Tele-Robot Design for Deep Space Medical Emergency

Dr Vini Khurana

11 September 2021

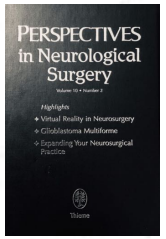
Acknowledgements & Declaration

No Conflict of Interest

Vini Khurana
Prashant Singh
Vikrant Singh
Cathy Zhou

Provisional Patent Application 2020903976;
“Life Support Tele-Robot”, CNS Aerospace Pty Limited,
Lodged with IP Australia/Australian Government
on 2 November 2020

Relevance



Virtual Frontiers, Part 2: Role of Virtual Reality Technology in Neurosurgery

VINI G. KHURANA, M.D., LISA M. BATES, B.S., FREDRIC B. MEYER, M.D., and RICHARD A. ROBB, PH.D.

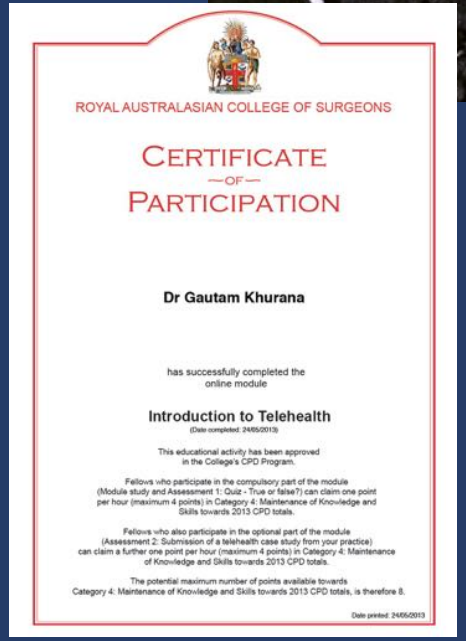
ABSTRACT During the last decade, advances in biomedical imaging and computation have enabled more precise and accurate determination of tissue structure and function, along with three-dimensional (3-D) reconstruction, visualization, and intuitive manipulation of such multimodality data. The practice of neurosurgery has benefited from such advances, as reflected by their facilitation of surgical diagnosis and planning, miniaturization of operative cor-

1999

Perspectives in Neurological Surgery

Fig. 5 VR methods may be used to further examine preoperative data in real time. A process known as tiling is used to define the surface anatomy of individual "objects" that have been segmented (i.e., differentiated) from the total volume image data. The left object is the "tiled" ventricular system of a patient, which can be

Neuronavigation since 2001



ROYAL AUSTRALASIAN COLLEGE OF SURGEONS

CERTIFICATE
—OF—
PARTICIPATION

Dr Gautam Khurana

has successfully completed the online module

Introduction to Telehealth

(Date completed: 24/05/2013)

This educational activity has been approved in the College's CPD Program.

Fellows who participate in the compulsory part of the module (Module study and Assessment 1: Quiz - True or false?) can claim one point per hour (maximum 4 points) in Category 4: Maintenance of Knowledge and Skills towards 2013 CPD totals.

Fellows who also participate in the optional part of the module (Assessment 2: Submission of a telehealth case study from your practice) can claim a further one point per hour (maximum 4 points) in Category 4: Maintenance of Knowledge and Skills towards 2013 CPD totals.

The potential maximum number of points available towards Category 4: Maintenance of Knowledge and Skills towards 2013 CPD totals, is therefore 8.

Date printed: 24/05/2013

Tele-Med since 2013

Mazor Robot since 2017

www.surgicalneurologyint.com

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Editorial

Awake craniotomy versus piloting an aircraft: What medicine and aviation can learn from one another?

Vini G. Khurana[1], Praveen Vats[2]

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The "miracle of flight" and the "miracle of awake brain surgery" l
founded on innumerable person-years of invention, trial, error, a
success, almost every step needs to go right. Rules must be followe
the past incidents and experience. Innumerable technical, technologi
interactions must also converge to facilitate the completion of
neuroanesthesia, similar protocols apply to perform awake cranioto

Pilot Licence 2018

ASAM 2018 & 2019

REVIEW ARTICLE

Aerospace Medicine and Human Performance

THE OFFICIAL JOURNAL OF THE AEROSPACE MEDICAL ASSOCIATION

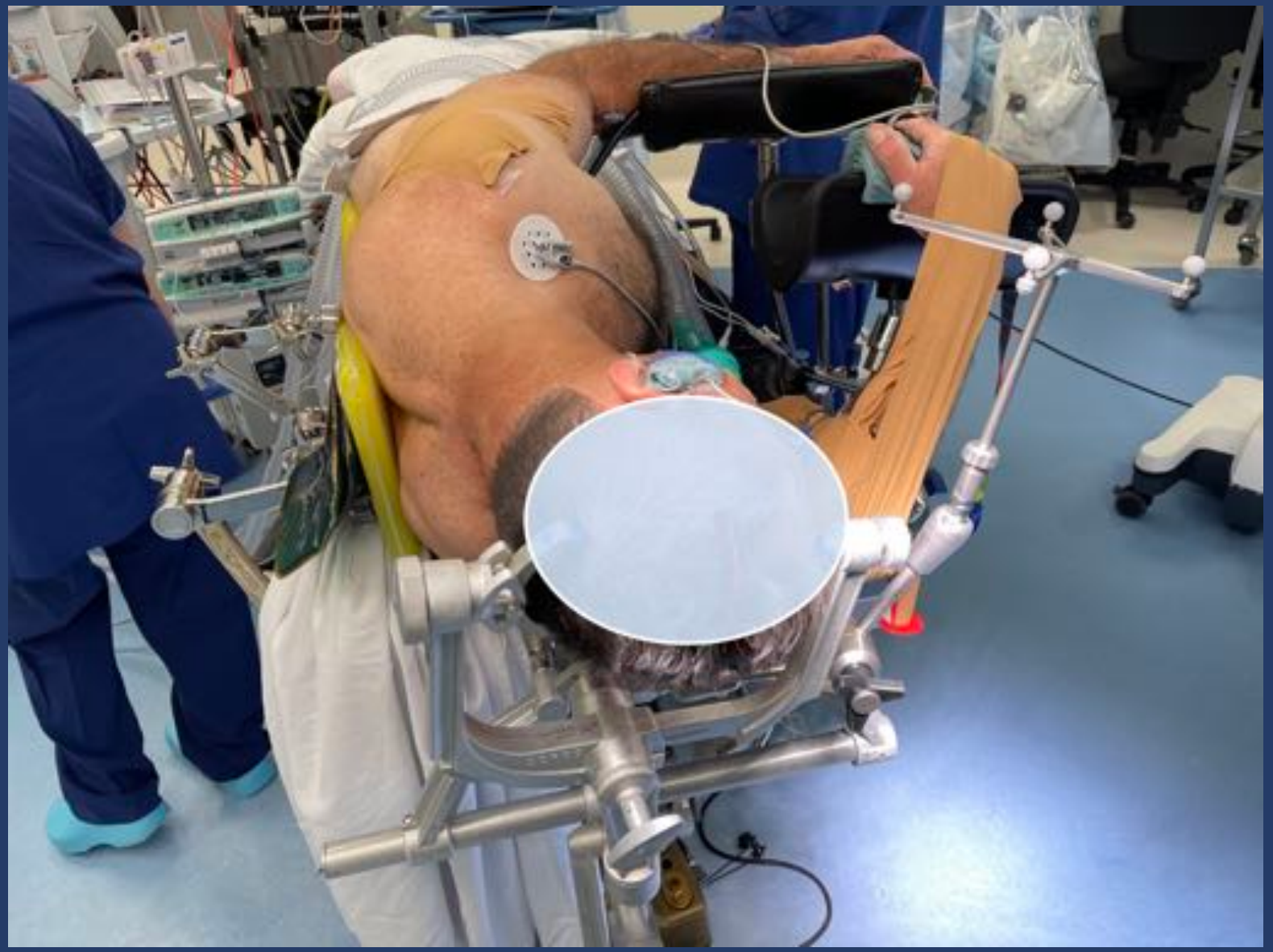
Aerospace Implications of Key Neurological Conditions

