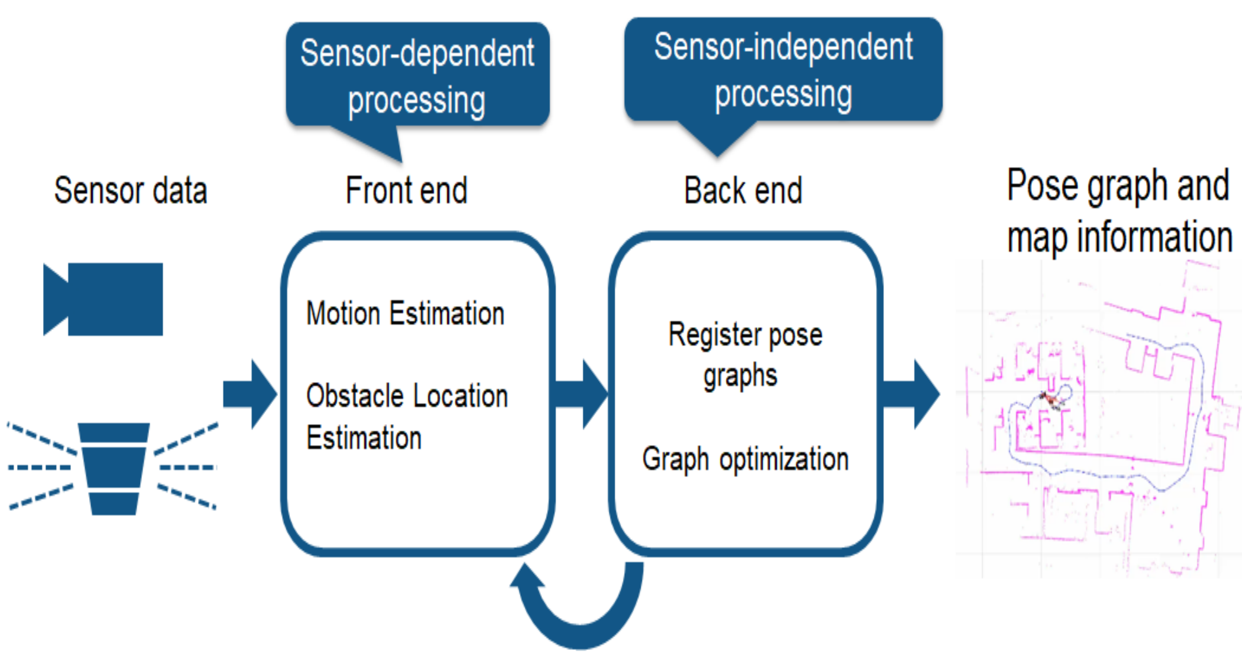
simultaneous localization and mapping(SLAM)

SLAM (simultaneous localization and mapping) is a method used for autonomous vehicles that lets you build a map and localize your vehicle in that map at the same time. SLAM algorithms allow the vehicle to map out unknown environments. Engineers use the map information to carry out tasks such as path planning and obstacle avoidance.

Consider a home robot vacuum. Without SLAM, it will just move randomly within a room and may not be able to clean the entire floor surface. In addition, this approach uses excessive power, so the battery will run out more quickly. On the other hand, robots with SLAM can use information such as the number of wheel revolutions and data from cameras and other imaging sensors to determine the amount of movement needed. This is called localization. The robot can also simultaneously use the camera and other sensors to create a map of the obstacles in its surroundings and avoid cleaning the same area twice. This is called mapping.

