

面向智能手机的室内三维位置感知与活动识别

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第一章

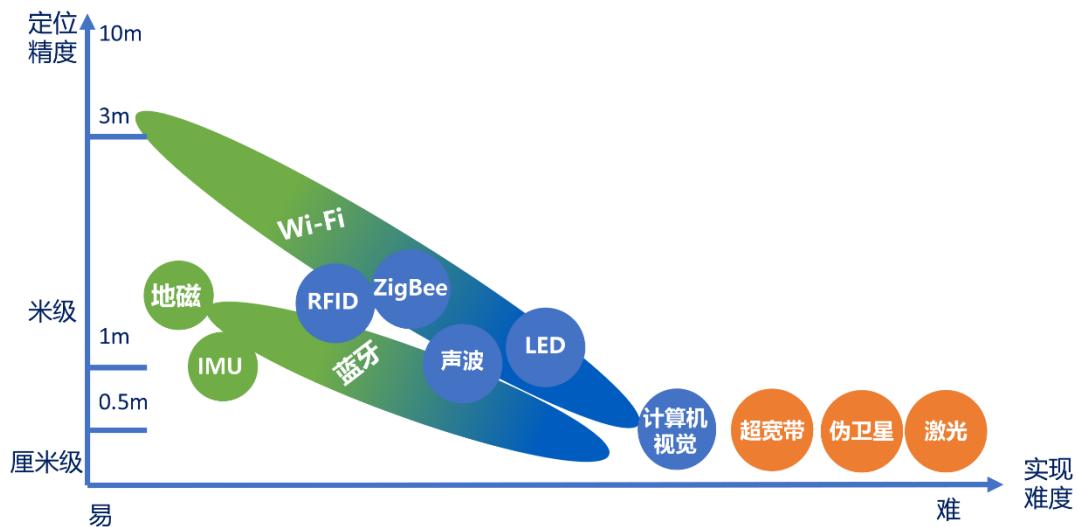


图 1-1 多数室内定位技术

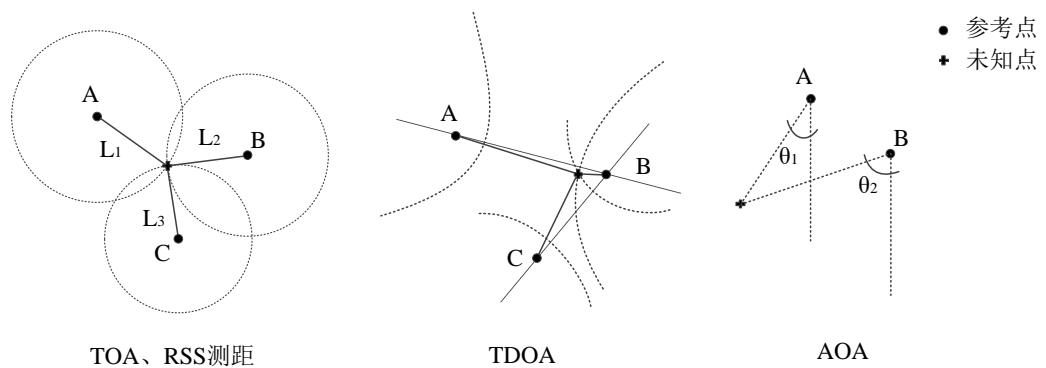


图 1-2 几何定位算法

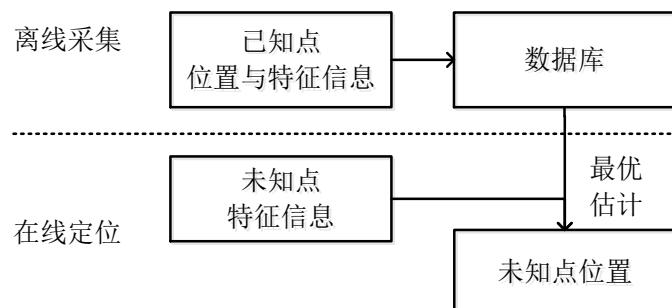


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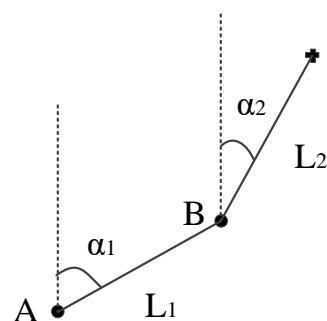


