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ROBOVANTRI

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Abstract

In today's society, robots have become an indispensible part of human life. With more than 12000 hospitals, curing the health of billion plus Indian population, the problem of medical wastage disposal is a growing concern. To overcome shortcomings/inconsistency of assistance in medication, problem of medical wastage disposal and humans getting affected, we have attempted to build our project "Robovantri , a medical robotic assistant, specially designed to aid the Indian hospital conditions.

We aim for overcoming shortage of nursing staff, segregation, recycling, disposal of medical waste, a floor-wise robotic control system that can operate multiple controllable robots, for storing the patients' medical history and also to overcome nursing problems in unreachable rural areas.

The robot uses signboards placed at various critical points in the hospital for deciding the best possible pathway to reach its destination. We are implementing this using image processing in MATLAB.

As there are more than 12000 hospitals and more than 500000 beds in our country, it is impractical for the nursing staff to reach out at distant places at same time, also in case of lack of nurses or sanitation staff in remote parts of our country, these robotic subordinates can be helpful.The tasks which can be easily accomplished using the robot are such as assistance in medication reminders, transportation of medical products, medicines, etc. Also, the nursing staff cannot be available 24 X 7 whereas these robots can be available.

Keywords- CSSD; robotic assistant; Zigbee

I. INTRODUCTION

With a population of about billion plus, it has become a seemingly impossible and tough task for the healthcare units to reach out to every patient or the convalescent person, so we aim to reduce the workload on the paramedical personnel, sanitation staff ,etc. using our medical robotic assistant. The goal of the project is to construct a lightweight, sturdy, and affordable product that may become helpful in handling medical products, equipments carefully and can automize certain processes. The Central Sterile Supply Department (CSSD) is the most essential department within a hospital set-up contributes in personnel, sanitation attendants. So instead of employing human resources for this purpose, we can use

robotic assistants for processes that can affect human health.

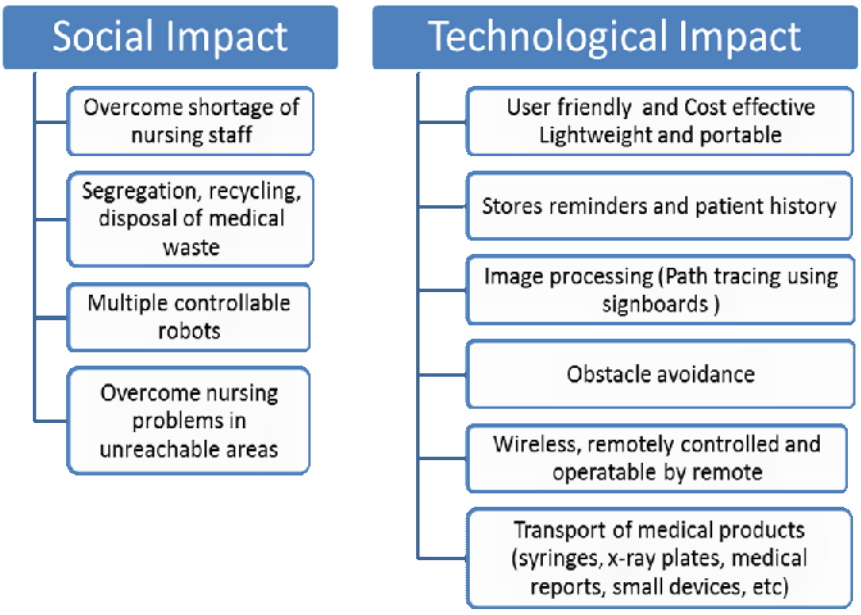
Robovantri can be used as assistants where there is shortage of nursing staff. These robots can be operated by staff and one trained individual can control 3-4 robots of this type at a time. The Robovantri will be user-friendly and is simple to operate. These robots are provided with the features of obstacle avoidance, tracing its path using sign-boards present in the hospitals with the help of Image Processing techniques. Thus, it will not interfere with the human activities and will perform as instructed.

II. PROBLEM DEFINITION

One of the major issues of developing India is the problem of 'Sterilization'. In most of the modern day processes, this issue is not given a heed as a result of which there has been an increase in the cases of health problems arising from improper sterilization and disposal of medical wastes.

