openPASS / OSI World

Overview OSI objects and OSI world implementation

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1 Introduction

This document shall provide an overview of the proposed implementation of an openPASS world representation based on OSI (open simulation interface) [1]. It’s focused on the required entities for our proposal of the “OSI world”.

2 World requirements

The World holds the data for the simulated entities and provides methods for queries on these entities via the WorldInterface.

In our proposal we will implement a representation of the environment with a road-based coordinate system (s-t-coordinates). The road is described by an aggregation of lanes. Each lane is defined by a reference line and various properties. The s coordinate of a location specifies the distance along the reference line from the start of the road. The t coordinate describes the offset from the lane’s reference line. In order to locate a point, s- and t-coordinates, as well as a lane identifier are required.

In addition, the global x-y-coordinates will be available.

3 Architectural overview

Our OSI world implementation will be just another implementation of the openPASS WorldInterface. OSI is actively being developed, a switch from protobuf to another underlying structure has already been mentioned. Thus, we decided to split the base data container (OSI) from the actual implementation by introducing another layer.

Figure 1: World_OSI class diagram (wip, suspect to change)
4 OSI messages

OSI provides data containers for various types of entities, currently based on protobuf [2]. Apart from methods for setting and getting the data, no means of manipulation are specified or implemented in OSI.

4.1 Existing messages

Many OSI objects describe sensor related data for detected objects and corresponding probabilities. These are not covered here.

All currently available coordinate systems in OSI are cartesian and are references to their parent frame (i.e. a sensor’s coordinate system origin is moving with the vehicle the sensor is mounted on). Exception: Spherical coordinates for specific sensor data.

Most objects can uniquely be referenced by their Id.

Following overview is based on OSI version 3.0.0.

BaseMoving

Base attributes of an object that is moving (or is able to move).

Properties

Position, orientation, dimension
Velocity, acceleration, orientation rate
Outline (as list of points)

BaseStationary

Base attributes of an immobile object.

Properties

Position, orientation, dimension
Outline (as list of points)

Dimension3d

Dimension of a box.

Properties

Length, width, height
EnvironmentalConditions

Conditions of the environment.

Properties
Time of day, Precipitation, fog, illumination, temperature, humidity, atmospheric pressure

GroundTruth

This is the simulation environment.

Properties
Moving and stationary objects
Lanes, lane boundaries, road markings
Traffic signs, traffic lights
Environmental conditions
Country code
Timestamp

Lane

A lane in the road network.

Properties
Type, road conditions (temperature, water film, freezing point, ice, roughness, texture)
Center line, driving direction, boundaries
Adjacent lanes, lane pairings (logical connection between predecessor and successor lanes)

LaneBoundary

Definition of the border of a lane.

Properties
List of boundary points (position, width, height)
Type, color
Limiting structures (stationary objects)
**MovingObject**

A mobile object, based on BaseMoving.

**Properties**

BaseMoving, type, assigned lanes

If type is vehicle: wheel radius, number of wheels, bounding box center to rear/front, ground clearance, type of vehicle, light state, trailer

**Orientation3d**

Specifies the orientation in Euler-angles.

**Properties**

Yaw, pitch, roll

**RoadMarking**

A marking on the road surface (excluding lane boundary markings).

**Properties**

BaseStationary, type, color, type/value/text of traffic sign, assigned lane

**StationaryObject**

Objects that are neither MovingObjects nor TrafficLight or TrafficSign.

**Properties**

BaseStationary, type, material, density, color

**TrafficLight**

Describes a single bulb of a traffic light.

**Properties**

BaseStationary

Color, icon, counter, mode (off, constant, flashing, counting)

Assigned lane
TrafficSign
A traffic sign.

Properties
BaseStationary, type, value, unit, direction scope (left, right, ...)
Supplementary information (arrows, distance information, ...), Variability (fixed, temporary, ...)
Assigned lane

Vector2d, Vector3d
Cartesian vector for positions, velocities, accelerations, ...

Properties
x-, y- and z-coordinates

4.2 Messages to be implemented
These messages are currently being specified and may be refactored, modified or extended at any time.

WorldInterface
Container for new OSI world interface messages.

Properties
Roads

Road
A road in the road network.

Properties
Type, framing
Antecessor/successor road connections
RoadSections
RoadSection
A section along a road. Grouping of lanes with same properties.

Properties
s-coordinate of beginning position, length
Antecessor/successor section connections
RoadLanes

RoadLane
A lane inside a road.

Note: Re-use of the existing OSI lane is preferred here (maybe as base-object).

Properties
Type (driving, nondriving, biking, sidewalk, on/off ramp, ...)
Geometry information (list of LaneGeometryJoints), length, reference line orientation
Adjacent lanes, lane pairings (logical connection between predecessor and successor lanes)
Lane boundaries, environmental conditions
LaneObjectAssignments (vehicles, stationary objects, ...)

LaneGeometryJoint
Base element of a lane geometry.

Properties
Reference line, left line, right line (as list of Vector2d)
Curvature, heading

LaneObjectAssignment
Link between objects and the road network location.

Properties
Assigned lane
s-t-coordinates
5 References

[1] Open simulation interface Github repository
   https://github.com/OpenSimulationInterface/open-simulation-interface

   https://developers.google.com/protocol-buffers