图 1-4 航位推算算法

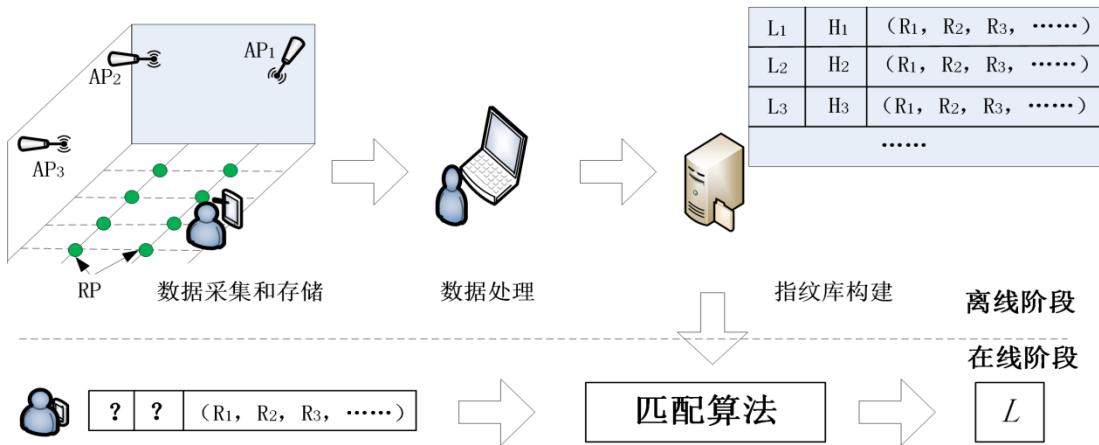


图 1-5 指纹定位方法流程

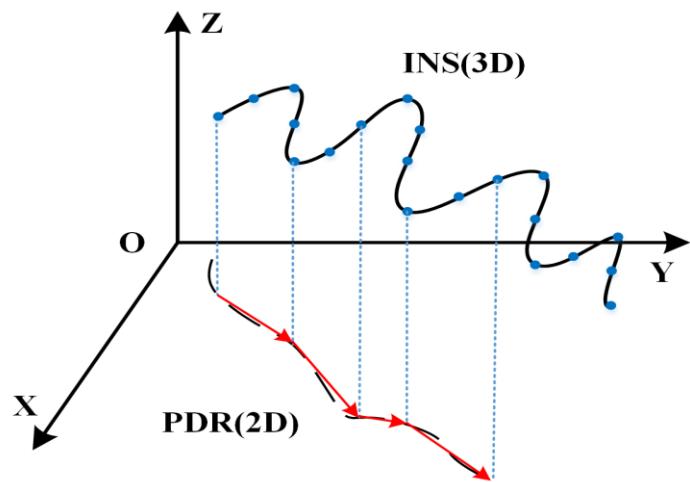


图 1-6 惯性导航系统与行人航位推算

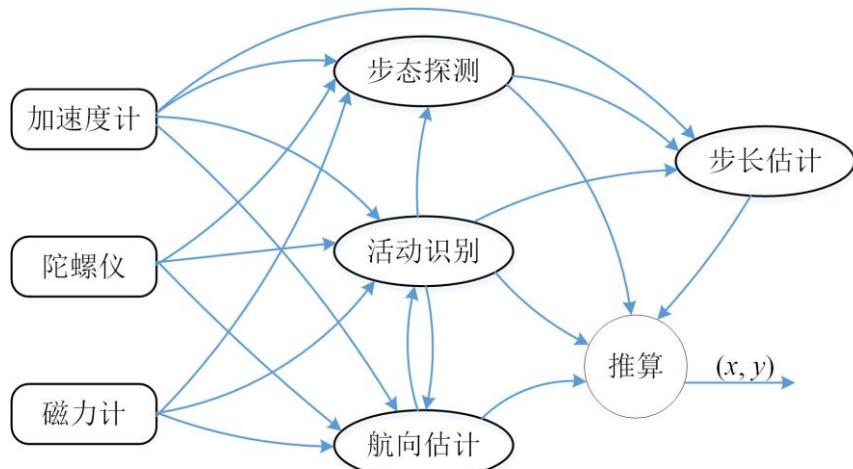


图 1-7 行人航位推算系统框架

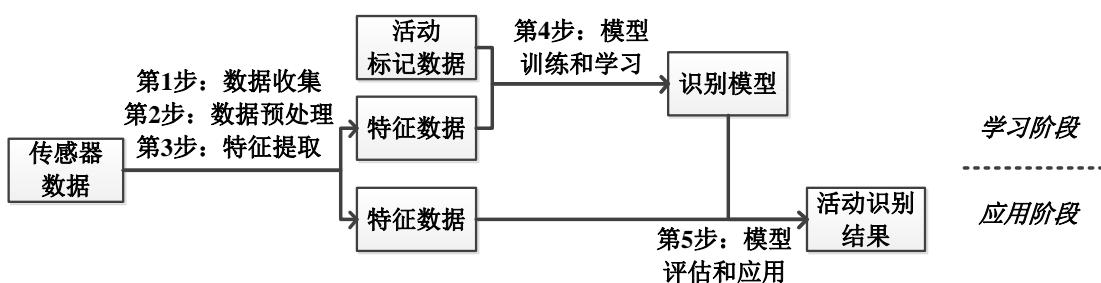


图 1-8 基于智能手机的活动识别数据处理基本过程

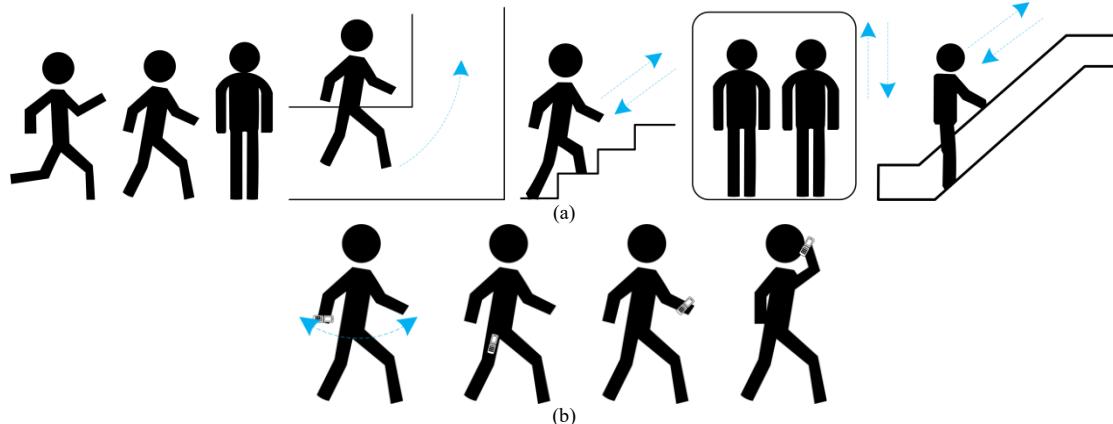


图 1-9 室内定位中的主要目标活动, (a)运动状态, (b)持有智能手机位置

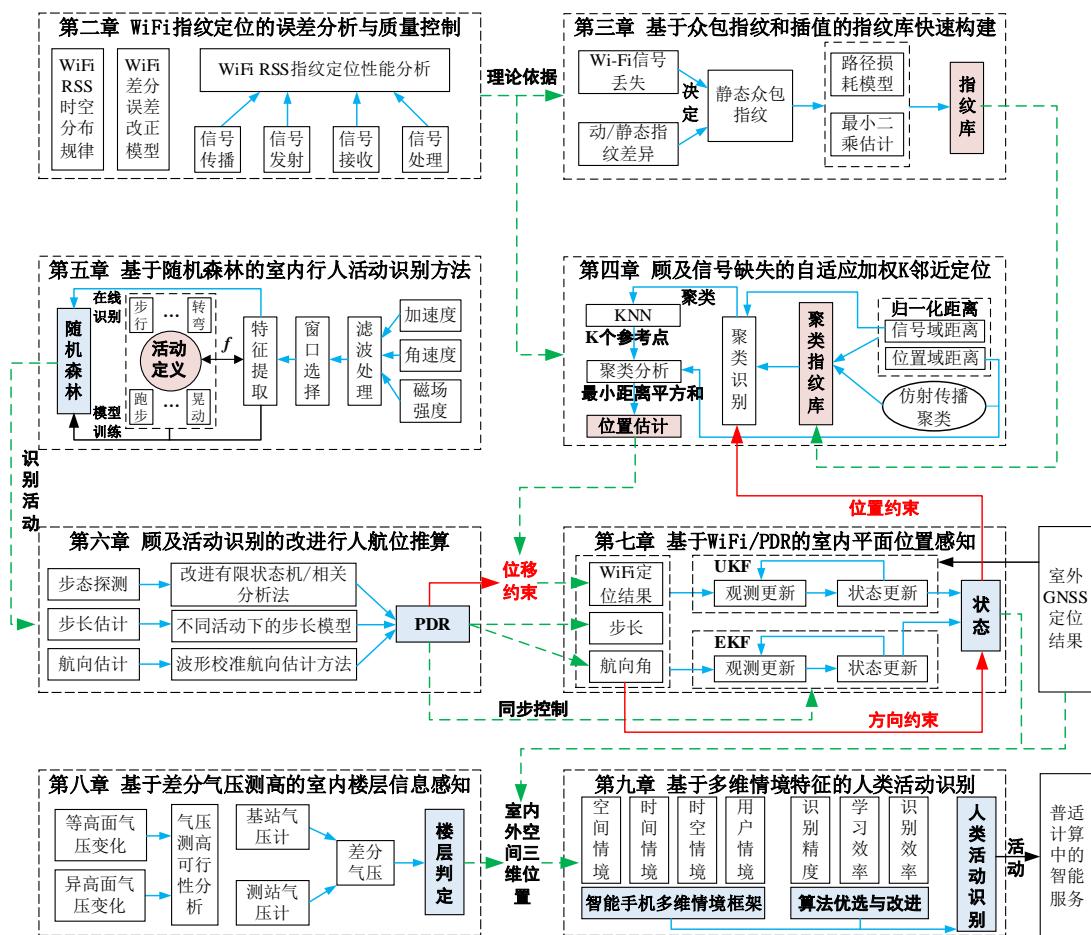


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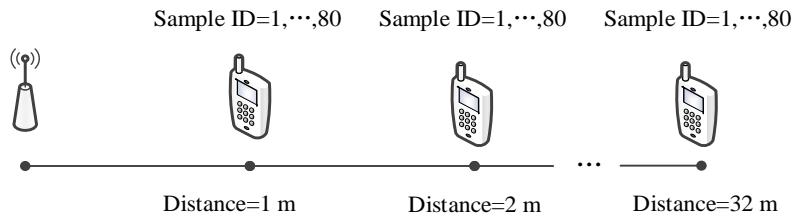