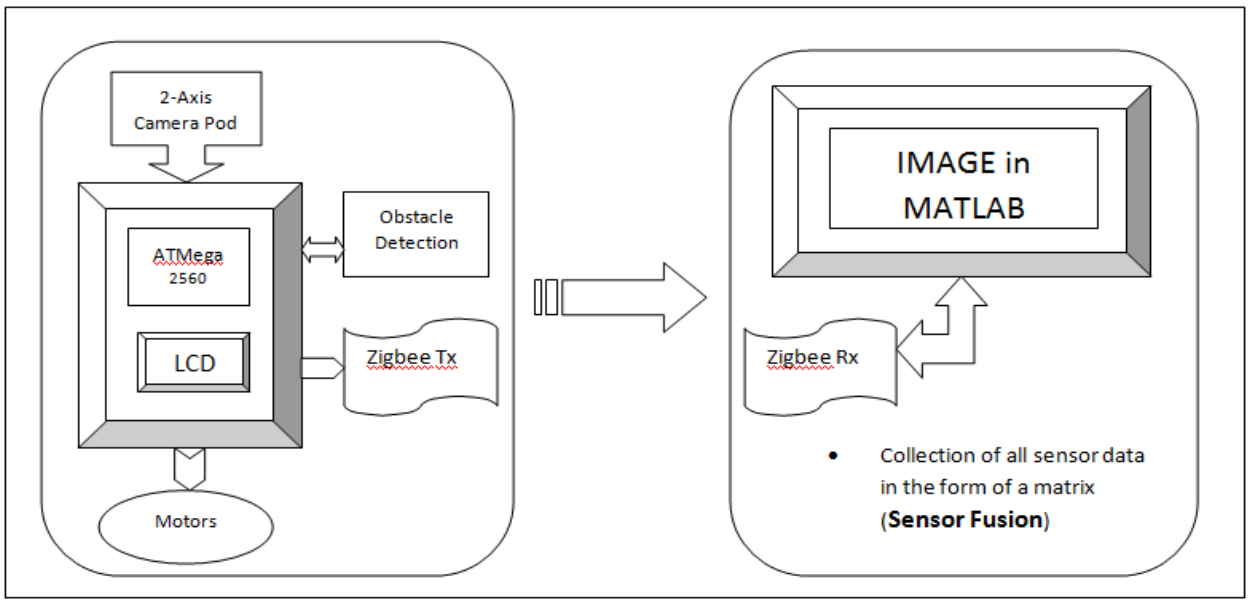
Through our project, we aim to devise a robotic assembly which would be adequate enough to handle medical equipments, sterilize the medication products before any use. The robotic medical assistant will be able to navigate within a hospital using the signboards present before every department within a healthcare network reduction of infection rate. The medical–robotic assistant aims to increase the efficiency of CSSD's activities of sterilization, storage and distribution of sterilized materials. It aims to reduce infection rate which may occur due to human errors. The segregation, recycling, disposal of medical wastage is a herculean task that can affect the health of nurses, paramedical personnel.

IMPACT:



III. DESIGN METHODOLOGY

In India, hospital wards are congested and difficult to maneuver due to a very high density of patients per unit area. This results in an insidious inefficiency in the nursing and sterilization system. Moreover, the hospitals work on an economic budget, leading to staff-cutting which creates a massive shortage of nurses and wards and also, a heavy physical and mental work strain on the employees. In order to do so, the Robovantri aims at being a cost-effective, easy to handle and maintain, and a low power robot.



(A) HARDWARE DESIGN

(1) **Selection of microcontroller:** The microcontroller chosen is ATMega 2560. The main purpose of chosing this controller is its ample support for motorized outputs via PWM (pulse width modulation) signals, a large programmable area, and the highest number of analog pins available in the ATMega series. The ATMega 2560 is equipped to provide a current of 100mA to every output pin with a typical fan out of 10. It is also easy to boot, program and reconfigure.

(2) **Electrical motors and actuators :** The Robovantri uses standard 300rpm (rotations per minute) motors with a torque of 4 $kgcm^2$ for the base movement, standard 180 degree metal gear servo

motors with 3 $kgcm^2$ torque for rotation and pitch movements of arms, and standard 180 degree microservo motors for end-effectors and manipulators having 1 $kgcm^2$ torque each.