Vini G. Khurana; Rondhir Jithoo; Michael Barnett

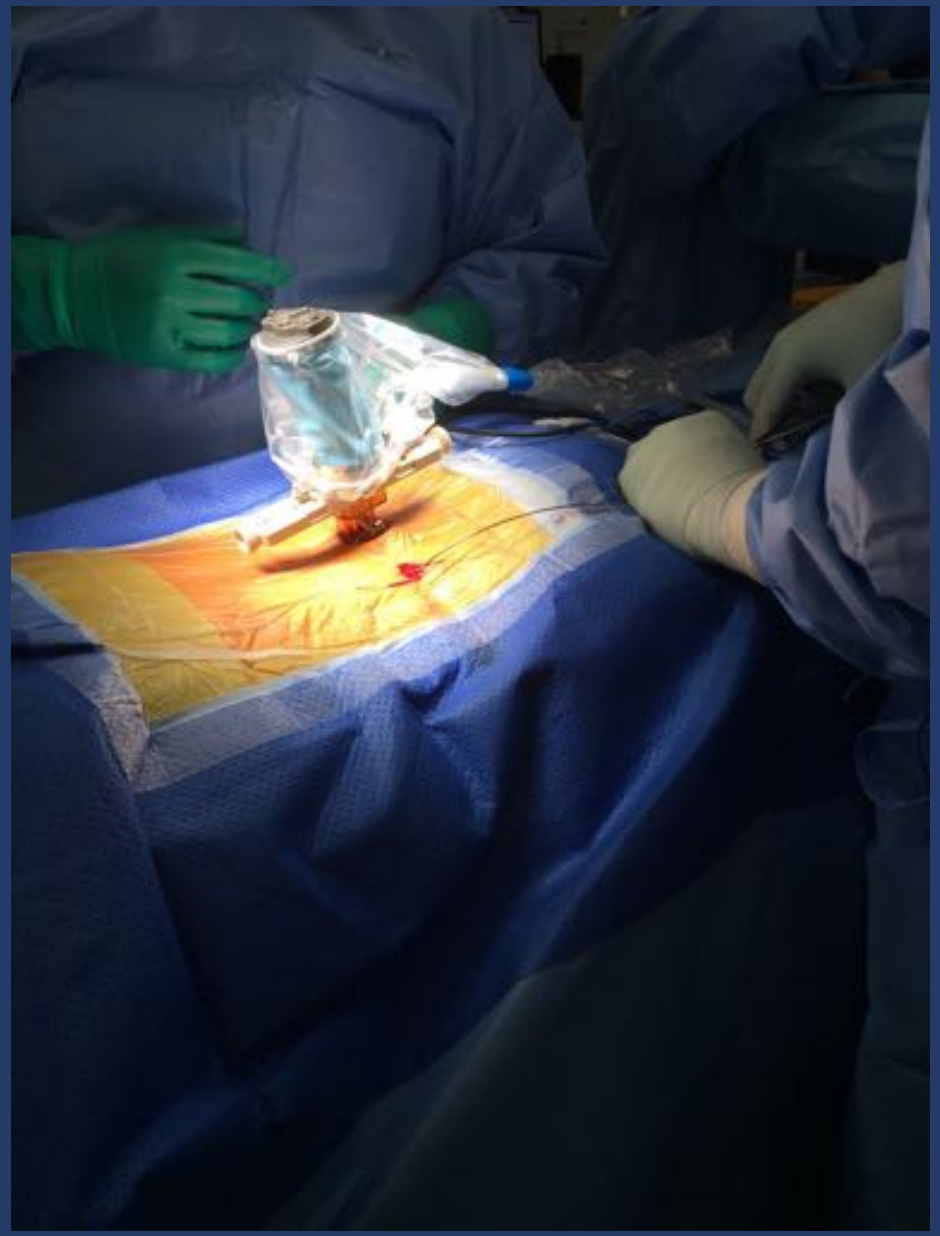
INTRODUCTION: The neurological impact (or lack thereof) of certain medical histories and imaging findings is important to understand in the context of air and spaceflight. There are a number of neurological conditions that, if present in pilots and astronauts, carry variable (and sometimes adverse) functional implications for safety and overall mission success. In this systematic overview, the authors will refer to the relevant clinical and radiological features of brain tumors and vascular anomalies, cerebral edema and intracranial hypertension, concussion and the traumatic brain injury (TBI) spectrum, hematomas, cerebrospinal fluid circulation anomalies including hydrocephalus and sequestrations, spinal degenerative changes, and cerebral ischemia and demyelination. It is notable that these last two conditions have recently been reported to be a complication in some people

Standard Modern Neurosurgical Theatre (on Earth)

A Highly Specialized Team (Earth ‘Crew’)