图 2-2 WiFi RSS 空间分布实验数据收集示意图

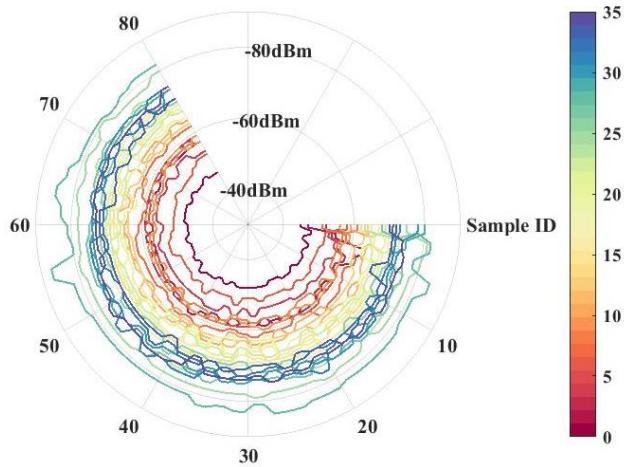


图 2-3 WiFi RSS 空间分布实验数据极坐标展示

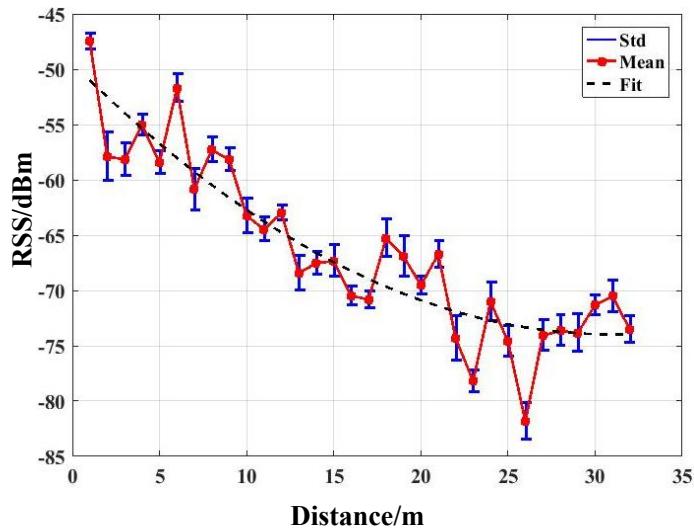


图 2-4 WiFi RSS 分布与空间距离关系

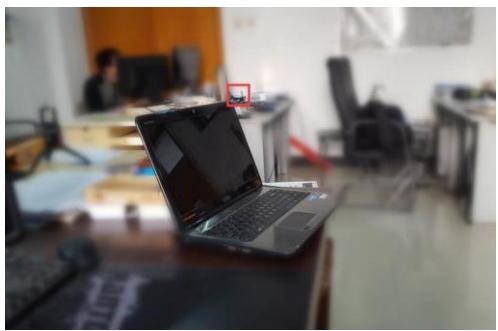


图 2-5 WiFi RSS 时间分布实验数据收集场地

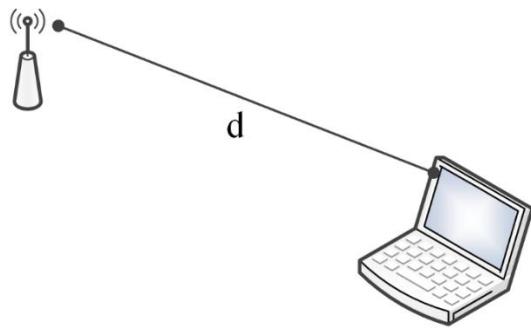


图 2-6 WiFi RSS 时间分布实验数据收集示意图

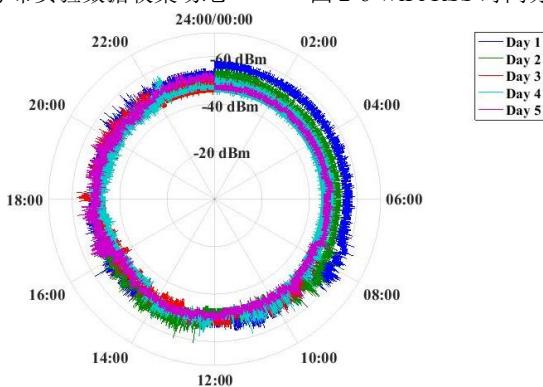


图 2-7 WiFi RSS 时间分布实验数据极坐标展示

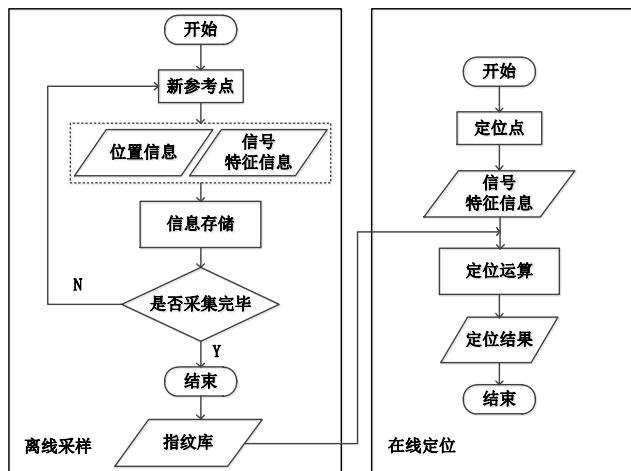


图 2-8 WiFi RSS 指纹定位流程图

