S.H.I.EL.D ROBO-2.0

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Abstract- Medical science has left no stone unturned to save humanity from various health diseases, injuries. Large, complex and effective equipment's have been designed to detect injuries, varying from micro to macro. By the help of these LARGE and COMPLEX equipment's such as X-RAY device, COMPUTER RADIOGRAHY and so on, we generate results of the ailment suffered by the patient within 2-3 Hours or so, where the doctor explains the patient about the ailment HE/SHE is suffering the next day, This happens due to vast amount of time taken to compile the result. On an average Doctor's save 6 of their 10 patient's they operated, but other 4 would have survived or cured if they had time in their hand, the reason could be the bulk time taken by the doctor's for identification of the cause of their suffering or lack of accuracy to determine the reason of suffering . So the point of concern in all the factors above is TIME, so why not save time and generate results and operate the patient within or less than 24Hrs of 1st stage of detection of the ailment suffered by the patient.

Index Terms- Anthropomorphic, bacteria, Hypothetical device, Prosthetics, Thermal Imaging Camera

I. INTRODUCTION

This research paper is about the coalition of common Medical equipment's and robotics, which will be explained in a form of a hypothetical device named "**Secured.Human.Imaging.Electronic.Device Robotics 2.0**", a combination of various medical equipment's and camera's about which we know, but only on individual basis. One day or the other Humans tend to suffer various diseases varying from comman viral to major organ disease. Bullet injury's ,Gas leaks and various HUMAN generated hazards are few of the common yet serious issues doctor face while treating patient's of different genre. "ROBO-Robotics", the whole world is filled with bio-robot's which performs various functions for Human either in anthropomorphic approach or Telemanipulator (minimalistic approach) [1][12][13][15], Robotics is not an alien topic to Medical science yet we are still not able to fill the Gap between the two. From various generations doctors are performing operation ranging from Low level to High level difficulty. As we know, there are generally very few high quality Docs present in individual hospitals across the globe, hence *why not introduce a device which simply Leave the Low level operations to itself so that skilled surgeon's perform the complex one.* Imagine a quality doctor performing an operation of a bullet injury in an abdomen region and at the same time a casualty occur of a HIGH level, (e.g. Kidney failure) that doctor wouldn't be available for this one so up to some extent we are risking the Life of patient suffering from failure. I am not objecting the skills of doctor's ,or underestimating the injury the only thing I am saying is we need a High grade Doctor's for a complex situation like this. *S.H.I.EL.D ROBO-2.0 is a 2 level device performing detection and operations varying from low level to a higher level casualty*. It is composed of X-ray Device, computer radiography-scanner, Thermal imaging camera, Bio-robotic Dexterous Hand. These are some major and important devices. Our aim is to detect the ailment and cure it as fast as possible by summing up the medical equipments about which we know individually. To analyze their behavior when summed up together is quite fascinating! Further we will study about working of every component and device used in SHIELD ROBO-2.0 and how can the further advancement be made for this **HYPOTHETICAL DEVICE** to originate from hypothesis to reality which will not only add an extra leaf to medical science but also make the treatment process faster.

II. 1ST LEVEL OF S.H.I.EL.D ROBO-2.0

The Device is complex hence to ease its complex nature it is divided into 2 levels on the basis of its complexity. The question arises how will the device differentiate between different modes, under this scenario it depend on the condition of the patient, if the doctor know that the patient is infected then in that case the doctor opt for low threat mode on the translucent panel emerged right at the source of the device, the translucent panel is a rectangular glass frame with touch mode enabled, similar to the touch mode that is present in the touch screen mobile phones. This rectangular frame will be the mother for operating and functioning of all three devices, will be enabled by this rectangular frame, which we will call as **REC. FRAME**. The Rec. frame is attached to the device. The infected person hence will be scanned by 2 thermal imaging cameras one on left hand side and other one on right side, the cameras will capture and provide the real time image display of the infected body on the LCD screen of the computer which is enabled by real time software, a projector of Low resolution at the same time will project the real time image to the patient as well. The working under 1st level comprises of 2 cases.

1st case : The background condition under which the patient is kept normal, as we know human body temperature is a complex phenomenon .Human are homoeothermic ; they radiate heat which must be lost to the environment to control their internal temperature[7]. Skin act as an interface to the emitted heat and environment. The organs of the body constantly need to adjust to the external environment. Infrared cams produces thermal images which detect even a smallest temperature difference, as small as 0.07 degree, these cams provide visual map of the skin temperature. The IR cams have temperature scales, color images, sound alarm which goes ON when

temperature exceeds threshold temperature [2][7]. The patient sometimes are unknown to the bacteria's and viruses or allergy they posses because of all these factor there is an elevation in the body temperature which can be measured by IR cams present in S.H.I.EL.D ROBO-2.0, hence by this way if a person have ailment other than bacteria's or viruses and he/she is unknown of it, they can also be detected by the help of this device. The temperature of the skin is different to that present internally hence to be more accurate in temperature-measurement the concept ,ACCURATE TEMPERATURE-COMPENSATOR……(ATC)[7] comes into action, under this technology the alarm is set at 38°C which goes on when elevated temperature of a human body is received[7].