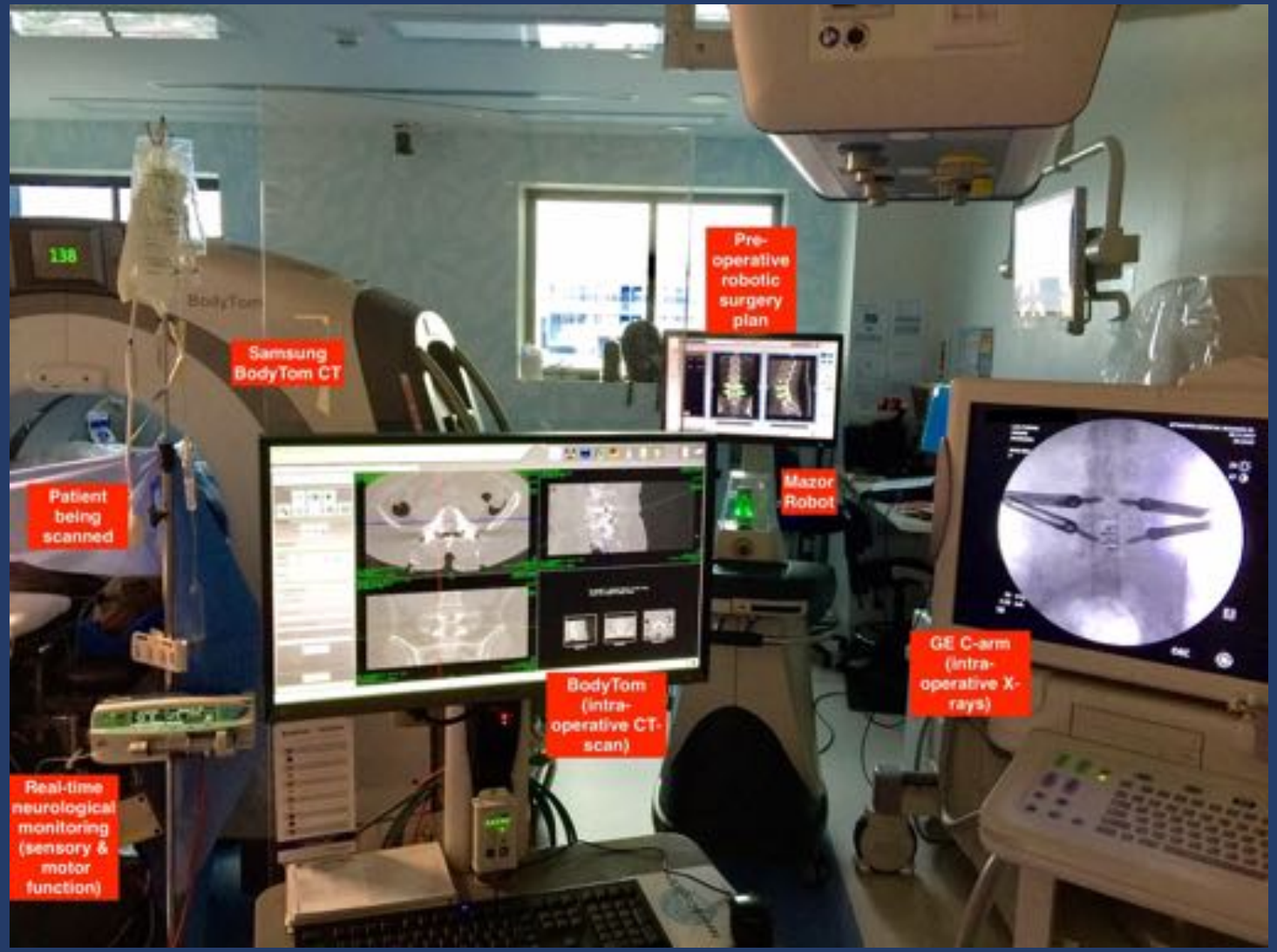
More Complex Patient Positioning & Monitoring (in ‘Standard Gravity’)



Mazor Robot (Ready Access to Supplies, Service, Technical Support Here)

Available Back-up (Personnel, Equipment)

Relatively Convenient 360-degree Patient Imaging



Equipment and More Equipment (Optimising Procedural Accuracy & Patient Safety)

Moon Base – Relative Proximity - More Feasible Translation in Medium Term

COMMENTARY

Making Humans a Multi-Planetary Species

Elon Musk

Chief Executive Officer
SpaceX
Hawthorne, California.

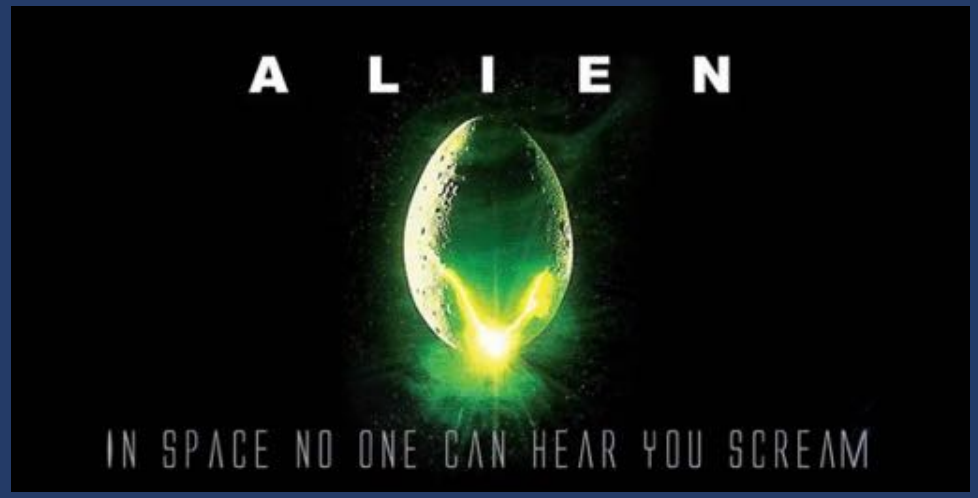
By talking about the SpaceX Ma
to make Mars seem possible—m
it is something that we can do
really is a way that anyone coul

WHY GO ANYWHERE?