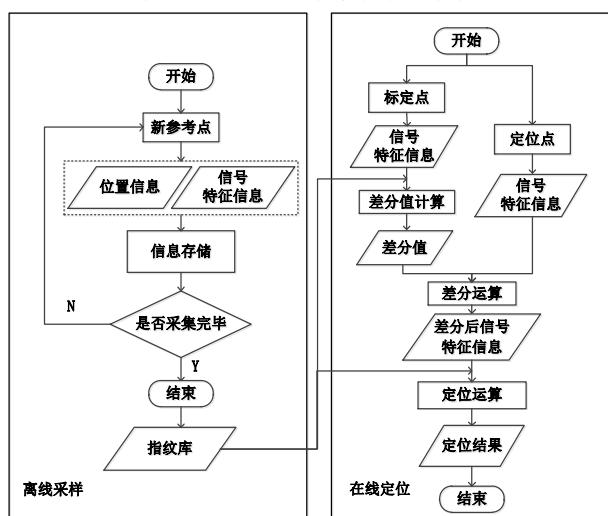


图 2-9 WiFi 差分指纹定位计算流程图

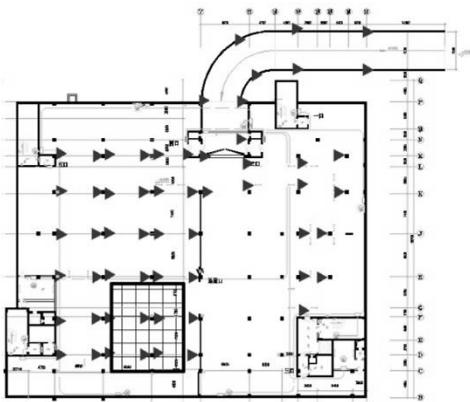


图 2-10 地下车库平面图



图 2-11 实验场所照片

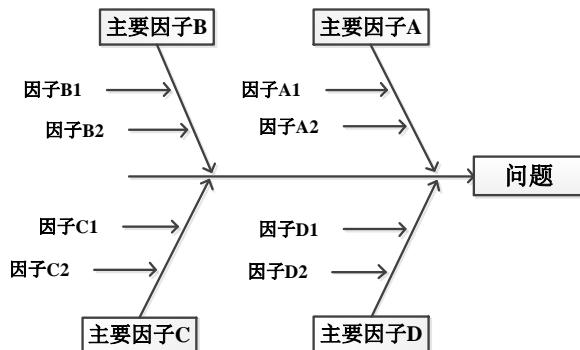


图 2-12 石川图实例

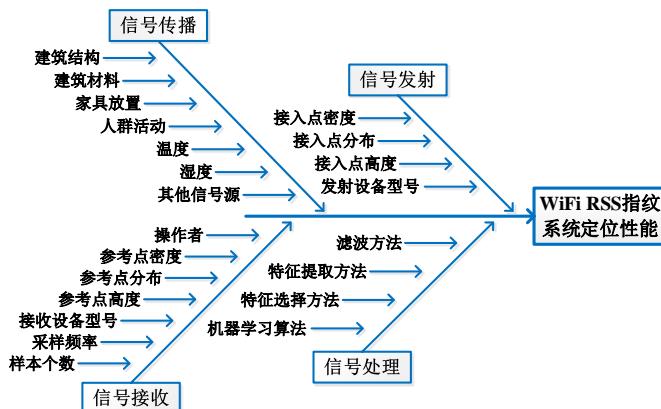


图 2-13 WiFi RSS 指纹定位系统中潜在影响因子的石川图

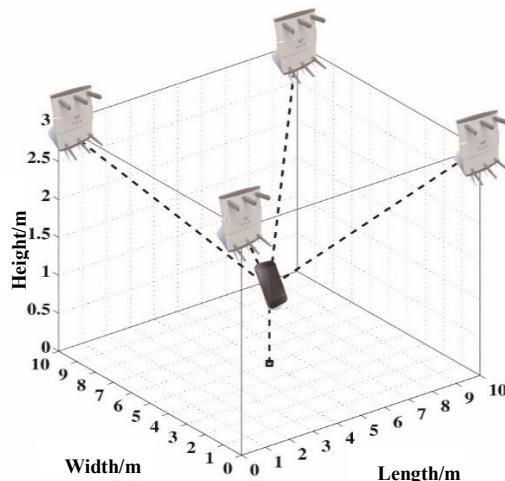


图 2-14 包括四个接入点和一个参考点的仿真实验场

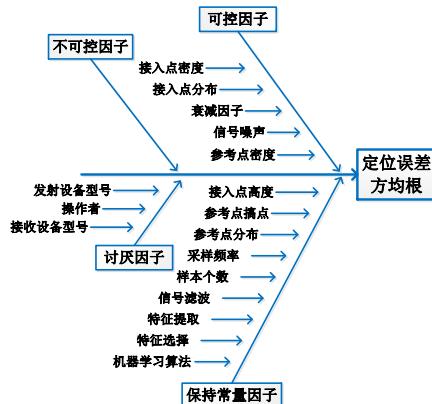


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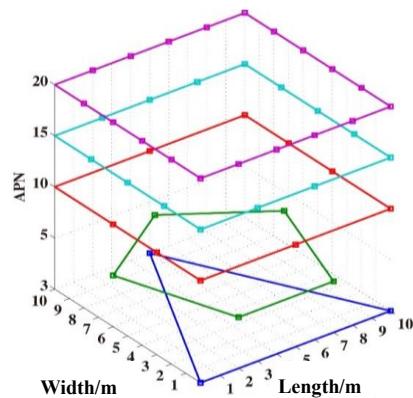