2nd case : the above procedure will take less than 45 seconds or so, once the imaging under normal background condition is taken we will soon provide a increase in temperature in a form of steam from 2 pin hole sized steam emitter , the temperature will be increased up to 50°C after we disable the alarm present in IR cams ,and will carefully observe the increase in temperature, as soon as the steam start to convert into moisture the dew point alarm turns on and at that time the increase in temperature will be stopped, After waiting for 3 seconds the KNOB would again be rotated so that a temperature of approx 10°C is emitted from the same emitter used to emit HOT steam after 5 seconds or so the temperature provided will be stopped and the body is allowed to relax, at the same time the image of the human body is being displayed hence it will be determined how the human body react to variation in temperature and is the body have allergy symptoms or not or if allergy is present how is it behaving, by this doctor have the idea about the type of viruses and level of hazard hence the doctor can work on the affected region.

2.1 2nd LEVEL OF S.H.I.EL.D ROBO-2.0

After the person is analyzed under LEVEL 1.0 the Process is terminated and an immediate printed copy of the result with a heat image of the patient is obtained via scanner and printer both of which is inbuilt in the S.H.I.EL.D ROBO-2.0 device. However the process will further move on to LEVEL 2.0 which is the High threat level, The patient is treated under this level when they acquire injury's or have complaint regarding pain in any part of the body, the injury may vary from (mm) sized muscle tear to a macro one .Under level 2.0 we will use the concept of x-ray scanning and computer radiography. The patient moves from level 1.0 to level 2.0 automatically. The operator however need to set level 2.0 in the Rec.frame initially so that the patient after viral scan automatically moves level 2.0 for X-ray scan and Computer Radiography. The level 2.0 does not end up here S.H.I.EL.D ROBO-2.0 also introduce the concept of operation via Bio-Robots and Anthropomorphic hand, though these devices will be able to perform operation strictly of complexity of lower level only. Hence we can say that level 2.0 also comprise of 2 stages where these stages may or may not be inter-linked to each other depending upon the complexity of the casualty. Level 2 of S.H.I.EL.D ROBO-2.0 can perform both tasks simultaneously according to the requirement.
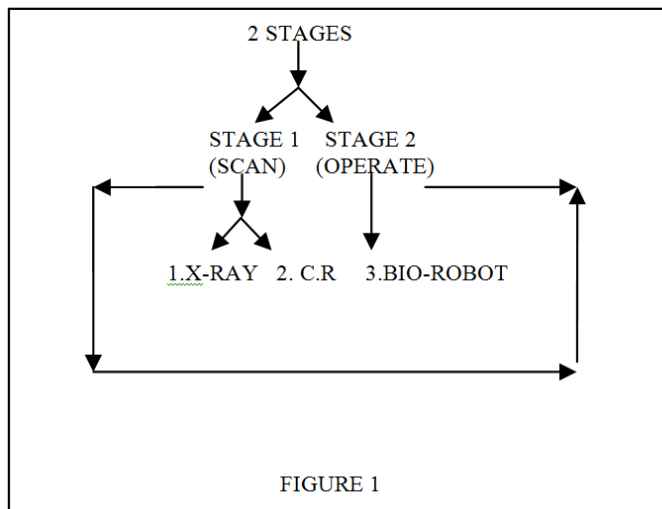

FIGURE 1

III. STAGE 1 (SCANNING)

Under stage 1 those patients are scanned who are suffering from various ailments, the nature of complaint may vary from a severe chest pain to pain caused by the prosthetic attachments (metal nature) present in human body. Patients having **prosthetic** attachment in their body are required to undergo level 1.0 scanning to check the **bacteria** contamination level[5][9][16], this give the idea to the doctor about the effect caused by the artificial attachment to human. The operator will enable LT mode and HT mode simultaneously on the Rec.frame. *It is important to specify that the LEVEL 1.0 AND LEVEL 2.0 are linked to each other* i.e. The device are physically attached, however it is possible to obtain results obtained from individual devices. As discussed earlier the STAGE 1 comprises of 2 scanning concept x-ray and computer radiography.

