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| **Project Title** | **Deep Neural Network Robotic Mapping based on 3D scan** |
| **Data Source URL** | <http://kos.informatik.uni-osnabrueck.de/3Dscans/> |
| **Project Members** | Ong Boon Ping (A0195172B), Cao Liang (A0012884E) |
| **Business Case and Objective** | Development of neural network SLAM on autonomous land vehicle.  Its objective is to allow mapping based on neural network which is trained using 3-point scan data on various surface |
| **Proposed Architecture/Approach and its Novelty/Benefits** | **System Design**  Input – 3D scan data  Pre-processing – Euler Angle, straight line interpolation to reference point, convert point into 2D array  Prediction – Bird eye view mapping generation using neural network.  **Preprocessing**  The scan point are taken from 3D point cloud scanner and so its coordinate are given in local coordinate. For global mapping, the point is converted with Euler angle and GPS reference point.  Due to large size of data, the scanned data are sliced into 1024x1024 sections before feeding into neural network.  Since the network is targeted on the autonomous vehicle, the scan point is pre-processed.  Ground or accessible points are the primary targets.  In area covered by overpass or tree leaves, it should be marked as ground points.  Building and grounded structure should be marked as high ground.  As a result, the inverted scale is used. Ground carries highest pixel value of 255 while other value is converted according to equation 255-height. Unknown points are recorded as 0.  This is suitable as neural network input.  The points are interpolated along the line of scanned point and point scan reference point. Only the points with interpolated points with <3 meter will be recorded.  **2D Mapping Network**  The scan points are scattered around large area. Even though lines are interpolated from scan point to reference point at 3D point cloud scanner, at area, which is far from the scanner, it is hard to predict whether an unknown point is manoeuvrable or not.  K-Means or Gaussian model interpolation may be used to predict nearby points but its prediction capability reduced greatly with distance.  However, neural network with point scan training dataset, will be able to increase the accuracy for unknown area which is far from any known points.  Max-Conv2D structure are aimed to interpolate the unknown coordinates with 64x64 pixel. The interpolation capability is gained thru the training of point scan datasets.  At final stage. Conv 2D filtering with (3,3) strides are aimed for smoothing and enhance the accuracy at single pixel level.  **3D View**  Aimed to generate 3D image on front and rear of vehicle based on IMU, GPS and 2D neural network prediction. |
| **Preliminary Results and Discussion** | **Input**  After pre-processing, the line is generated from each point to the reference point and rotated using the IMU Euler angle.  Scan point on building are scattered around.    Expected Map  Expected Map based on geometry data plotted in the scan pointed covered area.    Neural Network Generated Map  The accuracy is 93% in terms of number of pixel.  Able to interpolate the value in unknown coordinates within 64x64 area.  Inaccuracy comes from noise reflected by the tree leaves and other objects. Due to slicing, certain bordering pixel is not showing intended pixel.    The neural network is trained using 640 2D Lidar map. The accuracy is 85%.    K-Means Generated Map  The accuracy is 53%.  Neural network is able to generate more prediction when the scan points are scattered around larger area. |
| **Plans for the Remaining Duration** | 1. Enhance accuracy of 2D network which is at 85% now. 2. Generate 3D image on front and rear of the autonomous vehicle based on IMU and GPU reading. 3. Explore possibility of using 3D neural network in generating 3D images. 4. Construct GUI to display the result and suggest path when given a target point. |