(3) Obstacle detection and avoidance: The body of Robovantri is continually integrated with highly sensitive IR (infrared) reflective sensors. The IR spectrum is the heat spectrum of the environment and thus is sensitive to heat emanated from the surrounding. Depending upon the ambience, the IR receiver will obtain a range of analog voltage varying from Vcc (supply voltage, usually 5V) to GND (ground voltage, usually 0V). Using the simple direct proportion relation between light intensity and voltage, the robot decides the approximate distance of the obstacle in its vicinity. Using such information from a host of other IR sensors, it will form a graphical image of the distance coordinates of the obstacle.

A 2-axis camera pod fitted on the top of the robot will monitor the object continually and send the real-time images to the main control system. These images will be transmitted wirelessly via Zigbee module. The main control system has a TV tuner which can decode these images and control the subsequent actions of the robot.

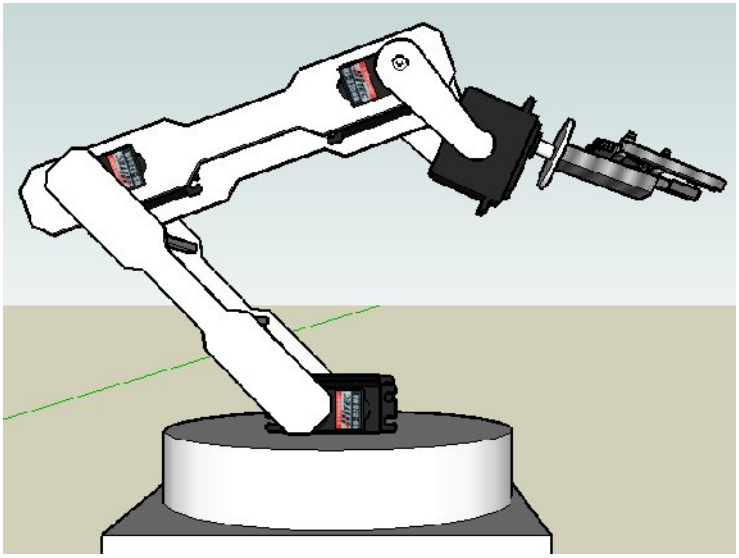
(4) Wireless communication: The Robovantri communicates with the Main Control Room at sight-dependent radio frequencies using Zigbee 802.15.4. This module provides a range of 30m to cover the topological area of an entire hospital ward. Thus the controller can remain stationary and control the Robovantri remotely and perform tasks efficiently. The Zigbee device operates at TTL 5V level and thus is easily interfaced with other circuitries in the embedded system. It utilizes a very low power of 130mW typically and works at a frequency of standard 2.4 GHz.

Feature	Typical Value
Model code	XB24-AWI-001
Operating Frequency	ISM 2.4 GHz
Antenna type	Wire antenna
Indoor/Urban Range	100 ft. (30 m)
Outdoor RF line-of-sight Range	300 ft. (90 m)
Interface	Serial(UART) at 1200-115200 bps
Supply Voltage	2.8 – 3.4 V
Transmit Current	45mA (@ 3.3 V)
Idle / Receive Current	50mA (@ 3.3 V)
Dimensions	0.960” x 1.087” (2.438cm x 2.761cm)

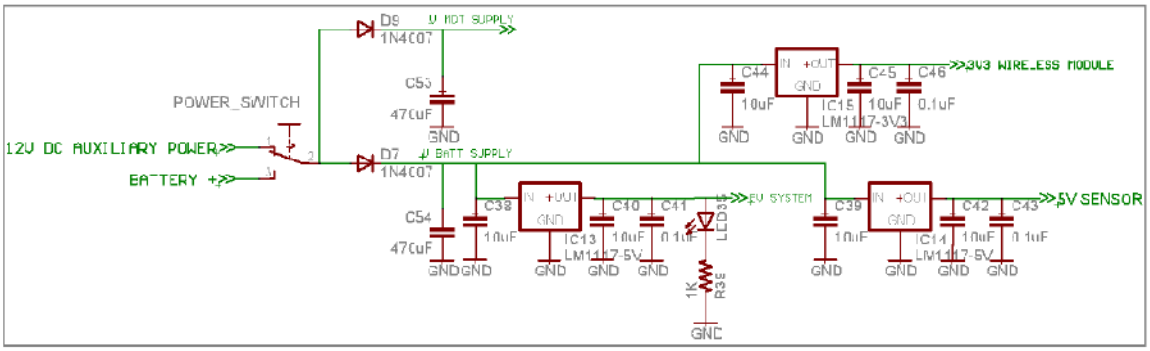
Operating Temperature	-40 to 85º C (industrial)