X-RAY: If we define x-ray in simplest language we can say that it is a device which uses x-rays to scan tools or human body. Going into depth of the definition of x-ray it is clearly defined as "a *device which uses X-rays to scan human body by directing them through a tube, onto the human body, some rays get stored in the area of concern due to its thickness or density those rays passed help in displaying image with the help of IMAGE PROCESSING SOFTWARE present in the computer".* [5][6][8][9][16]. Under stage 1 those patients are scanned who are suffering from various ailments, the nature of complaint may vary from a severe chest pain to pain caused by the prosthetic attachments (metal nature) present in human body. Patients having **prosthetic** attachment in their body are required to undergo level 1.0 scanning to check the **bacteria** contamination level[5][9][16], this give the idea to the doctor about the effect caused by the artificial attachment to human. The operator will enable LT mode and HT mode simultaneously on the Rec.frame. *It is important to specify that the LEVEL 1.0 AND LEVEL 2.0 are linked to each other* i.e. The device are physically attached, however it is possible to obtain results obtained from individual devices. As discussed earlier the STAGE 1 comprises of 2 scanning concept x-ray and computer radiography, the concept of x-rays plays a major part in our device and the

concept needs to be understood once again ,Going into depth of the definition of x-ray it is clearly defined as "a *device which uses X-rays to scan human body by directing them through a tube, onto the human body, some rays get stored in the area of concern due to its thickness or density ,the penetration level of ray may vary from the numeric half value layer of person to person.*"
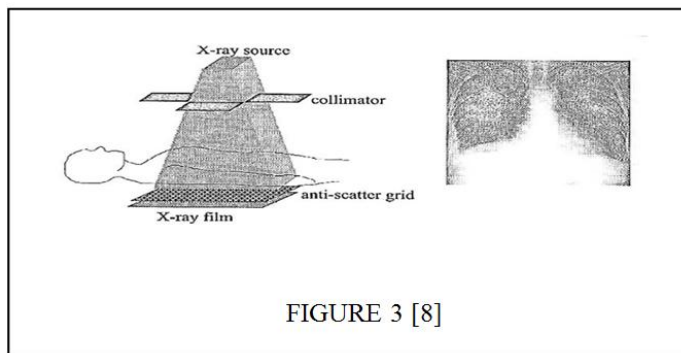
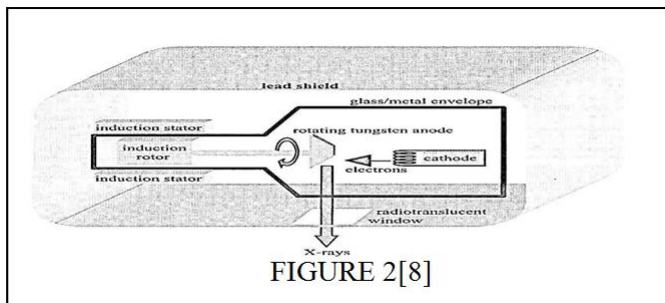| PROPERTY OF X-RAY		
ENERGY(eV)	FREQUENC	WAVELENGTH
4×10^{1} - 4×10^{5}	$10^{16} - 10^{18}$	$10^{-8} - 10^{-12}$
TABLE 2[6][8]		

IV. SCHEMATIC OF AN X-RAY

FIGURE 2[8]

The scanning is doable because of 5 provisos:

X-ray source [6][8] : provide x-ray's in the region for

- Scanning
- Collimator[6][8] : Device which restricts the beam of ray so as to irradiate beam to the region of worry
- Anti-scatter grid [6][8]: increases the contrast of tissue by reducing the number of detected x-ray as shown in figure 3.
- Compton scattering [6][8]: incident x-ray photon strikes the electron to generate (photon + electron) with which ionization occurs.

FIGURE 3 [8]

The Rec.frame is the actual brain of the device which controls the panels of different stages and this frame needs to be handled carefully.

S.H.I.EL.D ROBO-2.0 will utilize the same mechanism which have been performed by X-ray devices lately, however the only addition to level 2.0 will be the introduction of robotic operation via Bio-Robot and anthropomorphic hand about which we will study in PHASE 2.The 2nd phase of level 2.0 includes as said includes operation via Telemanipulator supported by anthropomorphic hands,

however the *operation performed will clearly be of LOW Sophistication level hence it would rule out operations of HEART, BRAIN, or other intricate organs of our system.*

4. STAGE 2 (SCANNING)

As discussed in the flow chart given above, stage 2 enable the operator to perform operation of LOW difficulty level. Operation performed under stage 2 strictly rules out all the complex operations which include operation related to heart, brain, or any sensitive organ of our system ,also S.H.I.EL.D ROBO-2.0 will perform only those operation that include removal of metal scrap such as bullet's, metal piece's, prosthetic attachment of lower grade, now the question arises how can the operation take place without any doctor as shield robo-2.0 completely rules out any involvement of surgeon's for operation purpose, though the operation will be under the guidance of the doctor ,as stated earlier that the surgeon are required for high grade sensitive operation instead of performing the surgery of lower sophistication level which can be performed by S.H.I.EL.D ROBO-2.0. The operation will be performed by Active Robots with **anthropomorphic hand** in support, the size of the **Telemanipulator** will be approx. (0.07~0.09) m and size of anthropomorphic hand will be of approx 0.3m.Rec.frame present at the initial source of ROBO S.H.I.EL.D-2.0 have the draft of the human body coded (inbuilt), the code outlining the anatomy of human body is projected on the Rec.frame when operator enables for stage 2 (operation mode) ,the projected body display's various region where operation is possible.

