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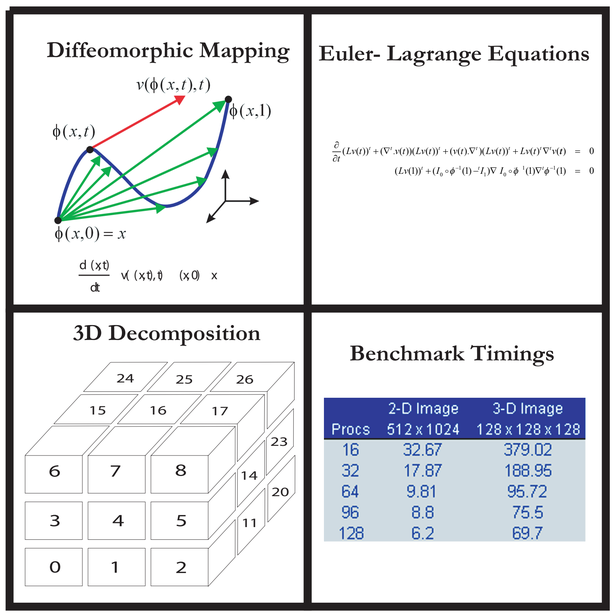
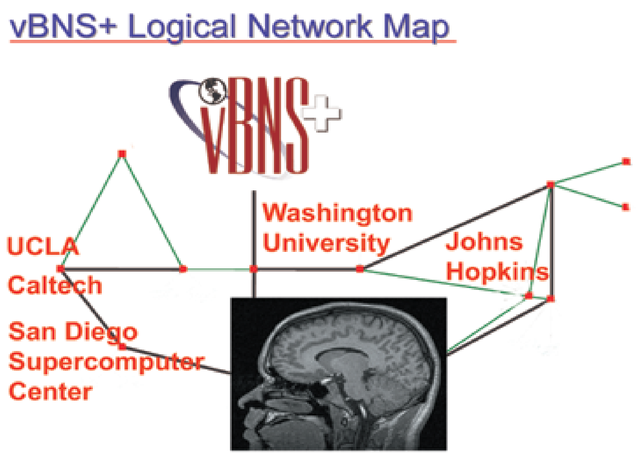
ENHANCING TOOLS TO MANIPULATE ANATOMICAL IMAGES: A STEP TOWARDS A FEDERATED NEUROSCIENCE IMAGE DATABASE

Essential to the construction of anatomical image databases is the ability to develop fast and efficient tools that manipulate large datasets. As part of the NPACI Strategic Applications Collaboration (SAC), we have developed a parallel 3D decomposition algorithm that takes advantage of the IBM RS6000/SP architecture to speed up computations of the Euler-Lagrange equations that describe the diffeomorphic mapping between anatomical images and yield a geodesic. Computing the geodesic can be speeded up by decomposing image data among multiple processors using 3D blocks. Each processor computes a section of the diffeomorphic map and then exchanges the data with neighboring processors.



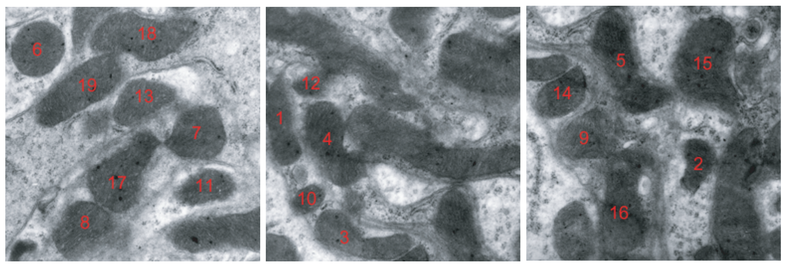
Procs	2-D Image 512 x 1024	3-D Image 128 x 128 x 128
16	32.67	379.02
32	17.87	188.95
64	9.81	95.72
96	8.8	75.5
128	6.2	69.7



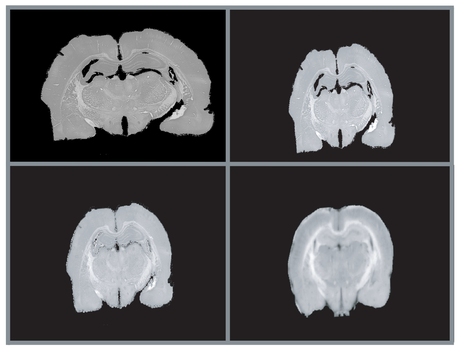
The Storage Resource Broker (SRB) is used to retrieve large datasets from remote servers at high speeds of 45Mbps via the vBNS on the Internet. We have begun manipulating large brain MRI datasets between Washington University St. Louis (WUSTL) and The Johns Hopkins University (JHU). The goal is to integrate the Euler-Lagrange solver to compute geodesics without downloading data. The table shows how long it took to determine the size of two MRI data files on the SRB server at WUSTL.

Image	Total # of Bytes	Time Lag Before 1st Byte	Time since reading 1st byte	Average	Total Elapsed time
pt3674	33554432	25.175 seconds	283.611 seconds	118.31 kb/sec	308.786 seconds
pt3729	33554432	28.577 seconds	225.129 seconds	132.27 kb/sec	253.706 seconds

Geodesics computed from the Euler-Lagrange equations can be used to compare several anatomical images in a database. As an example, we have generated geodesics from a set of 19 digitized, graylevel images of mitochondria. The table shows that mitochondria of similar shape have similar geodesic distance.



Mitochondria	1	2	3	4	5	6	7	8	9	10
Geodesic	620945	654400	769242	1011530	1235860	1292750	1344910	1554120	1569150	1679300
Mitochondria	11	12	13	14	15	16	17	18	19	
Geodesic	1685990	1725360	1816720	1877660	2079330	2402260	2784990	3115030	3356220	



The design of a federated neuroscience image database involves analysis of multi-modal images. For example, a neuroscientist would like to compare a histological section with a cryosection. This is achieved in two steps. First, the histological section (top left) is histogram-matched and then co-registered with the cryosection (bottom right) using landmark matching to generate the source image (top right). Then the Euler-Lagrange solver is used to generate the deformed source image (bottom left) which is similar to the target image (bottom right). Work is in progress to merge landmark matching with the Euler-Lagrange solver as well as developing a time-stepping algorithm to generate accurate diffeomorphic mappings.

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