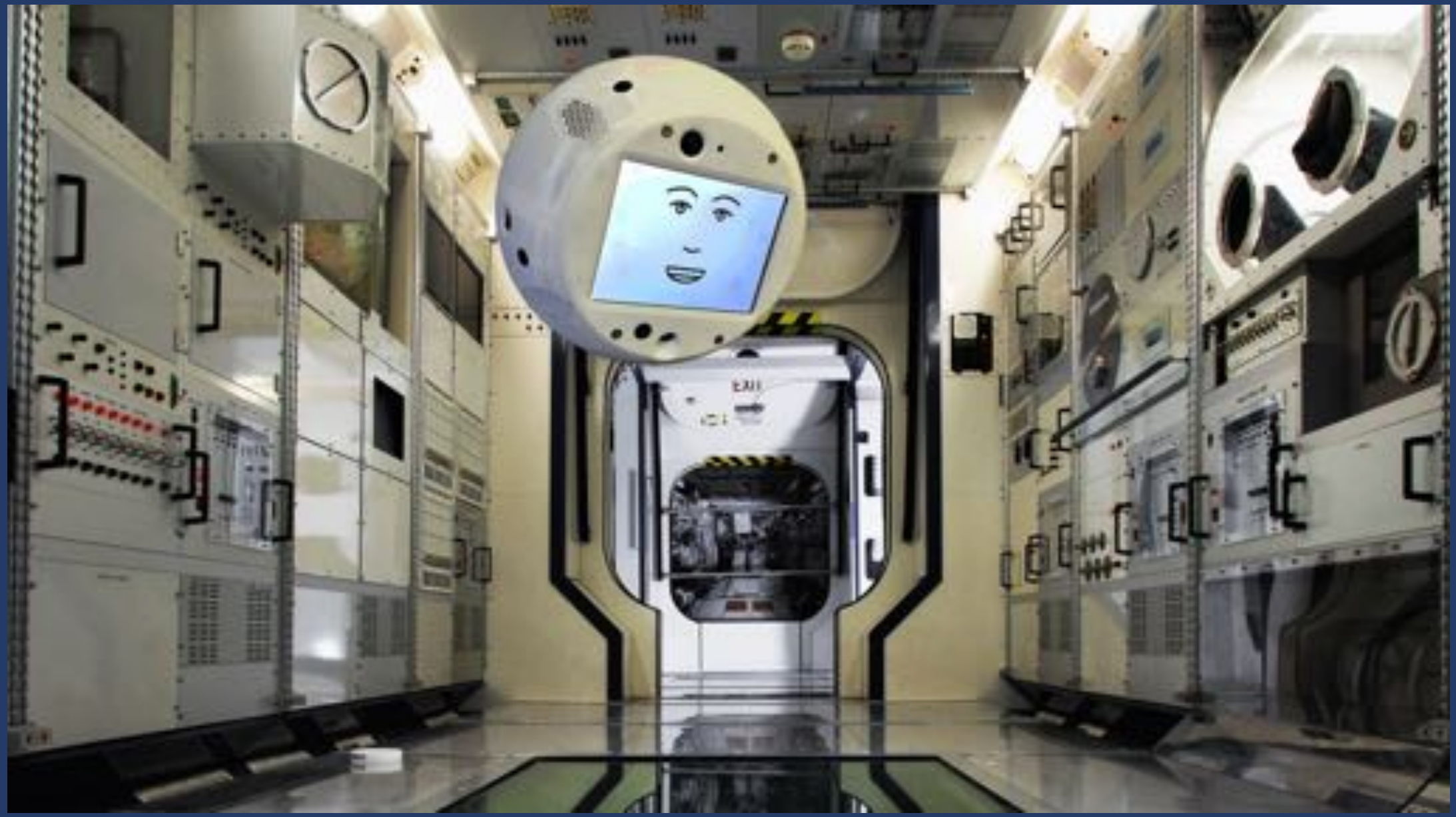
I think there are really two fundame
going to bifurcate along two directions.
Earth forever, and then there will be so
event. I do not have an immediate do

Mars Base – Relative Remoteness - Less Feasible Translation (At Least in the Short & Medium Terms)