The operator need to enable the region of operation which will activate and supply the information to the Telemanipulator, Telemanipulator recognizes the supplied information when it scan's the human body before performing operation.

Block diagram given above give us a rough idea about the content that will be displayed in rec. frame's screen, if we observe panel 2, it is displayed with both scanning and operation

mode, since we are discussing stage 2 (operation mode) hence the operator will enable operation mode via touch mode, an immediate panel 3 as a response to the selection will be obtained which will project the outline of the human body in which operation enable area are represented.

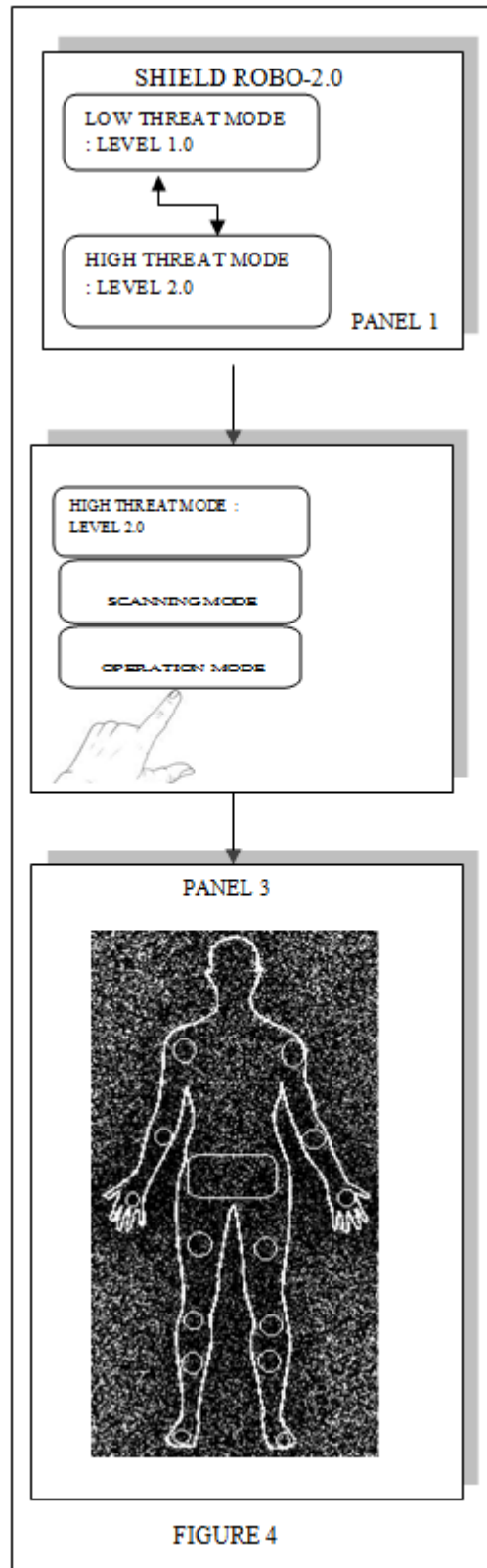## 4.1 REC.FRAME SCREEN DISPLAY

FIGURE 4

V.   ROBOTICS

Robotic hand vary from fire fighter cutting tool to micro gripper or in industrial field to medical science , especially in the field of medical science robotics have been used at its prime starting from 1983 when the first surgery via robotic was implemented in Toronto. Robotic surgery can be defined as a surgical process involving robotic system. Even though it robotic surgery was used to avoid loop holes in surgery's so that surgeon's can perform open surgery, still believe more in surgery performed by surgeon's (humans), rightly so because the possibility of malfunctioning of robot performing an operation of complex genre is high, but if we limit their ability by reducing the complexity of operation and there functioning then we can still utilize them for various low level operation about which we will be discussing. Our motive will be to study "**DEXTEROUS ROBOTIC HAND**" [1][10][11][15] and there operating, control and grasping approach. The term DEXTEROUS is defined as "capability of changing position and orientation of manipulated object from reference configuration to different one" [1][10][11][15] basically the hand should and will work in arbitrarily chosen position in 3D space.

As discussed in various papers the application of hand can be used for making:

- Anthropomorphic hand (anthropomorphic approach)
- Efficient manipulator (minimalistic approach)

Anthropomorphic Hand:

"Resemblance to human hand is the meaning of anthropomorphic" elaboration of the statement is "making the designing and functioning of hand as human as possible" the goal is achieved when [1][10][11][12][13][14][15]

- Prosthetic hand is developed where prosthetic is defined as "substitute /external implant to a missing part.
- Mimicking the human hand

"When we talk about anthropomorphic hand then a human operator map his own way of manipulation in the robotic hand, however it need to avoid complicated task from being performed (i.e. avoiding complicated task to programmed grasping algorithm) and avoid malfunctioning due to complexity which may cause any serious casualty while performing the operation."

