Info:

Shared scenario creation flowchart
https://miro.com/app/board/o9J_ktNrYxE=/

Overview page with all rules/guidelines and some design elements
https://www.notion.so/avatarmedic/XPRIZE-MEDInaut-1abfe69cc8164605a85f478ba445f493

Key aspects

behavioral human interaction

- keep simple
- patient assessment
  - questionnaires

medical intervention

- vaccine administer
- IV administer
- bleeding control
  - Pressure
  - tourniquet administer

Example scenarios:

IV scenario

- ~~ping before losing consciousness~~
- ping vitals are critical
- rover goes to location

take vitals

person dehydrated

administer IV

~~person regains consciousness~~

avatar does psych evaluation

COVID 19

collecting blood for antibodies

using syringe

nose swab

doing patient assessment (gathering personal history)

Biometrics

Triage

bringing samples over to lab

or onboard tests?

cleaning surfaces?

COVID 19 treatment

Intubating

Ventilating

connecting to external system

robot has ventilator

monitoring intubated patient

Needs of the robot

- sterilization
  - Use UV light?
  - Copper surfaces?
- manipulator
  - Handles x tools

COVID-19 PANDEMIC SCENARIOS

Author: Susan Ip-Jewell MD

SCENARIO:

NOTE: Scenario setting can be modified for a clinical setting, for example, ER or ICU

- COVID-19 Pandemic – Oder "stay-at-home" self-quarantine, social distancing and isolation

- Call for EMR/paramedic services for a Patient is 61year old Asian female; complained of fever, slight short of breath and hemorrhaging from a broken lower leg ankle after falling from a chair

- She is under self-quarantined in the house with her family member(s)

- Patient can also be isolated inside a medical facility and hemorrhaging from a recent surgery but also contracted COVID-19

- Arrival of AvatarMEDIC enters area

There are five areas:

- **isolation room /area with patient (A)**
- **AIRLOCK Area (B)**
  - CDC Protocol for Cleaning and Disinfection for Households
- https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cleaning-disinfection.html
- **Designated UV sterilization room/area (C)**

https://www.amazon.com/Shindn-Disinfection-Sterilizer-Purification-Multipurpose/dp/B08699J8XP

- **Common area for family member(s) (D)**
- **Controller and team area (E)**

FIGURE: Example of the scenario setup inside a controlled, monitor building

TASKS:

NOTE: from the previous team meeting there is a tie constraint for performing the tasks At this time, the proposal is TOTAL of 60 min/ team which includes setup and completing the tasks)

1) AvatarMEDIC robot rover (ARR) enters UV room (C) for sterilization
2) ARR enters the Airlock (B) BEFORE entering the quarantine room (A) where the patient (Recipient) is lying on a table/ chair/ bed
3) ARR initiates a Patient Assessment & Evaluation (PMARCHP Protocol) – modified accordingly and time constraints

COVID-19 SIGNS & SYMPTOMS:

The COVID-19 virus affects different people in different ways. Most infected people will develop mild to moderate symptoms:

Common symptoms:

Fever, tiredness, dry cough

Some people may experience:

aches and pains, nasal congestion, runny nose, sore throat, diarrhea.

On average it takes 5–6 days from when someone is infected with the virus for symptoms to show, however it can take up to 14 days. People with mild symptoms who are otherwise healthy should self-isolate. Seek medical attention if you have a fever, a cough, and difficulty breathing. Call ahead USING TELEMEDICINE FOR CONSULT WITH PRIMARY CARE DOCTOR. If symptoms get worse then go to nearest ER.

