

BAIDU EGO LOCALIZATION SYSTEM SPECIFICATION

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1 INTRODUCTION

Baidu Ego Localization System is an accurate ego localization solution based on practical requirements of Baidu self-driving business. By combining sensor information, Global navigation satellite systems (GNSS), and Baidu HD Map into one system, Baidu Ego Localization System is able to offer a localization solution with high accuracy.

1.1 System Components

Components of Baidu Ego Localization System is depicted in Fig 1.1. Where the arrows indicate data flow or data dependency, and the boxes represent the relevant modules.

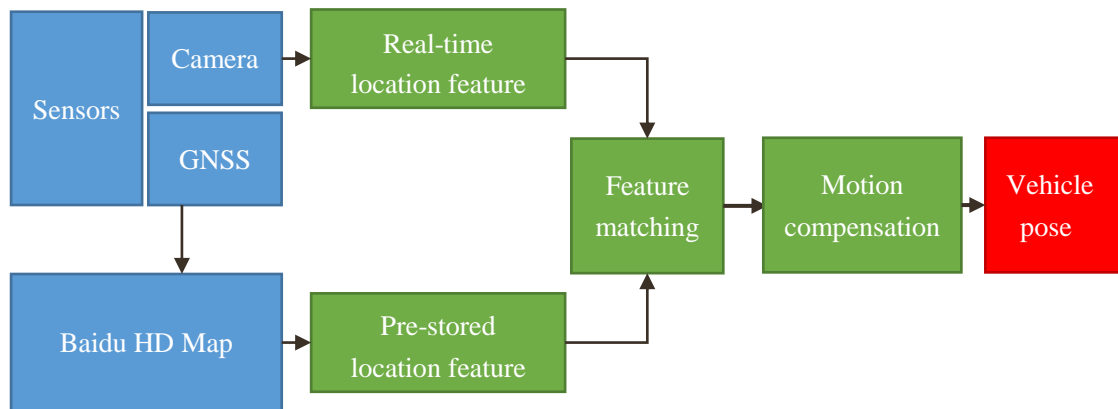


Fig 1.1 Components of Baidu Ego Localization System

A brief description of the relevant modules in Fig 1.1 is introduced as follows.

1. Sensors

a) Camera: Front camera, Baidu ego localization system acquires image features by the camera in real time (at 15-30 frames per second) for feature matching.

b) GNSS: GNSS receiver, GNSS provides autonomous geo-spatial positioning.

2. HD Map

Baidu High-definition Map, HD Map provides road information within specific area.

3. Real-time location feature

System internal calculation unit. According to the sensors, Baidu ego localization system is able to locate lane lines and mark features for feature matching.

4. Pre-stored location feature

System internal calculate eon unit. Baidu ego localization system extracts the lane lines and mark features of corresponding regions provided by HD Map module.

5. Feature matching

System internal calculation unit. According to real-time location feature and pre-stored location feature, Baidu ego localization system is able to locate current vehicle in HD Map.

6. Motion compensation

System internal calculation unit. Motion compensation module performs compensation on current frame and adjusts the matching result by historical frame information.

7. Vehicle pose

Baidu ego localization system outputs localization solution, including localization coordinates (X, Y, Z) and lane ID in Baidu HD Map.

1.2 System Functions

Baidu ego localization system includes the following localization functions:

1. Global localization

Global localization provides localization coordinates (X, Y, Z).

2. Lane level localization

Lane level localization provides current lane ID in Baidu HD Map.

2 HARDWARE SYSTEM

2.1 Hardware Modules

1. Sensor

Sensors are categorized into vision sensors and position sensors. Vision sensors include but not limited to in-vehicle cameras, industrial camera CCDs and other image collecting sensors. Position sensors include GPS, GLONASS, Beidou and other GNSS boards.

2. Processor

Processor is the core hardware equipment of Baidu ego localization system. It is used to process the data collected by sensors and match the HD Map. And then the ego localization information is accomplished and exported.

3. Peripheral device

Peripheral devices are essential for man machine interaction in Baidu ego localization system. Peripheral device include mouse, keyboard and monitor, etc.

4. Communication equipment

Data interaction between ego localization system and cloud server is necessary. Therefore, communication equipment is required for Baidu ego localization system to connect to web network.

2.2 Hardware Selection

2.2.1 Recommended Requirements

1. Sensor

a) vision sensor: SEKONIX SF3323

b) position sensor: Ublox M8

2. Processor

NVIDIA PX2

3. Peripheral device

Omit here.

4. Communications equipment

Omit here.