Practical Limitations of Deep Space Medical Interventions

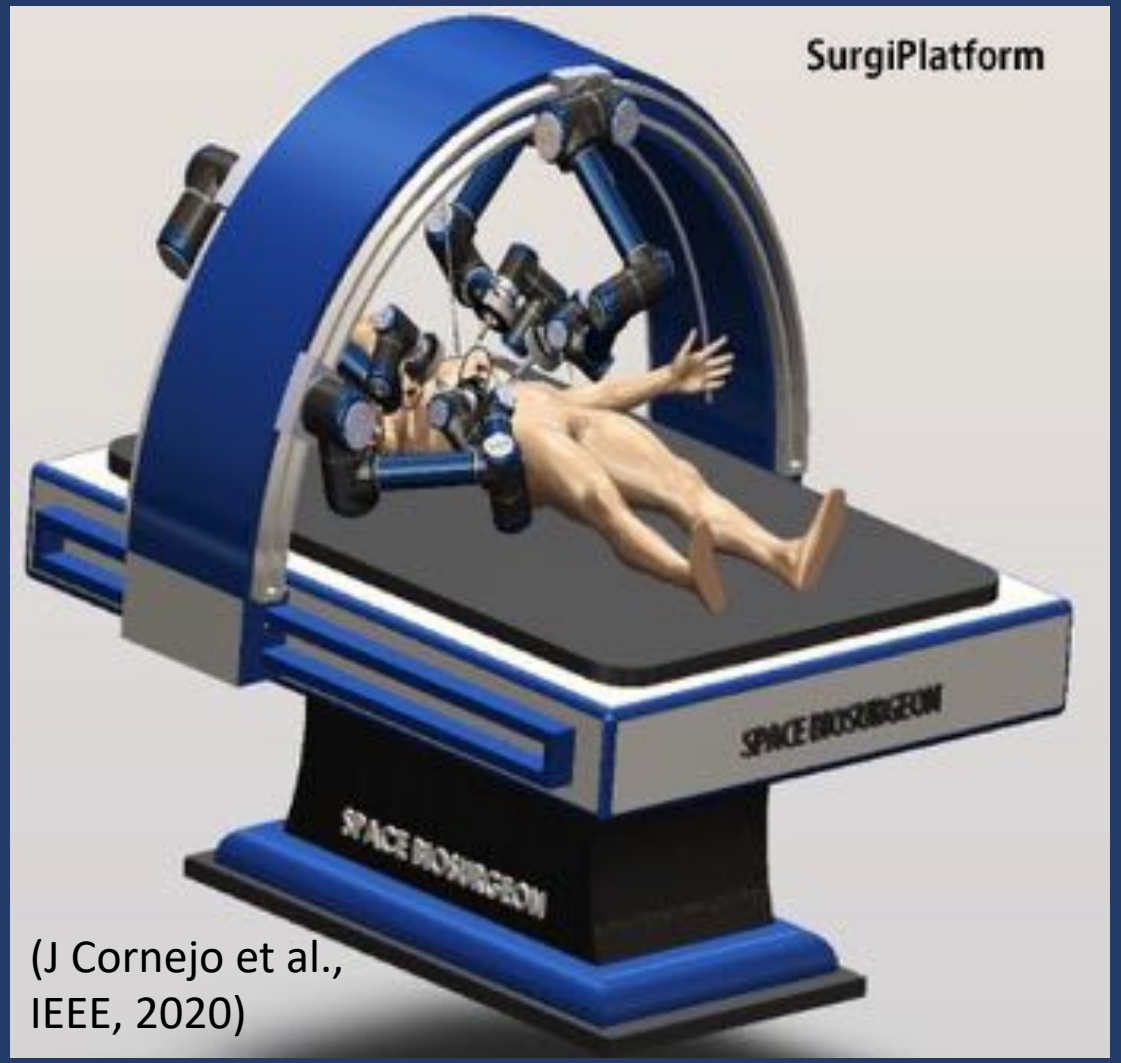


- Dangerous environment to begin with
- Communication delays/latency
- Accuracy of haptic feedback
- Operator experience
- Effects of low gravity on restraint of personnel, equipment and biological tissues
- Lack of availability of physical products even with local 3D-printing
- Deficit of human back-up and evacuation options



CIMON (German Space Agency, Airbus, IBM Watson; Used on ISS)

Robonaut (NASA; Used on ISS)



(J Cornejo et al., IEEE, 2020)

Conceptual Design of Space Biosurgeon for Robotic Surgery and Aerospace Medicine

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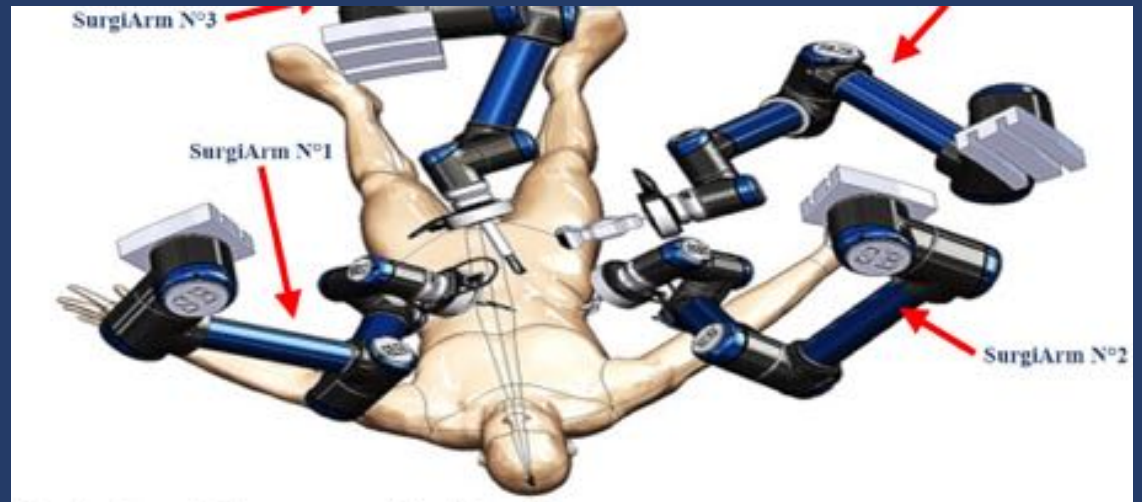
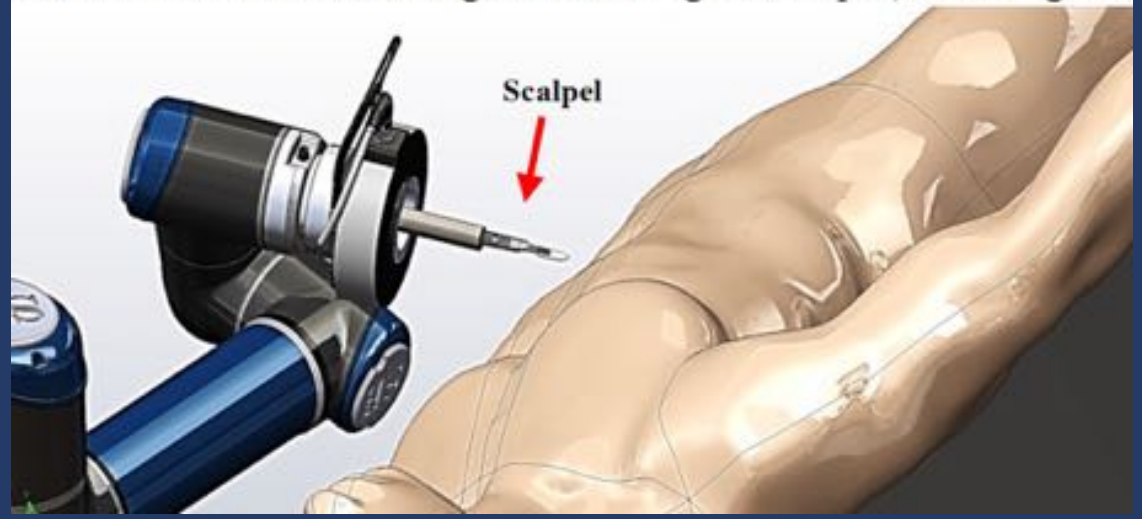


