**Need 2:**

A way to reduce tediousness of counting surgical instruments in every surgery, that will increase the efficiency of the medical procedures, decrease the workload of the Operating Room (OR) staff, and decrease surgical complications caused by human error.

**Problem:**

Surgeons utilize an array of instruments during every procedure. Before a surgery begins, counting all available surgical instruments such as scissors, scalpels, tubes, sponges and so on is a standard and important practice. At the conclusion of surgery, the stuff in OR should count all surgical instruments as well, if the count is different, it is clear that an instrument has been left. Retained surgical instrument (RSI) is any instruments accidentally left inside a patient’s body following a surgery. Apparently, this sever mistake could lead to significant health injuries, repeated surgery, even in some cases death of patient [1]. Therefore, the surgical instruments counting is an indispensable and essential process during a surgery.

At present, the surgical instruments counting process generally is undertaken by human.

Thus, mistakes in counting process is inevitable, according to a study which reported to the Annals of Surgery that mistakes in instruments counts happened in 12.5% of surgeries [2]. An inaccurate count can occur when nurses are deprived of sleep, especially when the surgical operation is particularly difficult, long and mentally draining, when the operation is an emergency, or when there are unforeseen changes in the procedure [3]. The Association of Operating Room Nurses published an uptodate.com policy in 2015 recommending the points below that are widely used in the United States hospitals [4] Specifically, counting should be performed at the following time points during the surgical procedure: before the procedure begins (initial count); whenever new additional items are used during the operation; before the surgeon closes the body cavity; when the surgeon begins to close the wound; and when the surgeon closes the skin (final count) [5]. Therefore, counting surgical instruments is a tedious and boring work, it requires lots of manpower, thus it is a heavy work for nurses.

**Existing solutions:**

In order to solve this problem, Israel RFID (radio frequency identification) medical solution provider Haldor Advanced Technologies developed ORLocate system based on passive RFID tags, it can monitor and track the surgical instruments and consumables before, during and at the conclusion of the surgical procedure [6]. Penelope robot system designed by Micheael R.T can also count surgical instruments [7]. However, these two methods are more complex and the price is pretty high, the cost of each system is more than $100,000 [8]. Moreover, these systems are rely on tags, they need add some tags to the instruments, hence the fabrication process of surgical instruments may be changed, this property brings some difficulties to these systems be used widely.

**The current market:**

According to the data from the National Center for Health Statistics, 48 million surgical inpatient procedures were performed in the United States in 2009 [9]. And the number of cases in which surgical instruments are left behind during a procedure in the United States has been estimated at around 1500 cases per year, while approximately 88% of these cases occur in a situation where the surgical instruments counts were declared “correct” [10]. Medicolegal and compensation costs associated with RSI are high, even if there has been little or no harm to the patient. Costs vary from $37,041 to $ 2,350,000 per incident, with an average cost per case estimated at $95,000 [11]. If a more accurate and efficient surgical counting approach can help hospital to avoid these losses, it will benefit to both hospitals and patients.

**Need criteria**

1. The aiming approach should not change the fabrication process of surgical instruments.
2. The aiming approach should be more accurate than these existing approaches.
3. The aiming approach should be easy to use.
4. The aiming approach should be low-cost.

**Reference:**

1. Nemitz R. Surgical Instrumentation: An Interactive Approach[M]. Elsevier Health Sciences, 2013.
2. Gamble K H. No sponge left behind: Cutting-edge bar coding technologies are being leveraged in an attempt to make foreign bodies left in patients a thing of the past[J]. Healthcare informatics: the business magazine for information and communication systems, 2008, 25(12): 34, 36, 38-9.
3. <https://en.wikipedia.org/wiki/Retained_surgical_instruments>
4. Denver CA. Guidelines for prevention of retained surgical items. Guidelines for perioperative Practice
5. Zejnullahu VA, Bicaj BX, Zejnullahu VA, Hamza AR. Retained Surgical Foreign Bodies after Surgery. Open Access Macedonian Journal of Medical Sciences. 2017;5(1):97-100. doi:10.3889/oamjms.2017.005.
6. <http://www.haldor-tech.com>
7. <http://rstautomation.com>
8. J. Tan, S. Wang, H. Wang and J. Zheng, "A new method of surgical instruments automatic identification and counting," 2011 4th International Congress on Image and Signal Processing, Shanghai, 2011, pp. 1797-1800.
9. <https://stanfordhealthcare.org/medical-clinics/surgery-clinic/patient-resources/surgery-statistics.html>
10. Gawande AA, Studdert DM, Orav EJ, Brennan TA, Zinner MJ. Risk factors for retained instruments and sponges after surgery. N Engl J Med. 2003;348(3):229–35. https://doi.org/10.1056/NEJMsa021721. PMid: 12529464.
11. Berkowitz S, Marshall H, Charles A. Retained intra-abdominal surgical instruments: time to use nascent technology? Am Surg 2007; 73: 1,083–1,085