MAIN TASKS:

a. **Short of Breath, SOB** – ARR offers oxygen to patient, place face mask on patient, turn on oxygen tank

b. **Fever** – ARR takes temperature with a thermometer, read temperature and sends data to medical team via telemedicine onboard or wifi

c. **Dehydration** – ARR does an IV Placement for saline infusion

d. **Cough –** ARR place a facemask if not on oxygen

E. bring in cpap (ventilator), plug in and connect to patient

F. take blood

Avatar should stay with the patient for comfort and periodic checkins

Needs to find power source for itself too

2) **ADDITIONAL TASKS:**

a) Phlebotomy Protocols:

Three popular methods of blood collection are:

1. Arterial sampling – take blood from artery
2. Venipuncture sampling - take blood sample from vein

· Training video - https://youtu.be/e58lLJ-2gBI

· IV Practice Arm - Phlebotomy and Venipuncture Training Kit *(MAU will be purchasing this kit for missions)*

1. 

https://www.amazon.com/Practice-Arm-Phlebotomy-Venipuncture-Perfecting/dp/B01G276VPM/ref=sr_1_1_sspa?crid=3VPXAEN8JFPBV&dchild=1&keywords=phlebotomy+training+arm+with+blood&qid=1587095756&sprefix=Phlebotomy+training%2Caps%2C226&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyWUZIMTg5VFpXV1c4JmVuY3J5cHRlZElkPUEwNDE5MTMyMzlNTjBZSVIxWjYzRiZlbmNyeXB0ZWRBZElkPUEwMDg3NDY4MUxaSk5UODhNRUxIMSZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

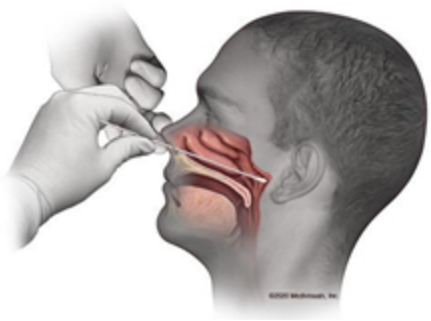
3) Fingerstick sampling – finger prick using manual lancing device
https://www.amazon.com/AUVON-Lancets-Lancing-Monitoring-Glucose/dp/B07P4612JM/ref=sr_1_2?crid=2BXU8DZ25K207&dchild=1&keywords=finger+stick+machine&qid=1587096147&sprefix=fingerstick+%2Caps%2C224&sr=8-2

b) Tourniquet Placement – stop hemorrhaging bleeding, packing bleed, first aid

c) **Perform a Nasopharyngeal Swab or NP swab for COVID-19**

Use a flocked tapered **swab**. Tilt patient's head back 70 degrees. While gently rotating the **swab**, insert **swab** less than one inch (about 2 cm) into nostril (until resistance is met at turbinates). Rotate the **swab** several times against **nasal** wall and repeat in other nostril using the same **swab**.

Video: how to perform a nasal swab for COVID-19: https://youtu.be/RQxxYJmF0cw



d) Give injection (give antibody vaccine?)

e) Intubation Protocol – perform on a mannikin

f) Perform Ventilation Protocol – use VapoJET System

VapoJET.site

Suturing

Could attach to end effectors or built in

LINKS

Medical Extra-Vehicular Activity, MEVA: Autonomous EMR-Rover Prototype 1 Test – using Matteo's rover which can hold up to 300lbs https://youtu.be/Nd6ukxEfXpc

MEVA & TELEANESTHESIA-TELESURGERY SIM https://youtu.be/Ws7XRqTr_Yc

PS. I also emailed this as a word doc \.

Umer Khan Current robotic capabilities for designing the simulation:

Rover Capabilities:

Rover Lifting capability? - Over 300 Ibs #Which plane up side down or side to side. JA **the heck do we need 120kg lift for? This isn't a robotic stretcher. If you need a rover with this much carrying capacity i need to know why and how big it can be -mkb**

Rover Battery Life? - **Potentially 2 hours. JA**

Rover Speed? 5 kp/h? Fast walking speed

How easily Maneuverable and stable will this be with the Ipad/Tentacle cantilever?