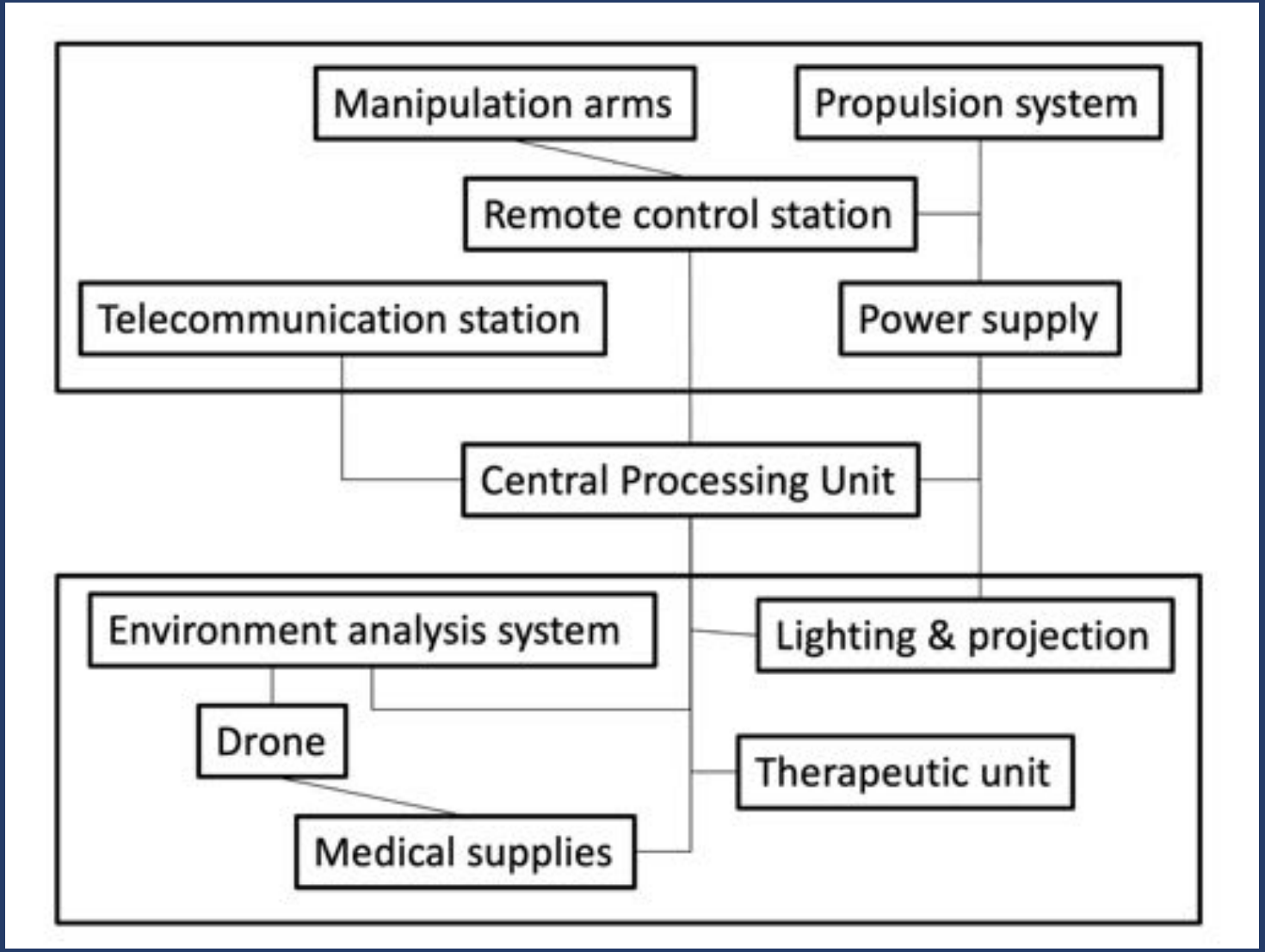
Fig. 7. Space Biosurgeon with 4 SurgiArms

c.1) *SurgiArm N°1*

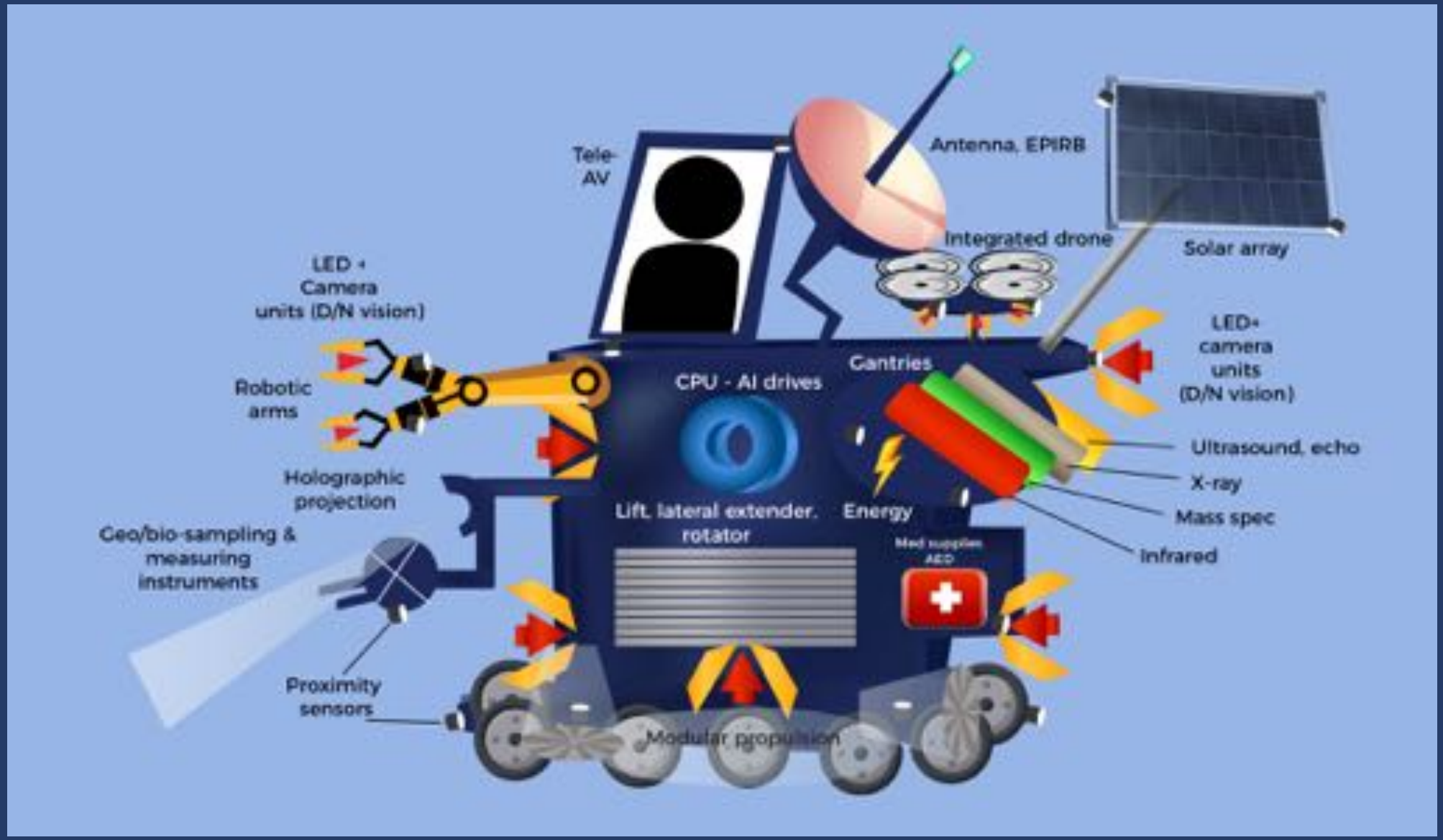
This robotic arm is located on the upper left side of the SurgiTable and of the patient (in External Axis-1); as well as it has the function of making a cut through a scalpel, as in Fig. 8.