2.3 Hardware Description

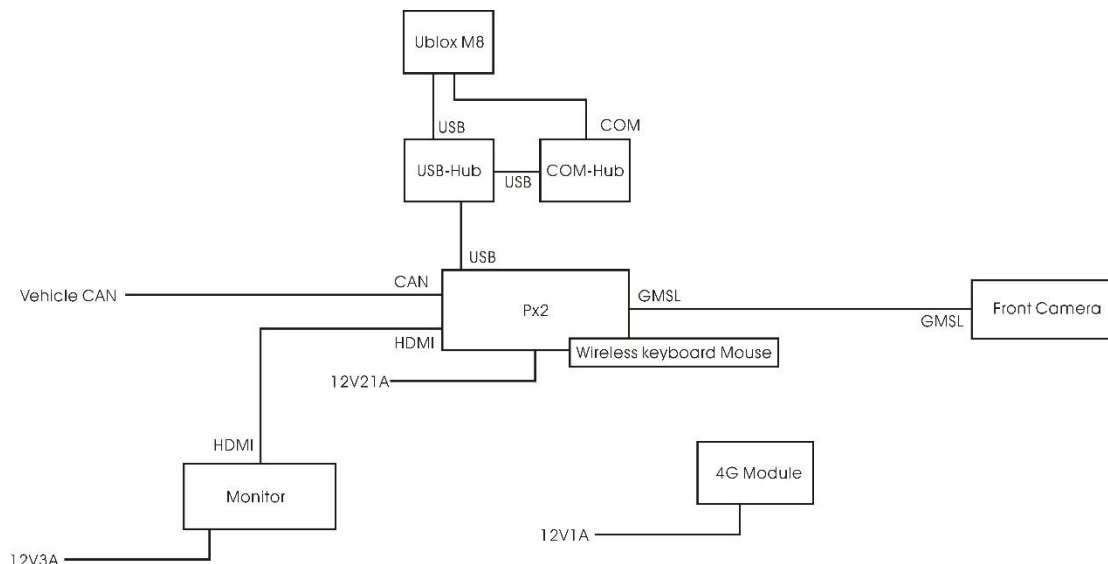


Figure2.1 Hardware Topology Diagrams

2.4 Hardware Installation

Front Camera Installation: Installed in front of the vehicle. The lens direction should parallel with the vehicle’s direction. Make sure that camera vision is wide enough and unobstructed. Front camera should fixedly connected with the vehicle, avoid relative move.

Ublox M8 Installation: GNSS antenna should not be covered above. The antenna should fixedly connected with the vehicle and avoid relative move. If localization system needs to output current lane information, the antenna should be installed on symmetrical axle of the vehicle.

Hardware installation site is depicted as follow:

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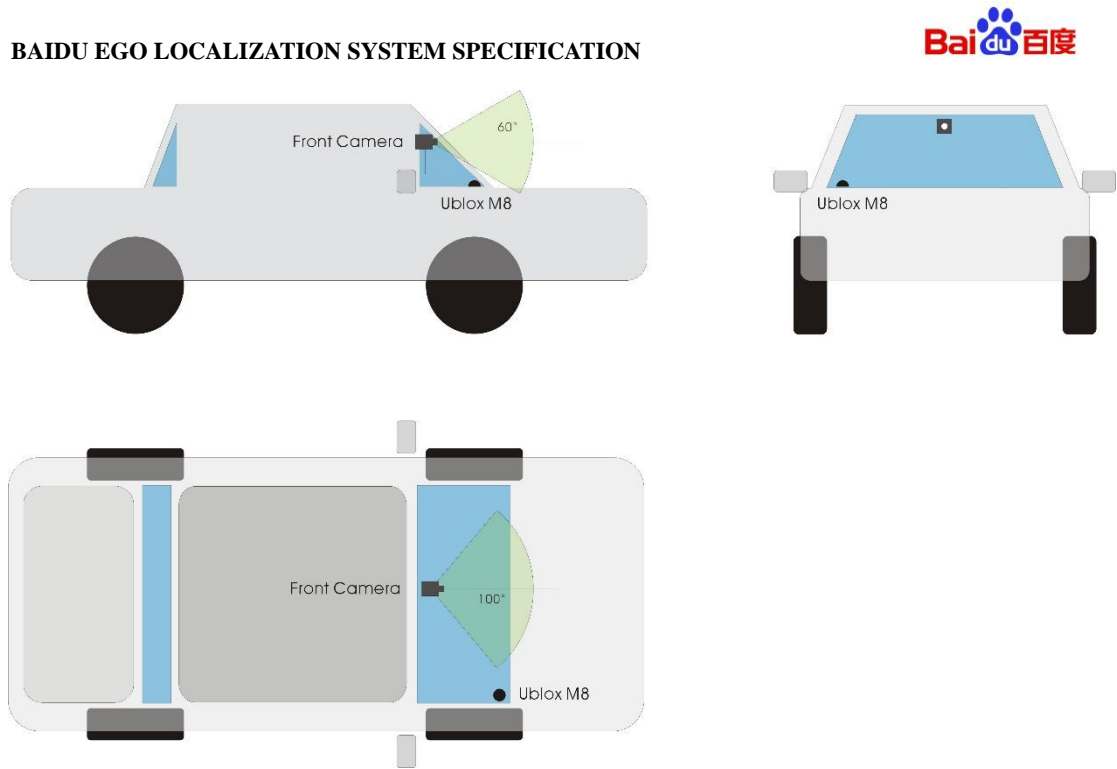


Figure 2.2 Hardware Installation Site

3 SYSTEM DESCRIPTION

3.1 Parameters and Data Requirements

Parameters and data requirements of Baidu ego localization system are presented in table 3.1.

Table 3.1 Input and Output of System

Input
Camera Parameters:
focal length along axis x, pixel focal length along axis y, pixel principal point of axis x principal point of axis y
rotation angle of camera related to vehicle coordinate system translation of camera related to vehicle coordinate system
Other Dependencies:
vision sensor (image data of BGR format, width of image, height of image) position sensor HD Map data
Output
Global localization: latitude and longitude information
Lane level localization: current lane ID in Baidu HD map