图 2-16 五种不同接入点密度条件下的“开放型”接入点分布形态

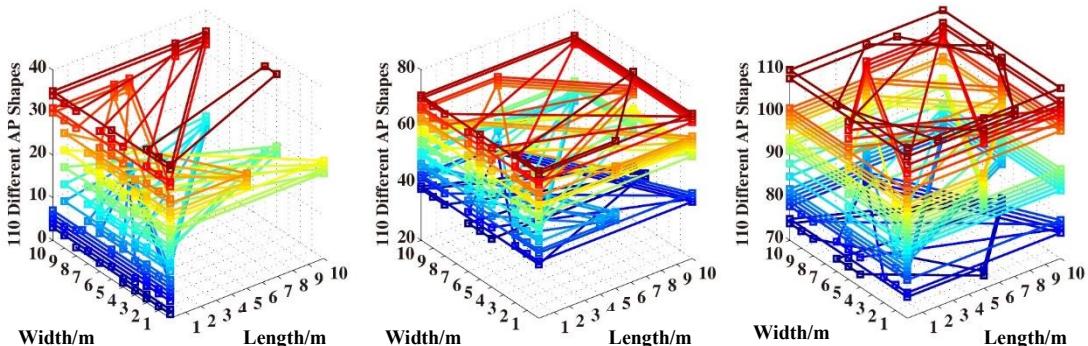


图 2-17 五个接入点条件下的 110 种不同接入点放置情况

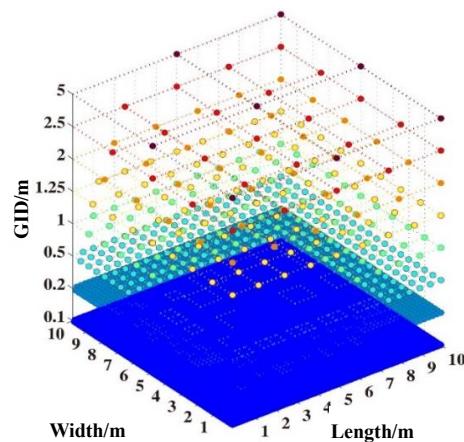


图 2-18 具有不同 GID 值的不同参考点分布



图 2-19 仿真平台上一个因子的测试流程

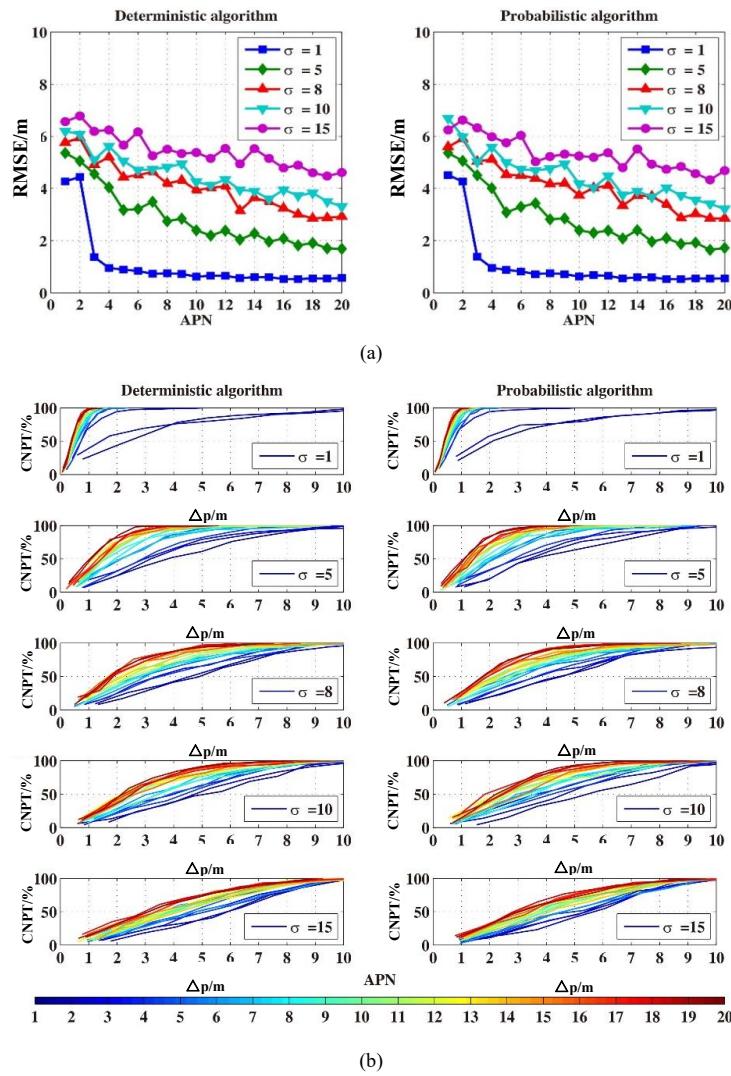
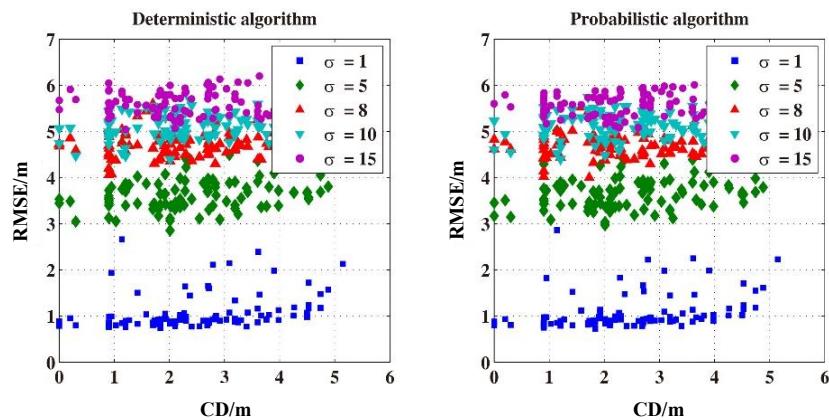
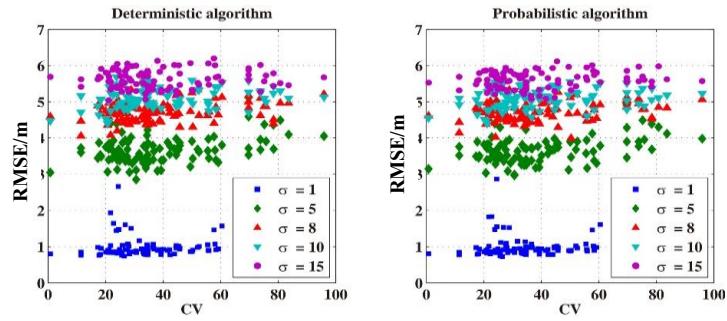


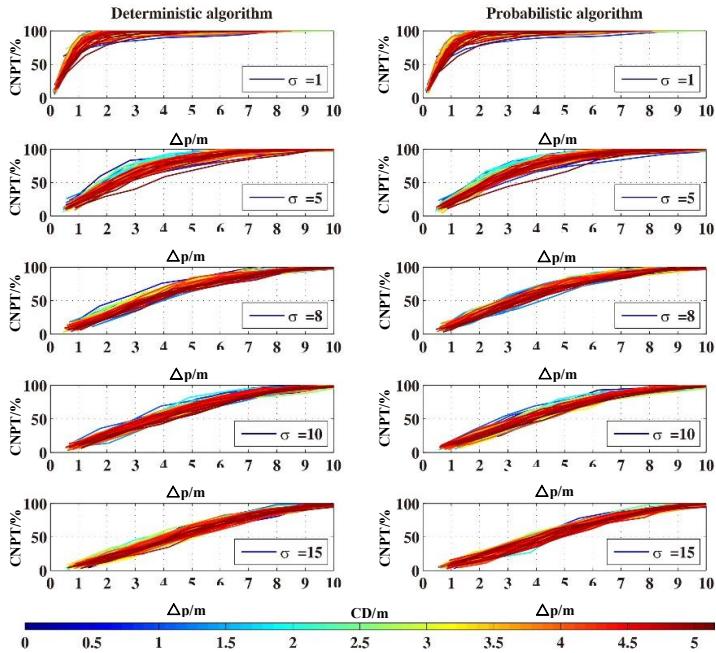
图 2-20 确定型和概率型算法对不同 AP 密度的定位误差测试结果, (a)RMSE 与 APN, (b)CNTP 与 APN



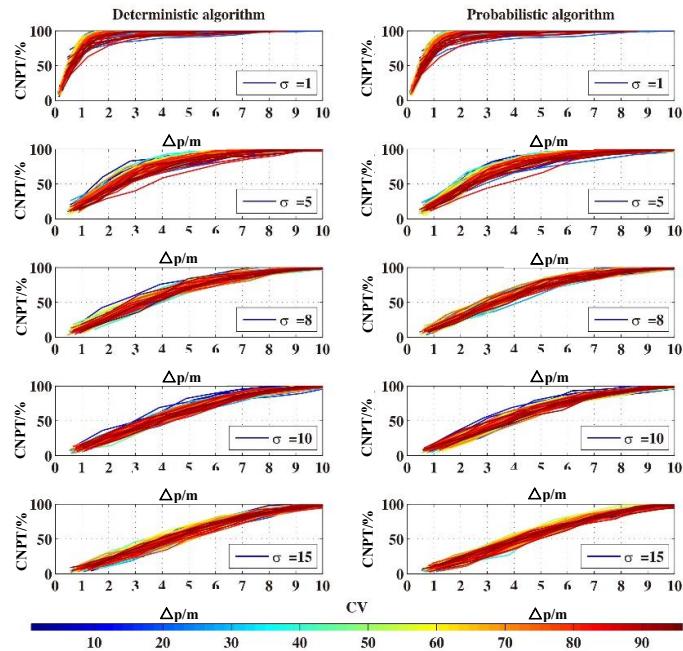
(a)