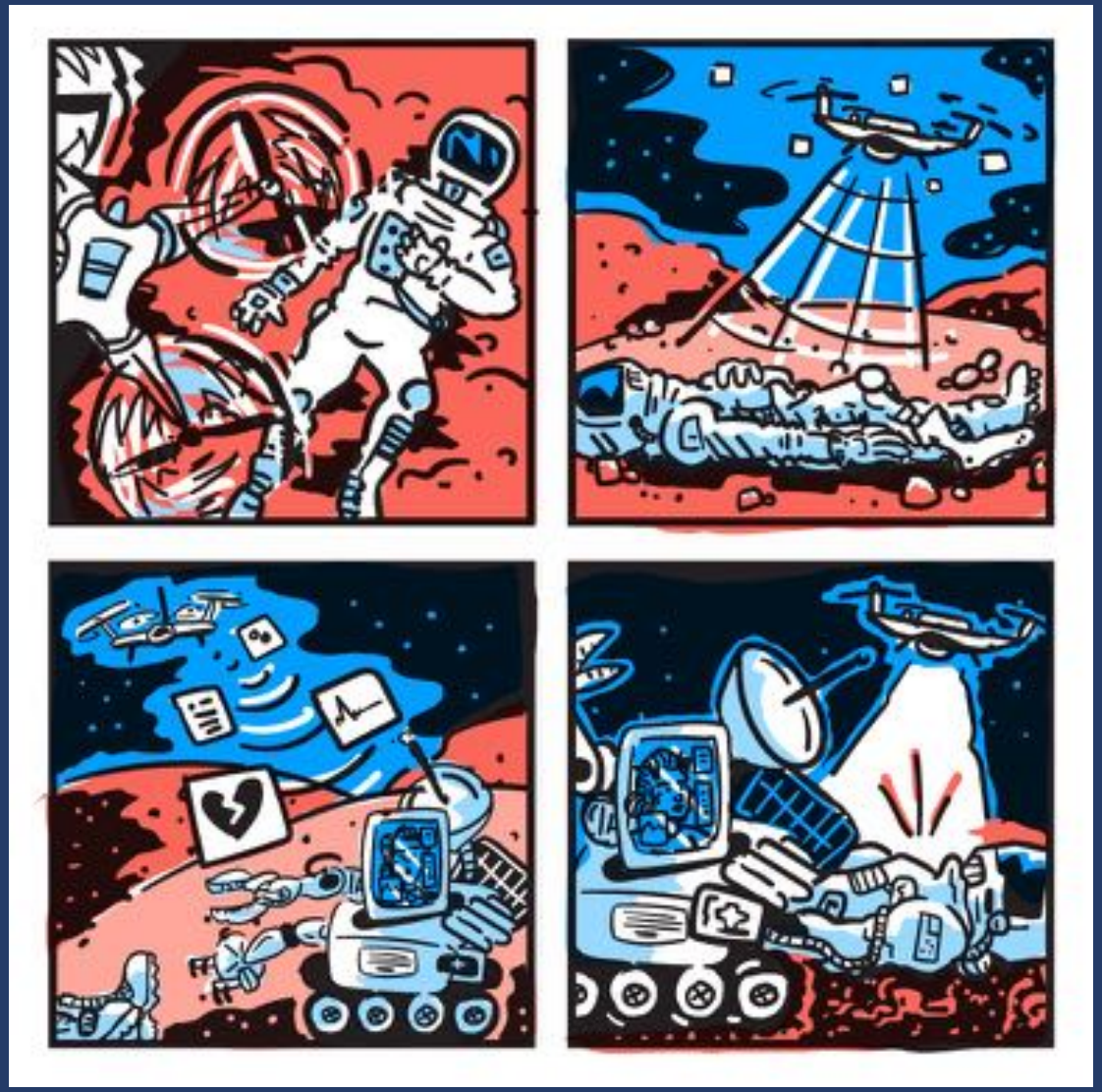
Our Goal – Design An Aerospace Robot Whose *Essential Purpose* is Medical Beneficence



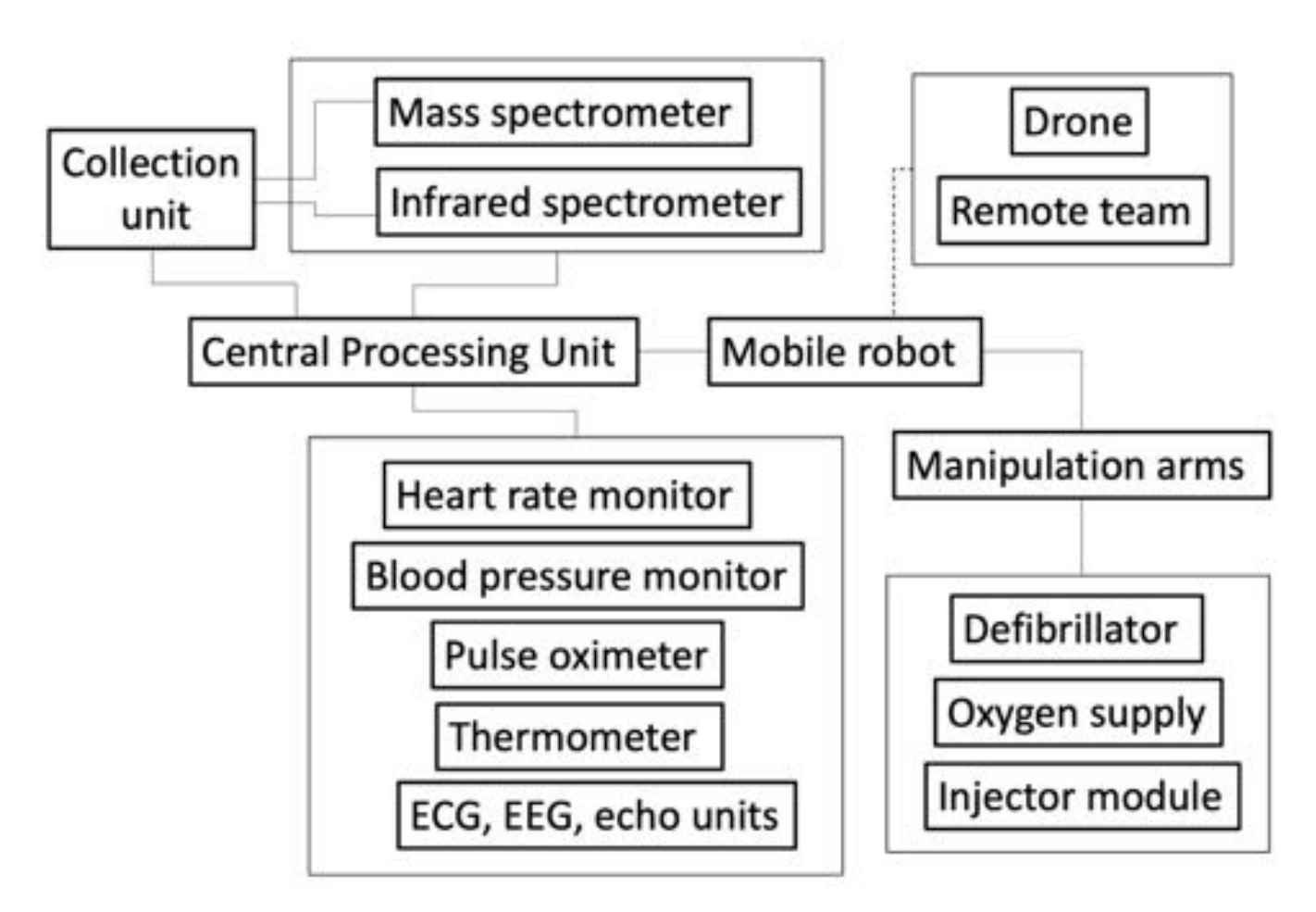
Our Goal – Design An Aerospace Robot Whose *Essential Purpose* is Medical Beneficence