Hand mapped by human operator divided into

1. Tele manipulation
2. Human teaching

The biggest advantage of anthropomorphic hand is it's usage in a manipulator for a better intuitive control.

Efficient Manipulator: Use of manipulator on daily basis is to displace the object from one point to an arbitrary point in 3-d space in flexible manner where the dexterous hand will be used to perform grasping function; however in SHIELD ROBO-3 we will enhance the usage of the Telemanipulator to scan and perform operation functions on human body. The hand should be made in minimalistic way hence making the "hand look simpler".

Under Telemanipulator:

FIGURE 5
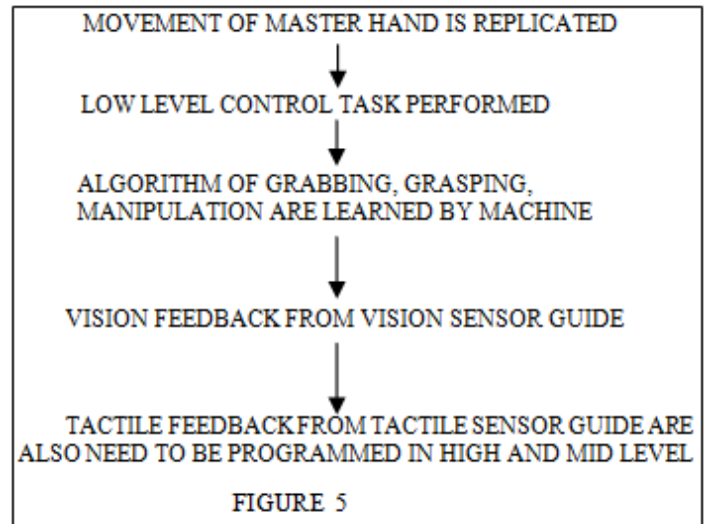
Since in SHIELD ROBO -2.0, dexterous manipulation function is needed hence the dexterous hand will be used to form an efficient manipulator , The operator enables the region of operation in panel 3 the working or the process of operation performed under that region will be mapped by the operator which will include the range covered by the hand , angle rotated , the grasping control ,also under panel 3 another command will be prompted about the nature of operation need to be performed (i.e. the operation performed could either be of a bullet injury or simple removal of artificial metal attachment hence by this when the operator enable a certain region the dexterous hand will automatically realize the work it need to perform.

1. Hand will scan the region of operation under this scanning x-rays will be used by the dexterous anthropomorphic hand so that it could find out the POINT where it needs to perform the operation.

2. As we know size of bullet will vary 0.22 caliber to 0.50 caliber similarly metal scrap from certain mm to cm, to counter this problem the panel 4will be generated when the operator will enable for operation mode which will provide option of bullet injury or metal attachment under which it will have range of sizes which will help the anthropomorphic hand to provide a controlled GRASP.

1. Anthropomorphic hand used will be both SHADOW HANDS with sensory guidance include. It is hand whose characteristics are very close to human hand.
.

SPECIFICATION ABOUT SHADOW HAND[1][15]				
NAME	COMPANY	FINGERS	DOF	SENSORS
SHADOW HAND	SHADOW ROBOT COMPANY	5	23	TACTILE,HALLEFFECT
TABLE 2				

Under PANEL 4 a heat image of the human body created on the rec. frame , for_ *E.g. in this case the patient suffer from shoulder injury hence the operator opts for shoulder region as the region of operation in panel 3, A panel 4 is generated which provide the options for bullet injury and metal attachment , in this case the operator opts for bullet injury*, a sub block is generated which provide options of bullet size ranging from "0.20 caliber to unknown size" along with a heat image of the patient showing the area of injury. The operator opts for a bullet size, Tele manipulator understand and process the information accordingly, the shadow hand is mapped by the operator with algorithms for performing operations initially hence it understand the toil it need to process. The shadow hand needs to be precise and accurate while performing operation and removal task to avoid any casualty and so the algorithm mapped should be appropriate.

