players operating in the medical robotic systems market include: Intuitive Surgical Inc., Accuray Incorporated, Hansen Medical Inc, Aethon, TransEnterix Surgical, Inc., Stereotaxis Inc. ReWalk Robotics, Titan Medical Inc., Stryker, and Medtech SA.

Rapid growth of the medical robotic systems is attributed to a blend of technological improvements such as use of more efficient motors, compact and light materials, power back-up and sophisticated controls and safety mechanisms, along with more economic versions. Moreover, rise in demand for minimally invasive surgeries further boosts the medical robotic systems market. Medical robotic systems have been widely used for minimally invasive surgeries in the field of gynecology, cosmetology, general surgery, laparoscopic procedures, and flexible endoscopic procedures. These techniques cause minimal complications, reduce risk of infections, cause less pain, and have faster recovery time, which leads to shorter hospital stay as compared to traditional therapies and treatments. These factors help increase acceptance and adoption of medical robotic systems by many medical facilities and centers. Almost all the Stakeholders involved like hospitals, patients, doctors' benefit from Minimally invasive surgeries. Perhaps only big pharma might not benefit as these patients require less pain-killers and have faster recovery times. Medical robotic systems are self-powered, computer-controlled devices programmed to aid in positioning and manipulation of surgical instruments.

The global medical robotic systems market was valued more than US\$ 5,581.8 Mn and anticipated to reach US\$ 25,738.8 Mn by 2025.

The US market from 2017-2025 Compound Annual Growth is 18% CAGR.

The Medical Robots Market is expected to be around US\$ 22.30 Billion by 2025 at a CAGR of 21% in the given forecast period. (Ref. 1& 2)

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## **Robots can alleviate the strained health care systems in the age of the Coronavirus pandemic**

The emphasis to increase the use of robots in medical field is becoming more imminent than we experienced in the past. Robots in many ways can mitigate the situation that our health care system is experiencing with the COVID-19 Pandemic now. One factor is that there are not adequate medical professionals, who can handle the size of patients infected by this disease, and second is the health medical professionals can be infected while they are in contact in the clinical environment. The development of the robotic arms could advance in more than one area, such as the arm can perform ultrasounds and take mouth swabs, nasal swabs, intubate patients, potentially allowing doctors to work with patients remotely.

The machine consists of a robotic arm on wheels that can perform ultrasounds, take mouth swabs and listen to sounds made by a patient's organs, usually done with a stethoscope.

Such tasks are normally carried out by doctors in person. But with this robot, which is fitted with cameras, medical personnel do not need to be in the same room as the patient, and could even be in a different city.

“Doctors are all very brave,” said Tsinghua University Professor Zheng Gangtie, the robot's chief designer. “But this virus is just too contagious... We can use robots to perform the most dangerous tasks”. (Ref. 5)

The idea came to Zheng around the turn of the Lunar New Year. Wuhan had just been put on lockdown and the number of cases and deaths was rising rapidly every day.

As an engineer, Zheng wanted to do something to contribute to the relief effort. On the first day of the Lunar New Year, he heard from his friend, Dong Jiahong, executive president at Beijing's Tsinghua Changgung Hospital, that the biggest problem was that of frontline workers getting infected.

Tech and medical experts say artificial-intelligence technology holds the key to preventing potential virus pandemics and outbreaks like the novel coronavirus

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