(b)



(c)



(d)

图 2-21 确定型和概率型算法对不同 APs 分布的定位误差的测试结果, (a)RMSE 与 CD, (b)RMSE 与 CV,

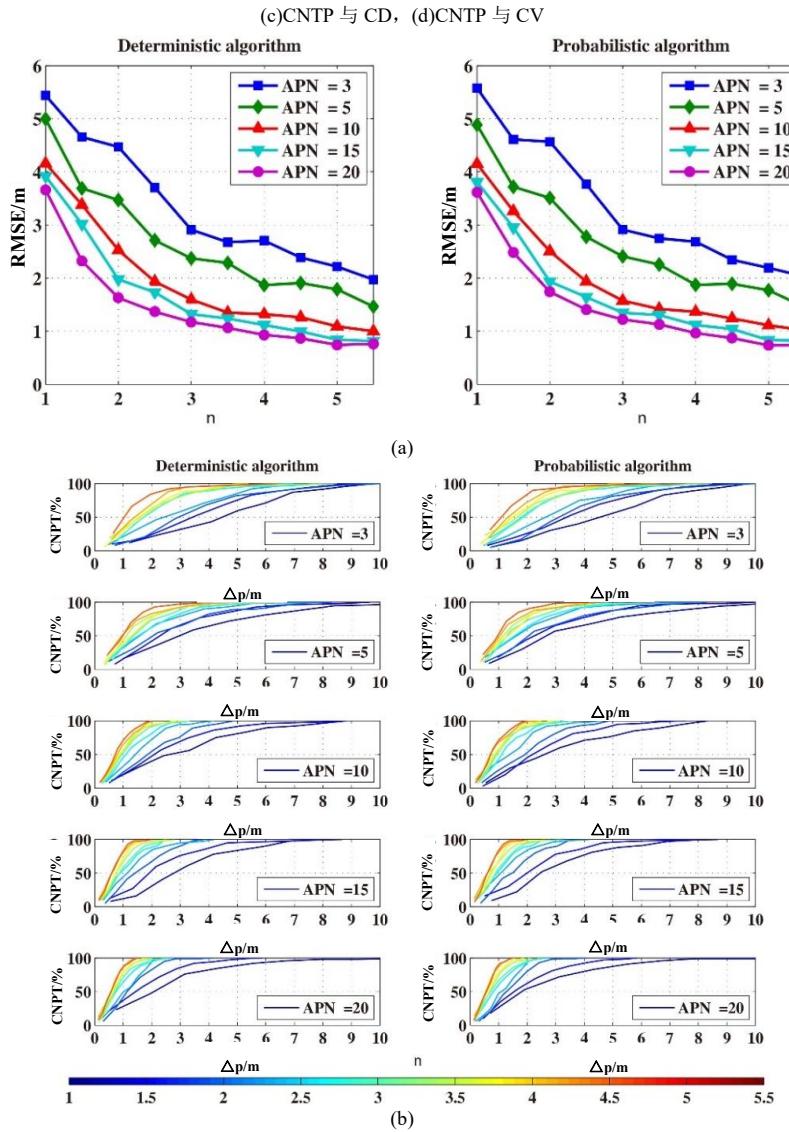
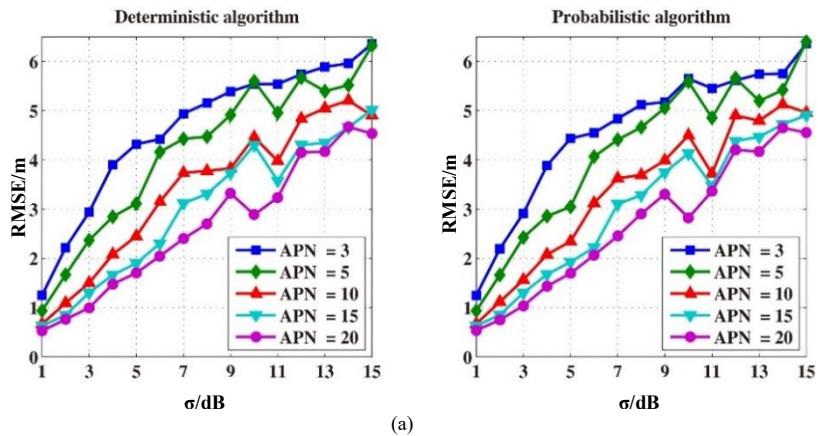