Consider a situation when you keep your finger in a cold storage box with temp below 0°C constantly for 2 minutes, your finger possibly will get frosted and no sensation whatsoever would be felt, it would appear as if your finger is not a part of your body anymore ,this happens possibly as the blood which is a fluid connective tissue get frosted because of which no transmission or receiving of signal would be possible between brain and finger i.e. The sense of touch vanishes for some time, Now if apply same concept in shield robo-2.0 i.e. under LEVEL 2.0 operation mode (bullet injury) the patient would definitely suffer from loss of blood the only work that the surgeon needs to perform is to stop the blood flow initially before the injured is transmitted inside shield robo-2.0 device. After all required selection made on the rec. frame by the operator the patient is transmitted via level 1.0 reaches level 2.0 where X-ray scanning is processed and via thermal camera the heat image of the body is captured. The level 2.0 consist of 4 Shadow hands 2 on either side of the human frame.
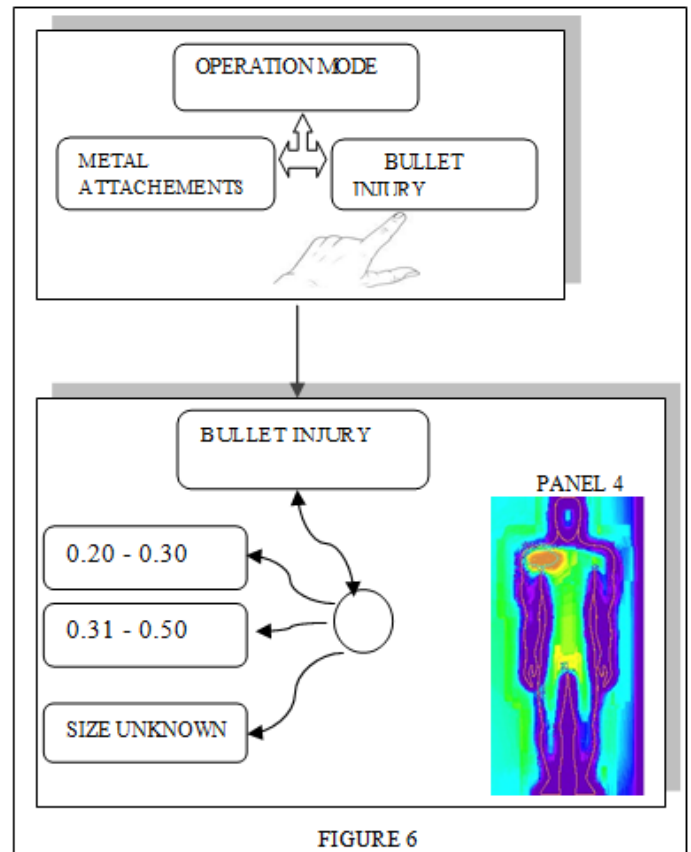

FIGURE 6

The hand is composed various sensory guides [1][10][11][12][13][15]:

1. Tactile sensor: A transducer that measures the information arises from the physical interaction with the environment, basically a Biological sense from coetaneous touch which is capable of detecting stimuli.

2. Hall Effect sensor: A transducer which varies the output voltage in response to a magnetic field used for positioning, speed detecting, current sensing.

3. Pressure sensor: A transducer which detect pressure (mechanical form) into an electrical signal for display.

The shadow hand is composed of 24 joints designed to have a human range of movement similar to human hand, 4 fingers have 2 one axis joints and little finger has extra one axis joint attached to metacarpus to provide hand curl movement.

All hands have Hall Effect sensor's [1][12] integrated in every joint to provide precise positional feedback, the hands are electric motor driven [1] .The motor hand is driven by 20 DC motor in forearm. However we will not proceed in detail about the configuration of hand as our aim is to give an overview of it and how it can be utilized in S.H.I.EL.D ROBO-2.0

The dexterous manipulator is composed of 5 fingers and a box like palm however the palm will have a certain level of functioning.

The patient who sustained bullet injury would definitely suffer loss of blood but as discussed earlier the only work surgeon need to do is to stop the loss of blood before transmitting the patient in the shield robo-2.0 device. The palm of the hand is

composed of 3 rotatable circular panel connected to each other, each panel has its own type of working.
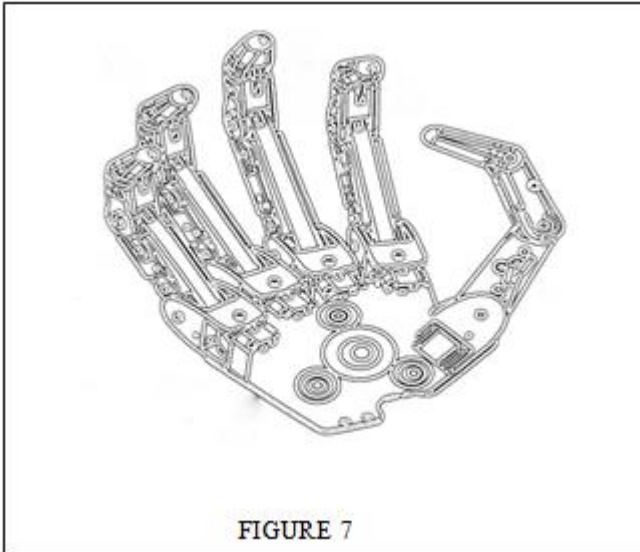

FIGURE 7

The palm is composed of 3 circular disks which are important while performing an operation

1ST disk is the most important of all the 3 disk as it emit X-rays which help the dexterous manipulator to scan and detect the region of operation after the operator has assigned the region of operation in panel 3/4 , this function of scanning is initially encoded in the Tele manipulator via algorithms, the scan completed by the manipulator will connect with the heat image generated in the panel 4 which will help the manipulator to identify the exact location of injury sustained, all the transmission and receiving of signal will be within [<=10 minutes] or so. The diameter of the disk will be [<=0.04] m approx.