M- Very maneuverable, Stability depends on height

What maximum height will the robot be able to achieve using telescoping and still maintaining stability?

M- I'd say 1.2 meters and so

What are the assumed dimensions of the rover and weight of the rover itself?

M- 60x60cm

Will the Rover need to rotate in order for the Ipad and arms to rotate or should these be independent?

M- (Probably needs to be independent in order to avoid the arms being dependent on the rover to turn. → This would likely result in instability of the arms.) Can do either way

How soft is the movement of the rover? Does it jerk in motion? Does it need to have a control that very gradually increases the torque on the wheels?

M- Jerks a lot with current firmware, can be made smooth if needed.

There will be 6 wheels from what Matteo considered to build and two center motors will be independently motorised to allow for rotating without the need to turn tires.

M- Correct. Easy, simple, robust. Not very efficient but we are not running a marathon

Our Scenario will likely require our robot to have the rover stationary as it works. The shoulders and arms will likely be doing most of the motion during medical intervention. The rover does not seem to have much suspension but perhaps the telescoping pole can have some sort of compression to reduce bumpiness for the arms and ipad? Ads complexity though

We should likely place the battery for the tentacles, telescope, and avatar interface on the rover to create a low center of balance. Also the tools and medical kit should be placed in this location as well if the avatar will be carrying all these items to the scenario. Best to use a car battery: lots of current, and we want the weight. And it's easy to replace in the field.

Telescoping Connection Capabilities:

Currently the sole purpose of the telescope is to provide structure to support Avatar interface and Independently moving arms.

Could this part be supported with a toolbelt so it doesn't vibrate at the base as much and also can carry all it's equipment?

Does this part need to be able to extend at multiple levels or is it assumed to stay in one stage during the scenario?

If it does need to be able to extend up and down, what is the assumed combined weight of the shoulders, arms, and avatar interface it will be lifting?

Are the cables assumed to be on the inside or the outside of the telescoping tube?

Shoulder Capabilities

What is the actual required motion for these shoulders?

M- Suggested a simple actuator to extend and retract.

What is the length required for the shoulder width, will it need to rotate or retract to fit through doors (Ex airlock) Do the shoulders need any form of an actual shoulder joint that rotate? This is likely not required and would add unnecessary complexity.

Do the shoulders extend and retract so that both tentacles move laterally independently or is this a bidirectional movement? Important since then lateral movement for one tentacle would affect the other.

Comedic depiction of our future robot!

I am trying to understand where the bulk of the tentacle “brains” will be located in comparison to the tentacles themselves but I assume the shoulders would be where those would be. We need to be sure that as the telescope and shoulders extend, the cables have ample room to stretch as well.

Do we need to build any form of protective covering for all of our cables and electronics such as a plastic molding or 3d printed cover? This would add weight and would not add much to the functionality but would at least make the robots aesthetics look much denser and not so “Wirey”and exposed. This would not be extremely difficult in my opinion and the main restriction would be weight restriction on the telescoping tube. I don’t assume this would be too heavy and actually is a good “Nice to have” Idea.

Tentacle Capabilities:

The motion of these tentacles is very impressive in terms of having nearly unlimited degrees of freedom. If these are able to stabilize in positions and lock that would be impressive, I have not seen that yet in the demonstrations but I’m sure that is part of the objective.

How much strength would the various joints be capable of maintaining? The movement is very impressive but reduces rigidness so we have to counter torque not using the material characteristics “bones” and rather using the cables “Muscles” to produce strength. This is my biggest worry right now in terms of carrying tools and kits.

The capabilities of the system will be very heavily dependent on the nimbleness and strength of these tentacles.

Speaking to David about his assumptions with how much weight would the end of these tentacles be able to hold with stability is critical to our scenario design.

The hands will likely have considerable weight relative to the tentacles themselves if they are mini tentacles with medical sensors at their tips and then every item carried at the end of these tentacles will be entirely cantilevered by the entire length of the tentacle.