Feature(s)	IEEE 802.11b	Bluetooth	ZigBee
Power Profile	Hours	Days	Years
Complexity	Very Complex	Complex	Simple
Nodes/Master	32	7	64000
Latency	3 Seconds	10 seconds	30ms – 1s
Range	100 m	10m	70m-300m
Extendibility	Roaming Possible	No	YES
Data Rate	11Mbps	1 Mbps	250Kbps
Security	CCMP/TKIP 128bit/64bit	64 bit, 128 bit	128 bit AES and Application Layer

(5) Arm structure: The robotic arm has been designed in such a way that it holds a total payload of 10-20 kg with its two arms. To effect this, the Robovantri is equipped with a pair of robotic arm that contains metal gear servo motors with a torque of 12 $kgcm^2$ each. The arm has a total of 5 degrees of freedom. The base of the arm can rotate axially followed by rotator and pitch motions of the wrist. The fingers are equipped with microservos with a torque of 3 $kgcm^2$. The end-effector has two fingers that simulate the motion of the thumb and the middle finger of the human hand. The reason behind choosing these two fingers is to maximize the normal thrust while picking and placing. These two fingers make an equiplanar distribution of applied force to initiate the gripping movement.



(6) Power consumption and security: The most important part of Robvantri's effective power consumption technique is its intelligent power supply. This supply can generate the voltage levels required for all outputs of the circuitry as well as the power to be supplied to the robot's microcontroller. The battery is equipped with an intelligent battery meter and has alarms for detecting low-power as well as overcharging. This is carried out using the BAT09 IC. The following diagram shows how the power supply generates a voltage output for 9V, 6V, 5V and 3V3 using voltage regulators:



Optoisolators

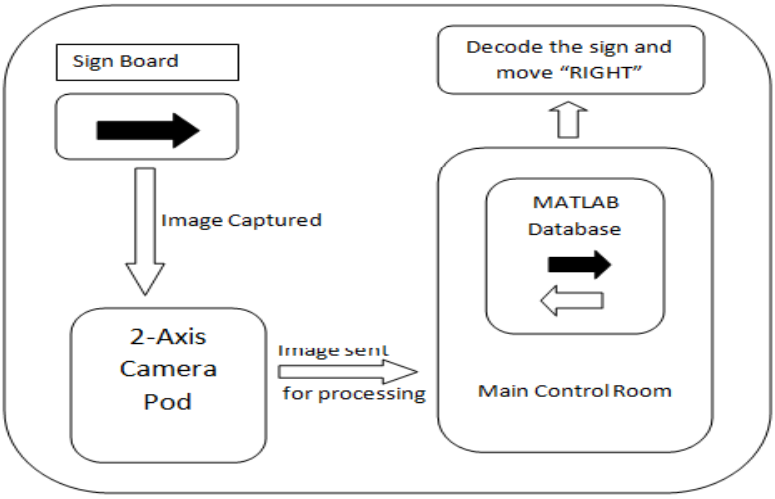
The entire assembly of the robot contains devices requiring a current rating from as low as 100mA to upto 2A. These include digital devices as well as noisy inductive devices like motors and gears. The digital devices control the functioning of the large noisy devices and even with a slight leakage of noise from motors into the digital devices, they may get damaged or even permanently

unusable. This may also result in unexpected sporadic reactions from the robot and damage the surroundings also.

To remedy this important problem, there is a need to separate and protect the sensitive devices from the noisy devices. The Robovantri uses Optoisolators for this purpose. The optoisolatorPC817 is been used to isolate the digital devices from the motors by creating a physical disconnection between them. It consists of an LED facing a phototransistor. When a digitally high bit is sent to the LED, the light emitted falls directly incident on the base of the phototransistor thus activating it. Thus a physical isolation protects the devices from leaky back currents.