L.I.S.T.E.R.’s Key Features (Digital Artist: Ayesha Ali)



Intervention Scenario (Artist: Ben Mitchell)



Injured (+/- Extravehicular) Astronaut – Location, Assessment, Supply, Intervention and/or Retrieval by L.I.S.T.E.R.

?Build a Scale Prototype (Parts under US $1,000)*

CONCLUSIONS

- **LI**fe **S**upport **TE**le-**R**obot (L.I.S.T.E.R.)– A dedicated aerospace medical robot
- Key *medical* features:
  - Modular biomed. imaging systems (mass spec., IR, ultrasound, X-ray)
  - Manipulation/intervention-capable arms
  - Receives and analyses telemetry biodata (basic vitals, oximetry, ECG, EEG)
  - Integration with e.g., Astroskin (even pre-positioned integrated defib. pads)
  - Tissue sampling systems (e.g., blood, breath)
  - Environmental threat analysis (radiation, noxious gases)
  - Analyses facial features, retina, gait, behaviour, verbal communication
  - Integrated drone for recon., med. supplies, illumination, intervention surveillance
  - Holographic projection for clearer communication of med. instructions/techniques
- Limitations include environmental, logistic, technological, operational

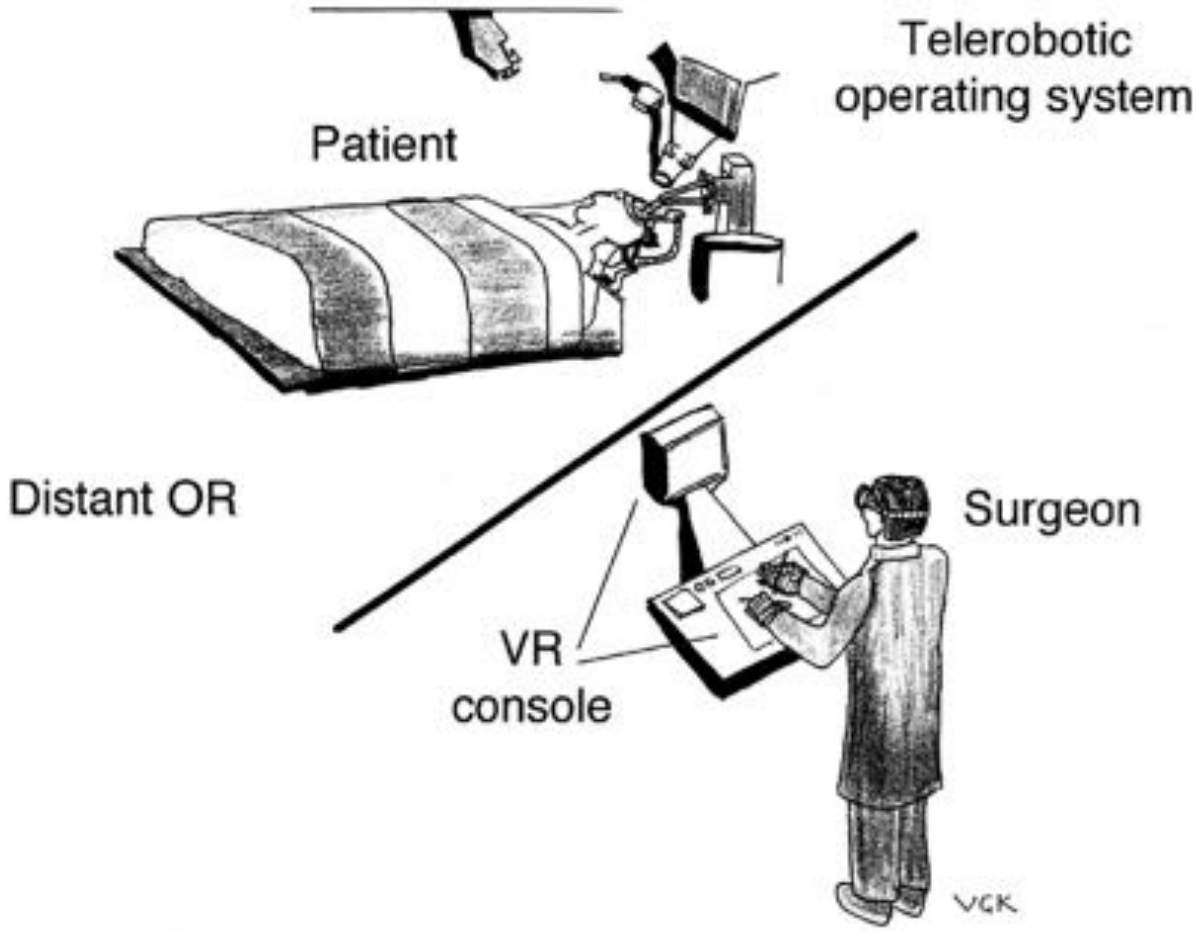


Figure 28. Telesurgery: The OR telesuite.

(VG Khurana, “Brain Surgery” - AuthorHouse, 2006)

We’re happy to collaborate!

Thank you