Spatial map and haptic feedback of textures using a tactile sensor equipped Soft finger.

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I. Problem Statement

The main of the project is to help a finger amputee get a sense of touch using a soft finger. Upon palpation with various known and unknown textures the amputee must be able to correctly get an idea of the texture he/she is touching. Using the input textures, we intend to create a spatial map of the texture and also give haptic feedback to the subject.

II. Approach

In this project, we intend to:

- Make a spatial map from given textures.
- Convert the textures to haptic sensation.

To achieve both the outcomes, we follow the same common steps initially.

1) The process would include collecting data from the soft finger. This step involves making a set up analogous to a 2D/3D-plotter, which could palpate over the whole texture. We intend to use the most readily available 2D/3D plotter i.e. the 3D printer. A custom mount would be made over the nozzle of the 3D printer, thus helping the soft finger (which contains the tactile sensors) to move over the texture.
2) Using neuromorphic computing and spiking neural networks (SNNs) to classify the textures using the input data from the tactile sensors.
3) Along with the SNNs, one of our objective is to visualize texture which are not known. For this, we intend to use Variational Autoencoders (VAE).
4) The intermediate weights i.e. the hidden features can be used to get useful information about the spatial mapping of the system. Moreover, as we would be palpating over the texture continuously, we will use LSTMs to capture the temporal aspect for the same. This spatial and temporal data combined will help us give the spatial texture map.
5) To convert the neuromorphic encodings to haptics, we intend to use the weights and hidden features as an input to the haptic system. The haptic system consists of a cluster of small vibration motors, which would rest on the wrist of the subject. So, on suitable input to the vibration motors, one could feel the sensation of the particular texture.

III. Barrier and Challenges

Some of the barriers or challenges that we will be facing in achieving our goal are followings:

- How to palpate the soft finger in similar fashion i.e. same pressure, same angle & cover whole 2-D plane, on different textures?
- How to use SNNs to classify textures and make spatial map?
- How to convert the classified data to haptic feedback?

IV. Timeline

Week	Dates	Tasks
1	17 May - 23 May	Finger mount and printing the textures
		Procure materials and fabrication of Finger
		Hands-on understanding of STM32 board.
2	24 May - 30 May	Designing the circuit related to the STM32 board
		Collecting Data using the setup
		Classifying the data using available codes
3	31 May - 6 June	Use SNNs and VAE to classify known and unknown data.
		Start learning the concepts of Haptics.
4	7 June - 13 June	Changing the environment of the texture.
		Printing custom textures.
		Converting the SNNs to spatial map
5	14 June - 20 June	Converting the SNNs to spatial map
		Implementing simple haptic concepts.
6	21 June - 27 June	Make haptics circuit
		Converting neuromorphic encoding to haptics
7	28 June - 4 July	Buffer Period
8,9,10	5 July - 31 July	Completion of remaining work and documentation

V. Short Term & Long Term Goals

Neel: My short term goal is to achieve the novelty in my internship work. I further want to publish a paper in a reputed conference on Soft Robotics. My long term goal is to opt for higher studies in field of Robotics and Data Science. I will prepare for GRE in my next semester and work on the application process. I am targeting Ivy league Universities for the MS in USA.

Rwik: I am interested in the field of Artificial intelligence and robotics.In the current internship I want to learn the aspects of prosthetics, designing the robot, playing with the sensors and designing the algorithm for it using ML and AI concepts. Moreover I intend to make something novel at the

end of the project and want to publish that. I see myself doing a PhD in robotics keeping AI as the integral part. Along with the internship I plan to study for the GRE to enable me pursue my long term goal at some prestigious university.