

Track3 – Long system description

BUPTer

In recent years, the indoor location system has emerged as a pivotal component in societal infrastructure. It leverages a variety of technologies to approximate users' location information. Commonly employed methods encompass GPS, image and video processing, inertial unit navigation, along with WiFi and BLE fingerprint matching. Nonetheless, every sensor carries its limitations, which remain unresolved. For instance, GPS systems are incapable of receiving signals in indoor environments; image-based positioning is significantly influenced by ambient illumination. RSSI necessitates prior known signal source location for accurate positioning, and filtration could undermine the algorithm's real-time performance. Moreover, an IMU-based pedestrian dead reckoning approach can precipitate system errors. Consequently, multi-sensor fusion can compensate for the insufficiencies of a singular sensor and secure a superior positioning outcome.

Our project, anchored on smartphones, leverages an amalgamation of various built-in sensors to facilitate user positioning. The data generated by the embedded IMU module and the pose sensor serve as the primary inputs for positioning, with errors mitigated via WiFi data. This is largely attributed to the fact that amongst the sensor data emitted by smartphones, these data possess higher frequency, thereby offering superior real-time performance and enabling accurate location estimations.

Moreover, an inherent integration process exists in the PDR solution steps predicated on IMU and navigation, inducing cumulative errors over time and resulting in deviations from the intended positioning route. Furthermore, the IMU's magnetometer is influenced by the earth's magnetic field and the surrounding environment, potentially causing signal mutations or fluctuations during motion. The mobile phone's IMU is also susceptible to user movements, generating irrelevant redundant data. Bearing these factors in mind, our project initially executes mutation removal and chattering elimination on the IMU sensor, mitigating environmental impacts. We subsequently employ a peak detection method to ascertain the step size from the acceleration signal, discarding noise outside the normal walking range. Simultaneously, to counterbalance the cumulative error triggered by the integration process, the velocity is reset to zero by leveraging the intermittent zero-velocity state in a pedestrian's walking cycle. The aforementioned measures effectively minimize the error magnitude in inertial navigation computations.

Given the relatively low precision of the IMU module within smartphones, catering primarily to rudimentary step counting, this project proposes to employ WiFi fingerprint information to supplement IMU positioning. Initially, to eliminate the interference of disconnected devices and environmental noise in RSSI, we designed a filtering algorithm to enhance the quality of RSSI information. Following this, the filtered RSSI is fashioned into a fingerprint image to augment the relevance of fingerprint-based location differentiation. Lastly, we designed a deep convolutional neural network based on the aforementioned fingerprint image. In the preparatory phase, we train the network with provided training data and fine-tune it to achieve

optimal accuracy in position prediction. In the competition phase, in conjunction with the earlier described PDR positioning method, we comprehensively predict position information to achieve high-precision positioning.

Height estimation is achieved using the smartphone's built-in barometer, where filtered air pressure values facilitate floor height calculation. GNSS information is also utilized for outdoor environments. Our project intends to implement a dual-mode positioning strategy for both indoor and outdoor contexts. For outdoor calibration, we integrate IMU with GNSS, while for indoor environments, we match IMU and WiFi. Additionally, light sensors and GNSS signals provide an effective means of discerning whether the environment is indoor or outdoor.

Predicated on smartphones, this project integrates a variety of sensors and autonomously selects suitable sensors and algorithms according to varying scenes and environmental characteristics. This strategy enables high-precision positioning across extensive indoor and outdoor environments.