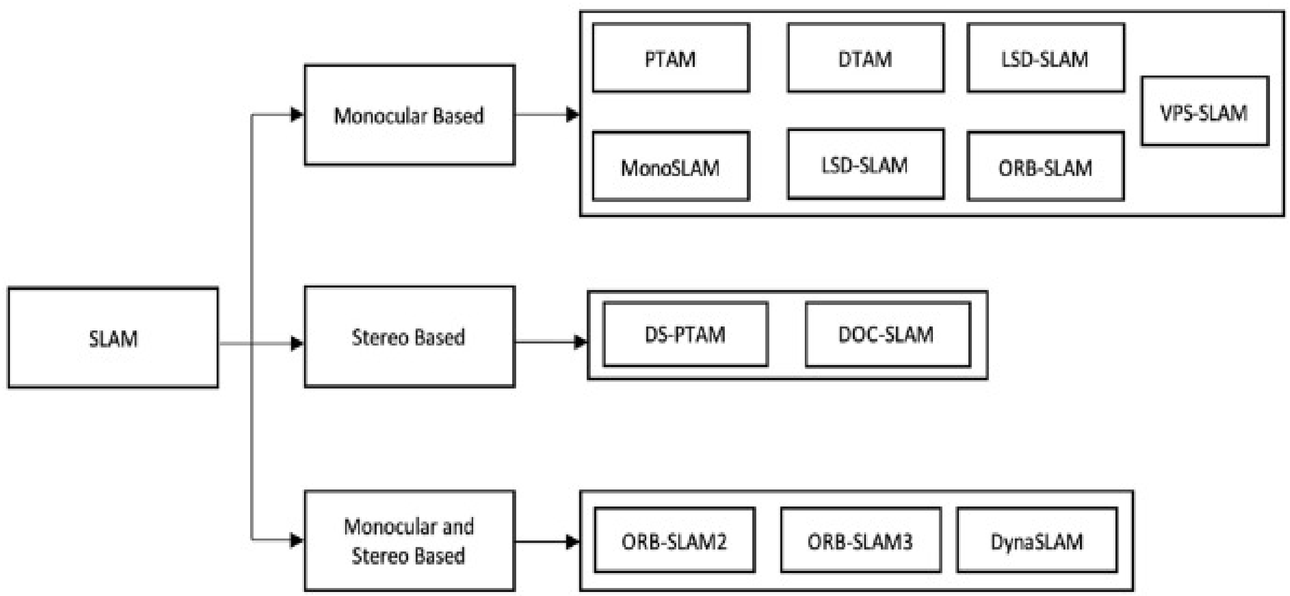
Broadly speaking, there are two types of technology components used to achieve SLAM. The first type is sensor signal processing, including the front-end processing, which is largely dependent on the sensors used. The second type is pose-graph optimization, including the back-end processing, which is sensor-agnostic.



SLAM algorithms are tailored to the available resources and are not aimed at perfection but at operational compliance. Published approaches are employed in self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newer domestic robots and even inside the human body.

SLAM algorithms

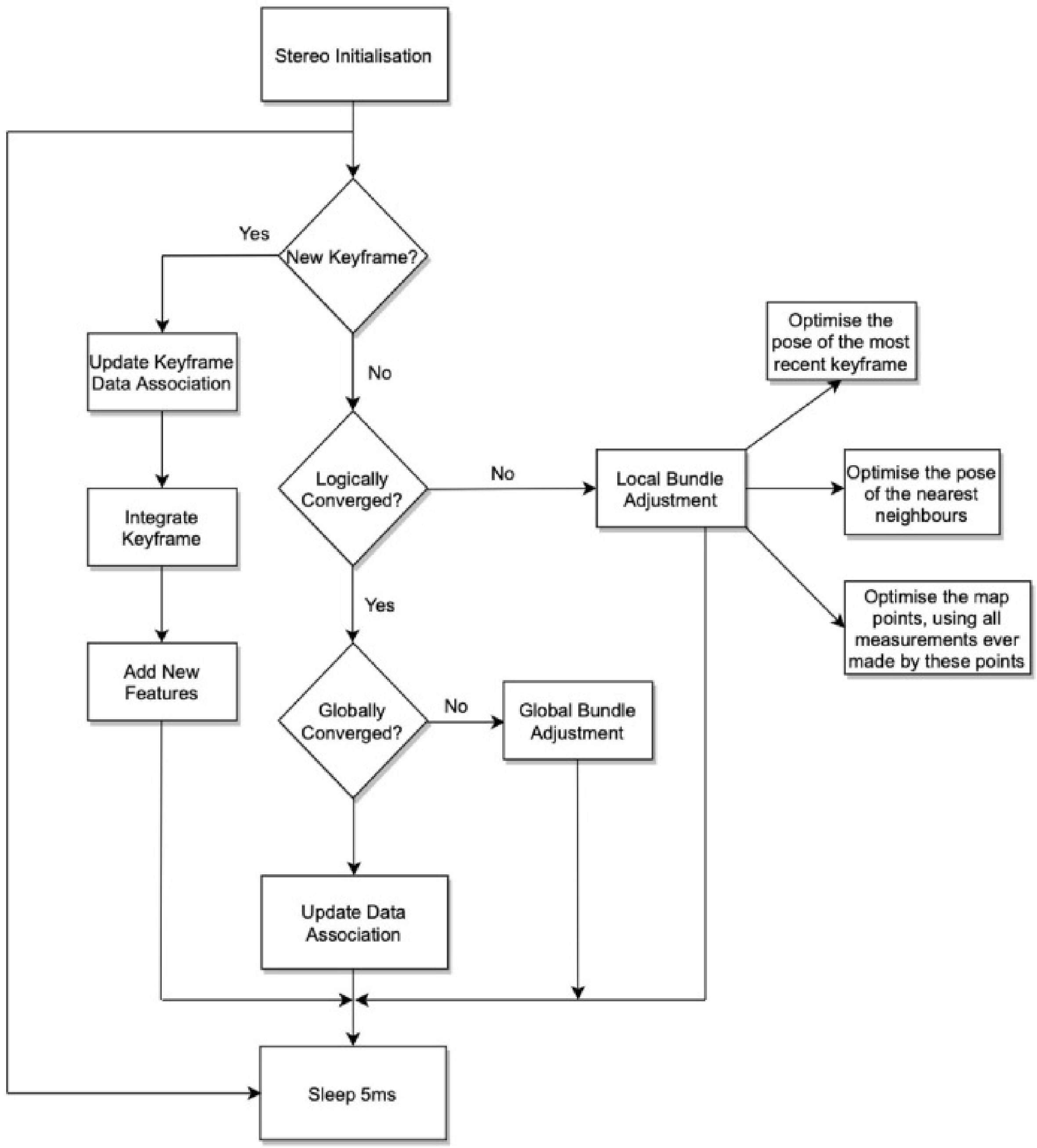
In general, Visual SLAM algorithms have three basic modules: initialization, tracking and mapping. The initialization consists of defining the global coordinate system of the environment to be mapped, as well as the reconstruction of part of its elements, which will be used as a reference for the beginning of the tracking and mapping. This step can be quite challenging for some visual SLAM applications.