2nd disk is used to emit wind of temperature of range varying from -2°C to 2°C , the temperature required this low is basically for frosting the region of injury the low temperature will minus the excessive blood flow from the body hence the region where the operation need to be performed by dexterous manipulator will get numb. The focal size of the disk will be pin hole sized. The thought is very dangerous and is very uncertain to perform however at the same time risk needs to be taken to achieve a successful task.

3rd disk is used to emit **LIGHT AMPLIFICATION STIMULATION EMISSION RADIATION (LASER)**[17], as talked about the emission of wind of temperature varying from -2°C to 2°C from disk2 it numb the area of operation hence the region of operation cited by the dexterous manipulator will have this disk emit laser which will burn the portion .

All the disk have clean and individual wiring which further sum up and get connected to the common rotor , these disk have individual Connection to the tubes which are externally connected to either a X-RAY source or a Gas chamber.

GRASPING [1][11][12][13][14]: Grasp by a human hand depend on the shape of the object, grasp is of 2 types:-

1. For heavy objects large force is needed hence the grasp required for them by the dexterous manipulator is ROBUST GRASP.

2. For light object "DEXTEROUS GRASP" is needed. *In SHIELD ROBO-3 Dexterous grasp is required by the dexterous manipulator*. As our focus is on dexterous grasp hence our emphasis is on dexterity and sensitivity

Control: Control is implemented in the robotic hand when a suitable operation and grasp choice is made hence in SHIELD ROBO-2.0 both the term is mapped in the

Dexterous hand, the grasp choice made is initially mapped in the manipulator via **algorithm** hence the dexterous hand will know the amount and control for the grasp is required.

2 main types of control:

1. Position Control
2. Force Control

Both the control are inter-related i.e. positional control is used in a situation when little force is needed to be generated basically for "good hand movement in AIR", however for manipulation task control amount of force is needed [1][11][12][13][14], and sensitize it to a level where the dexterous hand is able to peel a minor portion of the skin off from the area and grasp and remove the bullet, 2 fingers will be used to grasp a bullet.

Both the control are inter-related i.e. positional control is used in a situation when little force is needed to be generated basically for "good hand movement in AIR" , however for manipulation task control amount of force is needed.[1][11][12][13][14]

POINT OF CONTACT: For dexterous manipulation, contact between hand and object is very important. [1][11][13][15]

Frictionless point of contact:

Point of contact with friction:

Soft finger contact:
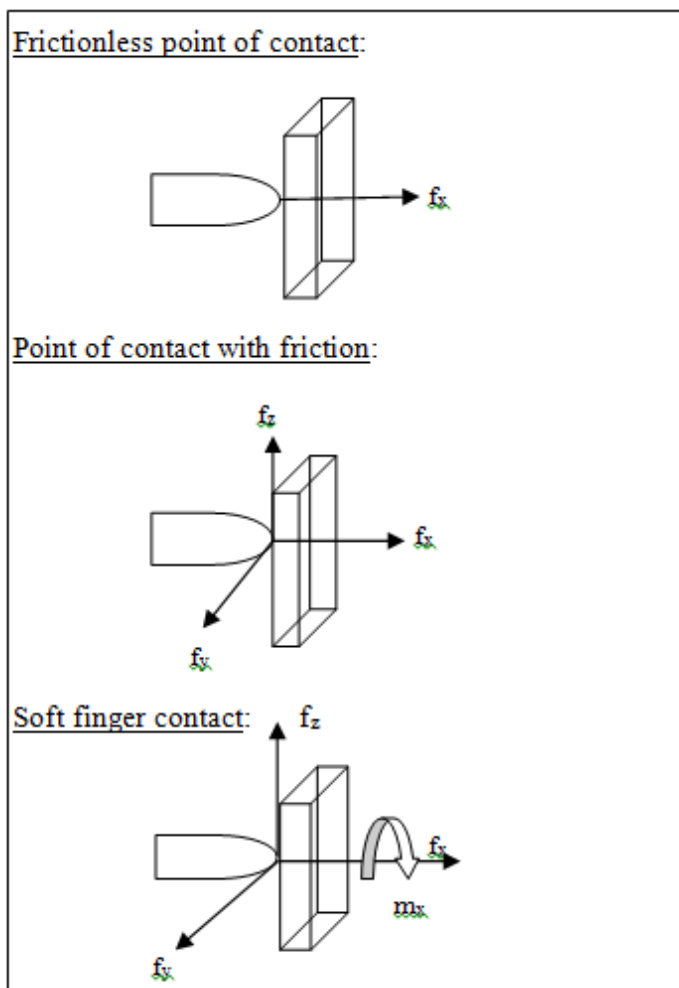
quality improvement. Final image is in **DIGITAL IMAGING COMMUNICATION IN MEDICINE (DICOM)**, the DICOM image is further sent to PACS. [3][4][5][16].