图 2-22 确定型和概率型算法对不同衰减因子的定位误差测试结果, (a)RMSE 对 n 和(b)CNTP 对 n



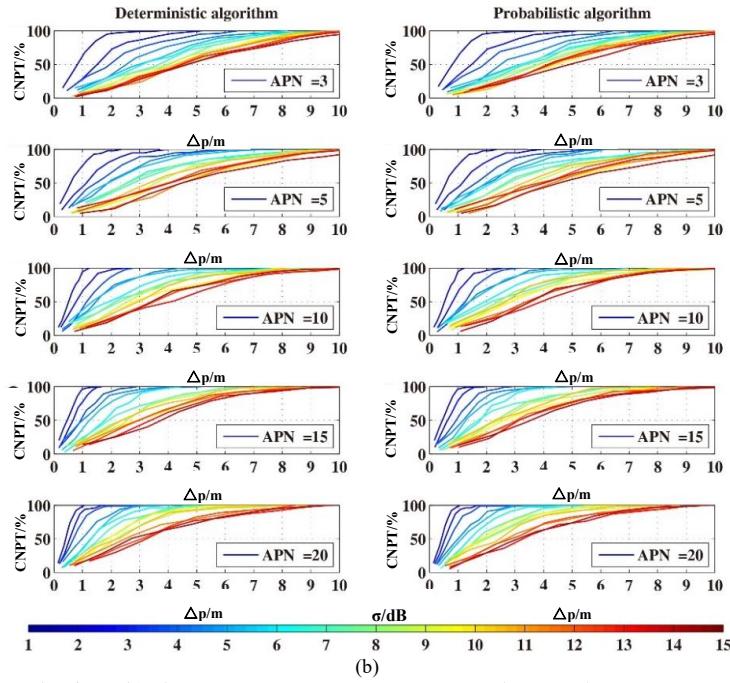


图 2-23 确定型和概率型算法对不同信号噪声的定位误差测试结果, (a)RMSE 与 σ 和(b)CNTP 与 σ

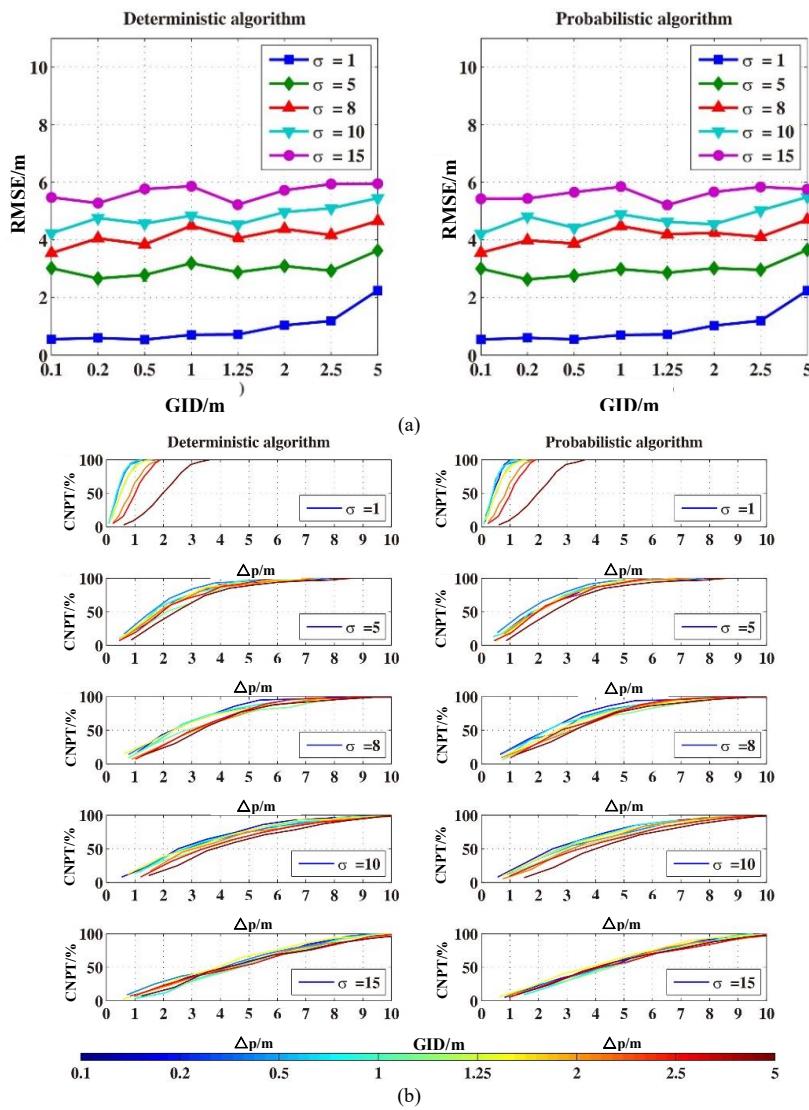


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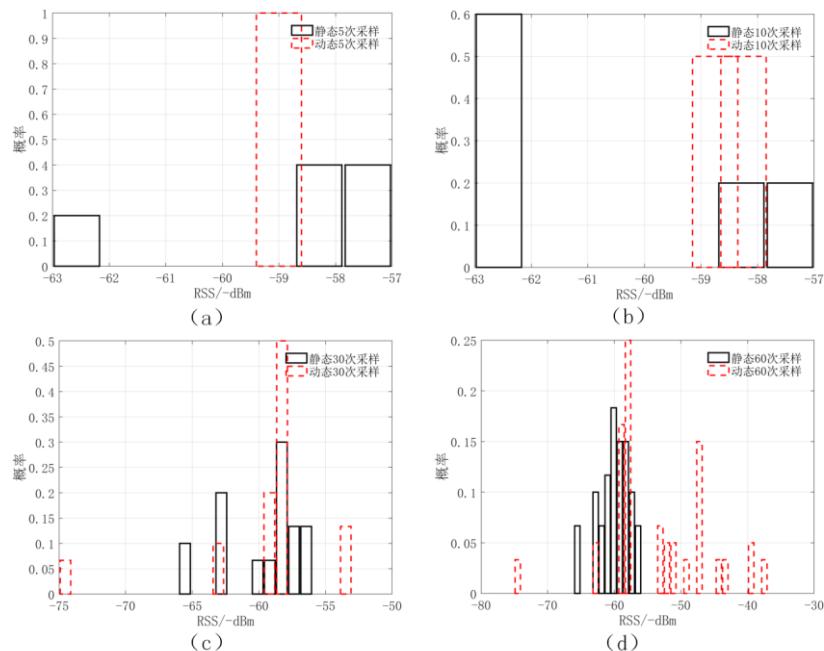