Monocular based

Monocular SLAM is a type of SLAM that relies exclusively on a monocular image sequence captured by a moving camera in order to perform mapping, tracking and way finding. A monocular image sequence is usually a set of images that are similar to each other.

PTAM. A hand-held camera can be tracked by Parallel Tracking and Mapping (PTAM) in an AR environment. In parallel threads, tracking and mapping are handled separately. The first thread tries to track the erratic motion of a hand-held device, while on the other hand the second method generates a 3D map of the point features based on previous frames. A detailed map is produced, with thousands of landmarks. Clearly visible at high frame rates Model-based systems are surpassed in terms of their accuracy and robustness by this method. In the process of mapping, there are two distinct stages. A first stage involves creating an initial map with stereo techniques. After the key frames (map points) are added to the map by tracking systems, the mapping thread refines and expands.



Video images captured by the hand-held camera are used to maintain real-time estimates of the camera's position in relation to the built map. After estimating the video frame, graphics can be augmented over it. To calculate the final pose, the system uses the same procedure every frame. The motion model is used to generate a pose estimate from a new frame every time the camera detects a new frame. An estimate of the frame's prior pose determines how map points should be projected into the image. A final pose estimation is computed based on the detection of coarse-scale features in the image. From these coarse matches, the camera pose is updated, and the overall pose is estimated.

PTAM is advantageous because it splits tracking and mapping into two separate tasks and processes them in parallel, allowing for batch optimization techniques that are not generally associated with real-time operations. This map only serves as a tool for tracking cameras, which is a limitation of PTAM. Virtual entities should be able to interact with the map's geometry, so it shouldn't be static. PTAM also lacks auto-occlusive capabilities, which mean that it cannot track objects without outside assistance. Another limitation of SLAM is that it is not designed to close large loops. M-estimators are a general class of extreme estimators where the objective function is the sample average. The non-linear least squares method and maximum likelihood estimation are both special cases of M-estimators. M Estimators of trackers do not take feature map uncertainties into account, but this does not affect AR applications.

To increase the accuracy of positioning and to reduce the effect of the accumulated error, an experiment was carried out to implement the SLAM method, taking into account data from **additional sensors**. The implemented method uses a depth camera (Kinect) as a basic. As the basic algorithm of SLAM. Let us use a bunch of gyroscope + accelerometer + magnetometer (MPU-9250) this sensors allow one to obtain additional accuracy and, as a consequence, a decrease in the accumulated error for the determination of the robot in space and the construction of the terrain map. Gyroscope allows one to avoid the error of orientation by the jump or vibration, magnetometer helps to determine the orientation of the robot, based on the magnetic vector of the planet; the accelerometer corrects the accumulation of errors in motion. These sensors complement each other and, after calibration, show good data with low error. Also, MPU-9250 is presented in the form of a small device that combines all 3 sensors, which simplifies the placement of the sensor on a moving robot.