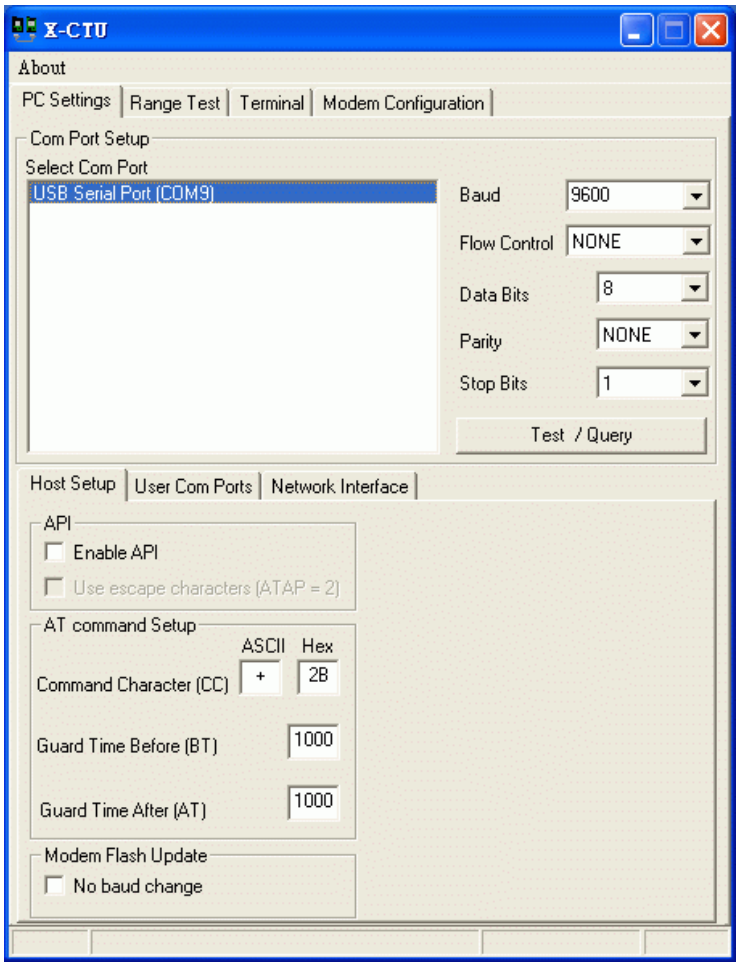
(B) SOFTWARE DESIGN

(1) Signboard detection and identification of direction: The Robovantri uses an innovative way of navigation. It uses a unique method of navigation by identifying the sign–boards mounted outside every hospital ward. Robovantri uses MATLAB Image Processing techniques for identifying the sign. When the robot comes across any signboards in the hospital, the image of the sign is captured by the Robovantri and is sent to the Main Control Room. Then it is compared with the existing MATLAB Database and the image captured is decoded using the tools present in MATLAB. After decoding, the Robovantri moves in the direction as indicated on the sign-board. Thus, the Robovantri is able to move in the intended direction.



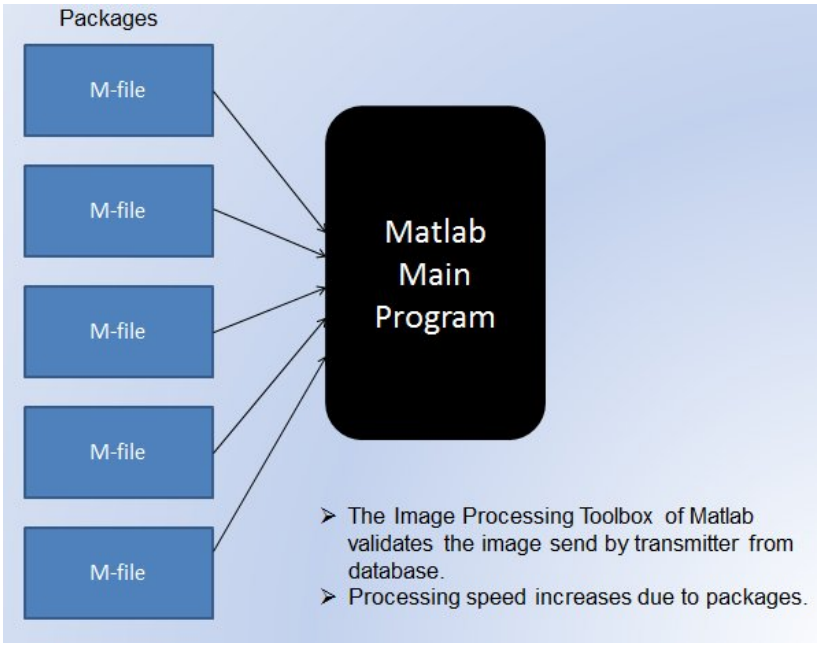
(2) XCTU : XBee modules are wireless devices which are easily available. It is a transceiver as it can transmit data wirelessly and it can also receive data wirelessly. To configure Xbee/Zigbee module,

XCTU is required. XCTU is **X**Bee **C**onfiguration and **T**est **U**tility and it is a free utility from Digi. It can read as well as write all the Xbee modules. It is mainly used to have a point-to-point communication between the robot assembly and the main control room.