I personally foresee this being the biggest hurdle in creating our scenarios. **If the arms are able to hold a 5 Lbs item and move that around with control, we can likely address many medical challenges**

The other detail to acknowledge is the nimbleness of these arms and hands. This is not likely as difficult to achieve since it is just a determination of how much tension each wire of the “Fishing line” will need to be adjusted to create an “x” amount of motion. If the “fishing line” is strong enough, the arms will likely be able to adjust to most positions while supporting their own weight. However the required tension may need to be reanalyzed depending on what the hands are carrying at the time, this may be an entire independent control system on its own and likely

the second hurdle is on the same lines as the first one. I'm sure this is something David's team is aware of though.

Avatar Interface Capabilities

The current software is integrated to be used in a headset in an Augmented reality? I actually have not used it but does that mean if I wore the headset then It would be as if I was present with the "simulation" appearing in my current environment? I assume this means there is an optical camera that is feeding into my headset to produce the environment and then overlays the simulation of the medical situation.

JH- Also slam via intel-realsense or such solution, so the viewer sees a 3D mesh, see this example of a scanned mesh from the magic leap device

So the robot would be acting as an extension of the operator and would be directly feeding it's environment using a camera to an external operator I assume is wearing the headset. The operator then will actively and entirely control the movement of the robot to achieve the medical procedure required for the scenario.

Will the operator wearing the headset still be seeing the software popups with the recommended medical action or is it assumed this operator is trained and does not require the software to inform them of the medical action needed.

> This is the ultimate design of the system, yet for this prize we can focus on assuming the operator is a medic of some kind already. The 'pop up' system can be part of the operator control UI that we can later add more features to. - JH

What information is being conveyed on the display to the recipient of treatment if the patient is conscious. Is it a video feed of the operator?

Does the Avatar Interface "Head" need to swivel independent of the robot? Would the camera feed to the operator need to be able to move independently from the avatar interface? How many degrees of motion would this camera require? I would assume this needs to be a pretty full direction of motion so the operator can work off what is in front of them but also able to look down on the robot's body to ensure everything is where the operator assumes it to be.

Stereo 360 dome with selective streaming is a possibility - JH

The motion of the arms is not the same motion as a human arm so my assumption is the arms will be stable and move to specific "positions" as dictated by the operator rather than follow the movement of the operators hands. This will likely result in a very slow procedure so we may need to think about how to control the arms movements if the operator has control.

I worked on an ROV (Remote operated vehicle) for submarine rescue operations that had arms it would use to clean surfaces deep under water. The obvious issue I saw was that the arms

would “jerk” into positions rather than slowly to where they need to go even with a highly skilled operator. Not a big deal when cleaning, but a massive deal when dealing with a patient in a medical procedure.I addressed the need for gradual motion of the rover but the gradual motion of the arms is going to be much more important since the rover can likely remain stationary during the actual medical procedure.

> Speaks to The need for a complex smoothing function to interpret operator motions into avatar arm motions. A filtering algorithm to ensure smooth motion from point to point, and handle any network drops or latency - JH

Hands Capabilities:

This is probably the most medically functional part of the robot and will contain the majority of medical sensors such as taking temperature / heart rate / blood pressure / O2 readings. The hand concept right now is to use additional mini tentacles. This method will depend on the strength of the tentacles. We would need all of the fingers to move independently so they can grip items but also measure items. This would probably be more difficult for the operator than actually designing. We would need to be sure that the controller for operating this allows for independent use of each finger if there's a different tool in each finger. The fingers will also need to be able to work together to grip items. Gripping items such as bandages and tourniquets with three finger hands seemed difficult to me originally but I think it will be highly capable. I did consider having a 4 finger hand so the three fingers can grip and the 4th finger can do an independent task. It may also be easier to conceptualize by an operator.

> 4 fingers, three fingers one ‘thumb’ is an interesting idea - JH