FIGURE 8
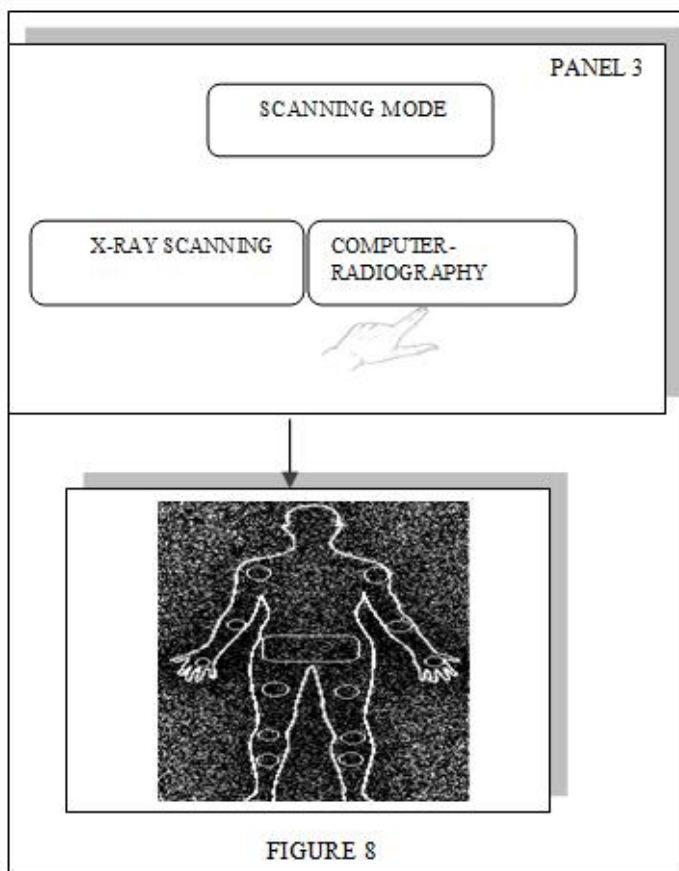
After the manipulator performs the operation function the patient is rested for 3-4 hours or so, after the time of rest is completed the patient is further moved for computer radiography to analyze the after effects of operations.

Uses the concept of radiography technique in which EM radiation such as x-ray is used to view internal structure of an opaque object, the x-ray generated via x-ray generator, certain amount of x-ray is observed due to the half value layer of the muscle and bone and some rays pass through it the x-ray captured by the detector which provide the 2-D image .The only difference is that the computer radiography uses imaging plate composed of photo stimulable phosphor. The imaging plate is placed under the area of concern, the imaging plate is run through special laser scanner or CR reader that read and digitizes the image. Hence role of CR is to scan the patient after operation and project the image of the operated area. However the radiography is also considered an advancement to x-ray.

The patient as well who are suffering from severe pain in any of the body area and which was not detected by x-ray. It can be as soft as tissue damage or torn muscle of a very minor nature. Then the patient is recommended for CR the patient will remain in LEVEL 2.0 scanning mode, the operator will enable the scanning mode via CR on the Rec.frame, the x-ray image received on phosphor plate which is further extracted via laser, and the image is a RAW IMAGE. This raw image processed for

VI. SECURITY

The term "secured" in SHIELD ROBO-2.0 is used for the security provided by the device, the security is provided by the Bio-metric panel inbuilt with voice recognizer, pattern and finger print scanner as this will help to avoid any intrusion or casualty caused by other present in hospital other than operator itself. Successful scan will unlock the device and provide full access to the device, non-recognized pattern or thumb impression if input more than 3 times then DEVICE alarm goes in ON state.

SECURITY PANEL: Using the concept of THUMB SCANNING/VOICE RECOGNIZING

FIGURE 9
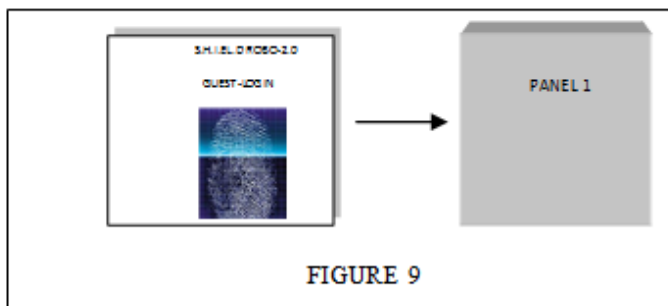
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