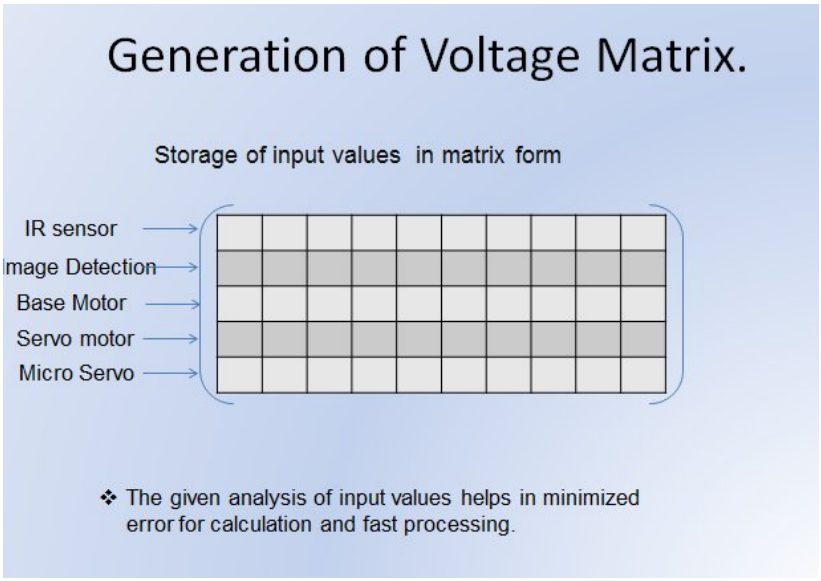


(3) Prepackaging and parsing commands : Pre-packaging refers to the process of creating various packages(function files) in MATLAB and Parsing refers to calling it in the main code file so as to easier the software computing, debugging and analysis. Pre-packaging and Parsing increases the speed of processing.

Collection of data by the sensors of the robotic assembly is referred to as sensor fusion. This fusion of data helps the person in the main control room to compare it with the database stored and instruct the robot accordingly.



The real-time data collected by the Robovantri is taken in the matrix form and using the different MATLAB tools, this voltage matrix can be analysed and accordingly appropriate control signal is sent to the robot. The block schematic of this voltage matrix is as shown below



IV. ADVANTAGES

Firstly, the Robovantri deals with handling the medical wastage disposal issue which is a great concern in many of the hospitals. Secondly, use of Robovantri in the Sterilization process can help to reduce the infection rate. Also , Robovantri can be used as an assistant for storage and transportation purpose.

The Robovantri's navigation using the MATLAB Image Processing tools is first of its kind to be implemented in a hospital network. Elimination of line sensing modules from our robotic assembly prevents to lay tracks inside the hospital ward. Also, it is a cost-effective project which can be beared by most of the state-run government as well as private hospitals.

V. DISADVANTAGES

Robovantri becomes difficult to operate in a congested environment such as the state-run government hospitals. Also, Robovantri may get damaged by any liquid chemical as it is not a liquid handling robot. Also the operation of this robot requires a skilled person for its operation and control .The power consumption can also be considered as not much efficient. And lastly, some patients may be uncomfortable with the robotic assistant used in their medication as they may not get the adequate help as in case of nursing staff.

VI. CONCLUSION

Robotics has been extensively explored for developing various uses in the industries , but the application of robotics in the field of medical sciences (hospital networks) can be still considered as untouched, atleast in India. So, we through our project- "Robovantri" want to exploit the use of robots in healthcare units.

Robovantri can reduce a great amount of strain and pressure of workload from the shoulders of the different medical attendees and sanitation staff. Also I, its use in the Sterilization process can reduce the infection rate and the risk of the infection to the person handling the sterilization process. The medical wastage disposal is another added advantage of this project. Thus, the "Robovantri " is a cost –effective project which ensures of reducing the workload by using it as a robotic assistant.

VII. ACKNOWLEDGEMENT

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