Low Contrast Mild Traumatic Brain Injury Detection Through Visual and Contextual Fusion

ANTHONY BIANCHI[1], BIR BHANU[1], VIRGINIA DONAVAN[2], ANDRE OBENAUS[2]

{ABIANCHI, BHANU}@EE.UCR.EDU, MMUST@CE.UCR.EDU

[1]CENTER FOR RESEARCH IN INTELLIGENT SYSTEMS, UNIVERSITY OF CALIFORNIA, RIVERSIDE,

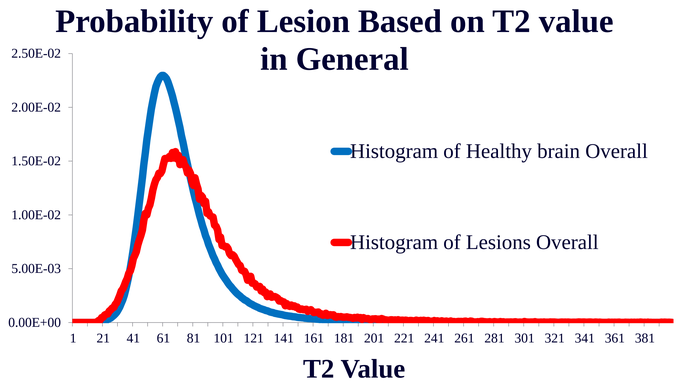
[2]DEPARTMENT OF RADIATION MEDICINE, LOMA LINDA UNIVERSITY, LOMA LINDA, CALIFORNIA

SUMMARY/MOTIVATION

- The Goal of this research is to develop an approach to quantify injury caused by mild traumatic brain injury (mTBI). From this quantification the correct treatment course can be determined.
- Determining the correct course of treatment will lead to attenuated long-term effects from the disease.
- 1.4 million TBIs occur every year in the United States Alone [Morris, 2010]. Estimated cost of mTBI in the United States is estimated to be $17 billion per year [CDC,2002].
- To overcome the difficulties in detecting lesions caused by mTBI Contextual information is fused with visual information through Bayesian Nets.

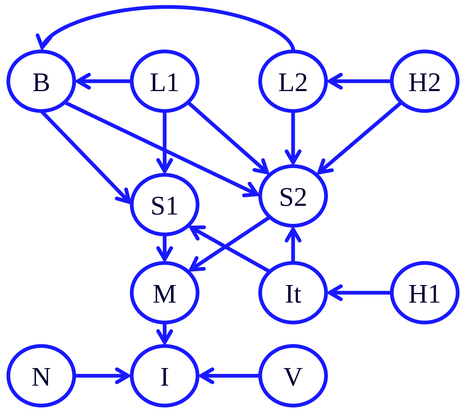
TECHNICAL CHALLENGES

- mTBI shows little change in MR imaging.



- In MR imaging there are many modalities that measure physical aspects of the material being imaged.
- Every modality increases the cost dramatically, so limiting the imaging to a single modality is very desirable.

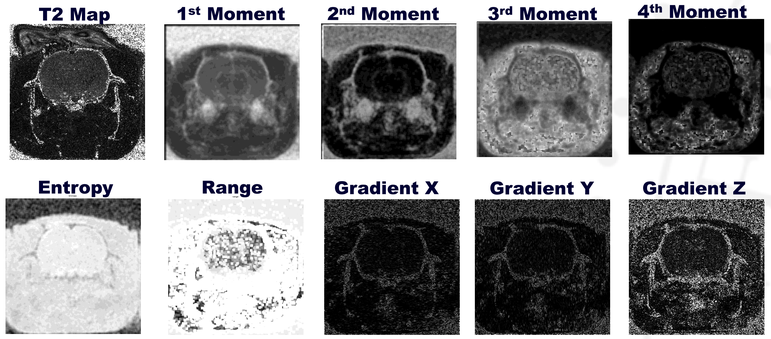
TECHNICAL APPROACH



I = Injury
L1 = Location first hit
L2 = Location second hit
H1 = Observation time from first hit.
H2 = Time from first to second hit
It = prob. of injury with time
S1,S2 = spread of 1st , 2nd hits
B = Biological Information
V = Volume Features
M = Max operator
N = Local Neighborhood

Graphical representation of the Bayesian Net. Each node represents a Random Variable, and the edges represent the dependencies.

- V represents the traditional method for detection. For the current experiments Non Linear Support Vector Machine (SVM) is used to find a complex decision surface based on the volume features.
- To increase the discrimination potential of the volumes texture analysis is used with the following features: local moments 1-4, LBP, xyz gradients, local entropy, local range.



- Contextual modeling allows for disease knowledge to be utilized in lesion detection.
- The contextual inputs in the model are optional and allow for ranged inputs due to the known distributions. The contextual inputs are : Time since first injury, time between first and second injury, location of first and second injury.

- The spread function captures the progression of the disease.

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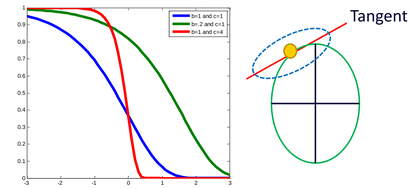
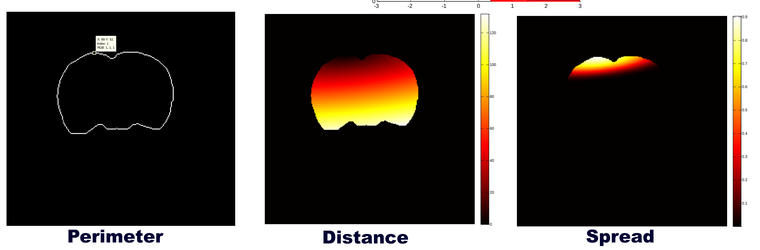
- b,c – Learned Parameters
- d- distance function rotated by the tangent and weighed





DATA SET

- Individual Animals: 57
- Volumes: 147 (63 Sham, 34 Single Hit, 28 Contralateral 3day, 22 Contralateral 7day)
- Lesions are small, on average 1.2% of the brain volume.

CONCLUSIONS/FUTURE DEVELOPMENT

- This approach for automatic quantization of mTBI lesions will be essential for determining treatment courses.
- Multiple contextual inputs allow for the knowledge of the injury to be utilized in the detection of lesions.
- Full testing of the system needs to be carried out with varying ranges of contextual inputs.

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