**Agenda MRP meeting 26/02/2021**

* How many sensors can we assume, what is the minimum number?
  + Play around with parameter, how many in sheet of paper can be set by hand or random, start with grid-like pattern maybe at the start but not pattern shouldn’t be so fixed -> add errors to randomize, for AI assume it’s not a perfect grid need to figure out location of sensors
  + Train again from scratch with every new pattern of sensors, try have layers in front which need to be re-trained with every new pattern, train on additional images with first images which have already learned from a representation.
    - 1st layers need to learn mapping between position and making sense of sensors -> guess should be possible
    - Throw away last layers for classification, train on different patterns -> check literature, wondering which type of architecture would be supporting -> maybe type of CNN (but assume perfect grid), simple convolution doesn’t work out with shift, would have to do transformation, shift -> really interesting

Lucas: 20-30 sensors, can give you surface size and calculate density per cm2, can give upper and lower bound and then explore upper and lower bound of sensors per cm2

-> haven’t explored overlapping sensors, make some intersection, sensors don’t need to be perfectly aligned with surface, can be tilted, take out sheer forces or pressure from the top

Reason for specific sensors: little supply and very good quality, but if find better ones sharing of information is appreciated

* What exactly is our goal? Should we focus more in a specific part of the project(classification of particular shapes, time movements, a perfect simulation, an optimization of number and position of the sensors.)?
  + Focus on simulation (derive data sets), even if they have hardware skin ready, they want to simulate a lot of different configurations. Also, it’s necessary to take into account soft and hard material underneath. A final element analysis might be a good way to do this, he wouldn’t simulate whole human, use as static model (arm), sheet of skin, simulation is tool to generate data for AI side. Needs to be realistic but doesn’t need to be overcomplicated.

The approaches we thought of:

1. Using Graph neural network, we can simulate an vertex behaviour using triangulation techniques. Moreover, since we don’t have an uniform distribution of the sensors we could represent the real distribution
   1. Don’t understand well enough to make a prediction, how do we figure out distances? Sounds interesting, explicit AI technique.
2. Use a CNN, assuming an uniform distribution in the sensors.
   1. Not further discussed
3. Should we use the sensor placement optimization for classification (SSPOC) algorithm?
   1. Challenging to evolve sensor placement optimization, but not sure if they asked about it, not a must (maybe add-on), could run additional simulations, would require some simulation of the application.
4. Should we find a way to exploit the physics of a flexible skin to reduce the number of sensors? –
   1. Next step of research, to make sure stimuli needs to be constrained in meaningful way, not as easy: constrain with costs but still preserve function, not make this a priority at the moment (can explore more later)

Interesting to do 2-step approach: figure out best sensor position and then know sensor position and then use in graph NN

Techniques to find out triangle + touches

Classification:

Identification of objects but more interested to classify in painful or not painful, sth sharp, corner touching me, should pull back my arm. Not even full object in that way, come up with categories, what kind of things can happen: healthy vs. dangerous (constant pressure on big area, have some support), needle should move away immediately, interested in natural stimulei, come up with some sort of suggestion of DB what is meaningful. Don’t care about big hand/small hand, Rico suggests that research from image is taken too seriously, humans can also not differentiate clearly how hand is touching you. More interesting to explore if a touch is it edgy/supportive, take DB of natural interaction with arm. Idea is to make a protocol and simulate in some way, give person back what feedback is.

Simulation:

Approximation in the way to make a mesh probably based on triangles, will assume that in this mesh the points are connected by some springy elements. It should be a big difference to standard CV approach, you want to have some forces you can apply, distance can be changed by pulling and pressing. Mesh has a much finer resolution than sensors. Need to figure out model which you can put sensors inside. Underneath sensors there will be continued mesh. Properties in mesh are not homogenous, mesh beneath sensors will have different properties, once arm is moved -> bones will also have effects. Even with same stimuli, sensors will give different results based on the environment, important for applying on hardware. But mesh like idea is perfect, simulate forces in mesh is good, sensors are connected to little springs.

Q: Sensors are objects put on mesh or embedded? Answer: 2D not embedded -> we need something 3D, sensors can be tilted. It’s useful to have parameters to change stiffness in mesh. Keep in mind that naturally sensors can’t move anymore at some point, so they can’t be compressed in x direction. Give them some constraint of relative forces, calculate transactional force, proportional to pressure on force.

Blender:

Rico knows property, but has never used for complex data. We should give it a try, on practical side cool as can incorporate CMD model, wouldn’t need to worry about modelling dimensions correctly. Good for realistically simulating, also if you can get access to these forces. Blender mostly used for visualization, remember there were some issues with physics, but 6 years ago, but Blender is optimized to be fast.

For soft tissue: just write itself, that’s mostly what we have been looking for.

Very often: code in C++, very good libraries exist, numerical solver, run into problems with numerical simulation, use good physic simulation, have strangely deforming objects, not worry about intersecting objects, hopefully make things easier

Organizational:

Send Thursday 18th report to Lucas and Rico -> final report

Send draft before the 12th or 15th (not everything formulated)

Structure: short motivation, clear statement of what we want to do and clear statement on how we want to achieve it, clear plan and related literature, formulate some research Q

**Next meeting: Friday 12th 4pm**