图 3-1 动/静态指纹采集信号强度统计

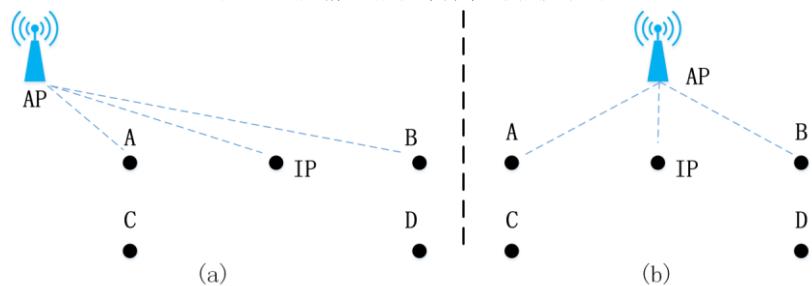


图 3-2 指纹插值的两种情形

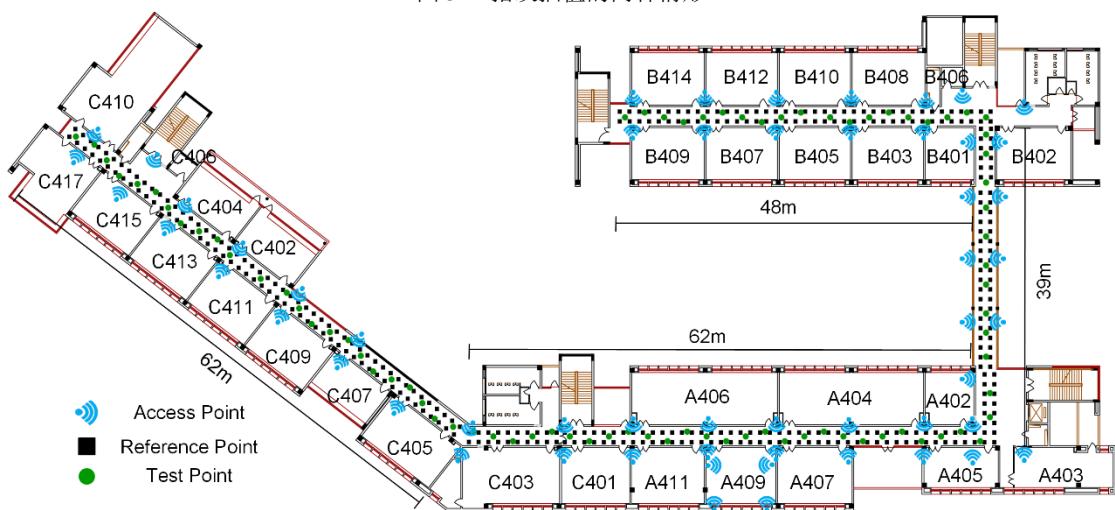


图 3-3 试验场示意图

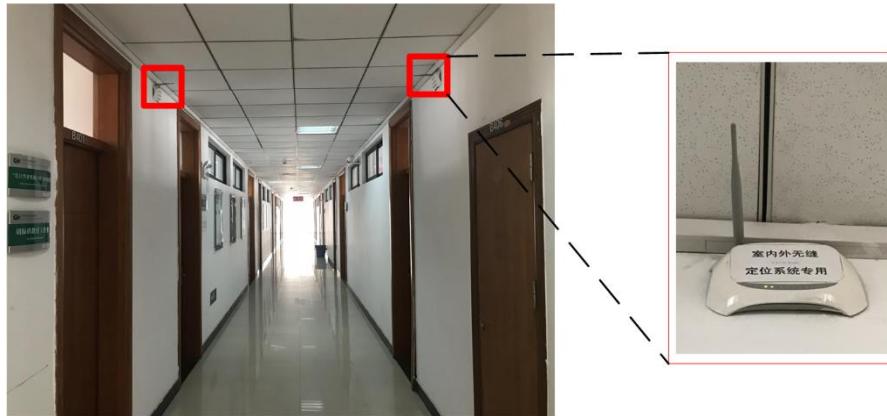


图 3-4 安装的无线路由器

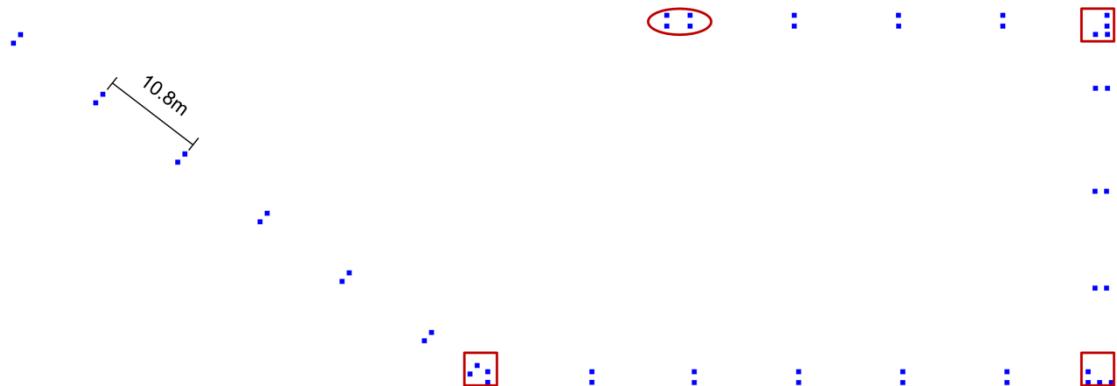


图 3-5 10.8 m 间隔的稀疏参考点分布情况

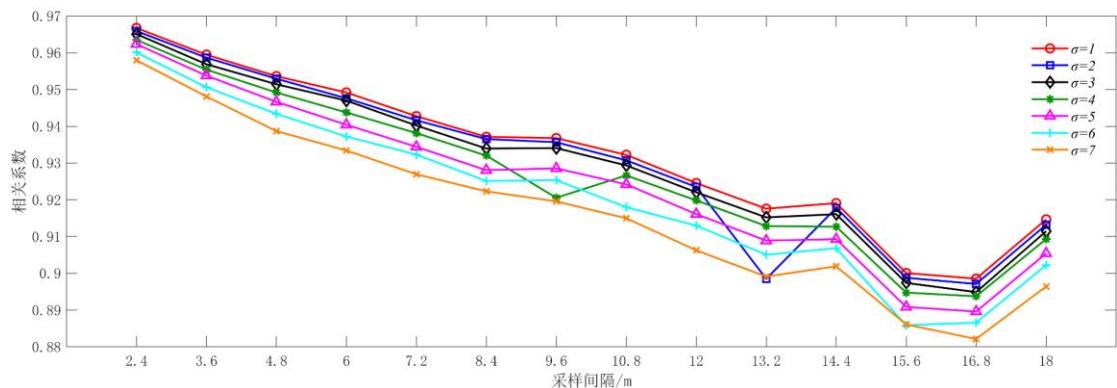


图 3-6 不同采样间隔和标准差构建的指纹库与完全人工指纹库的相关系数

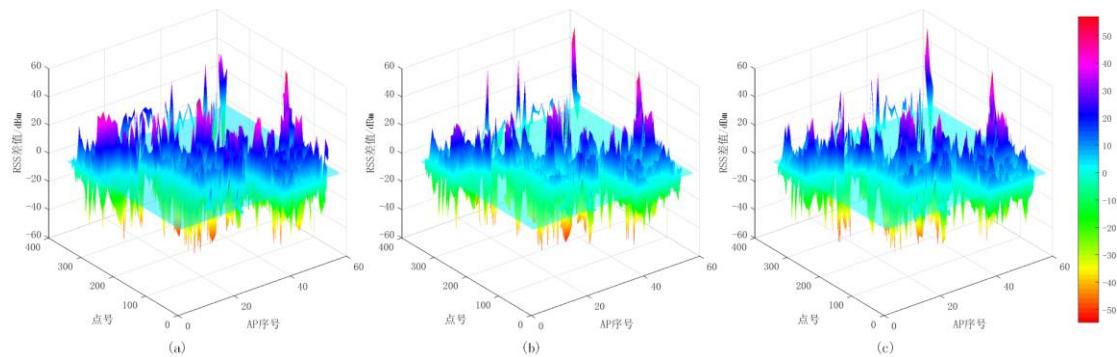


图 3-7 10.8 m 间隔生成指纹库信号差值统计

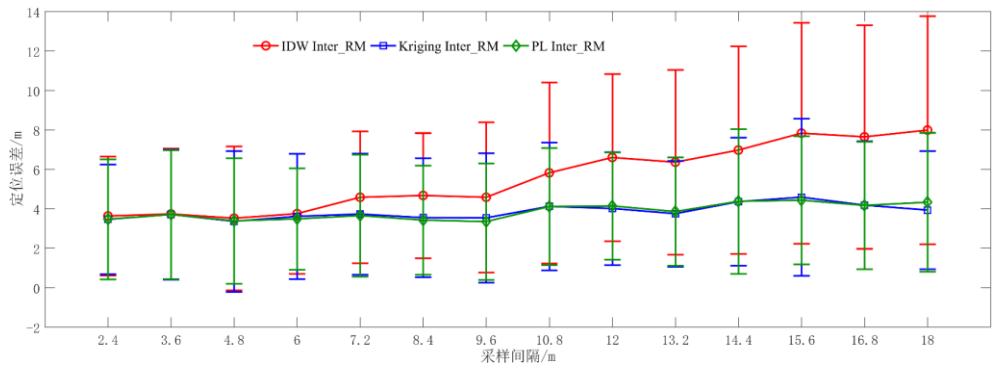


图 3-8 不同采样间隔生成的三种指纹库的定位误差

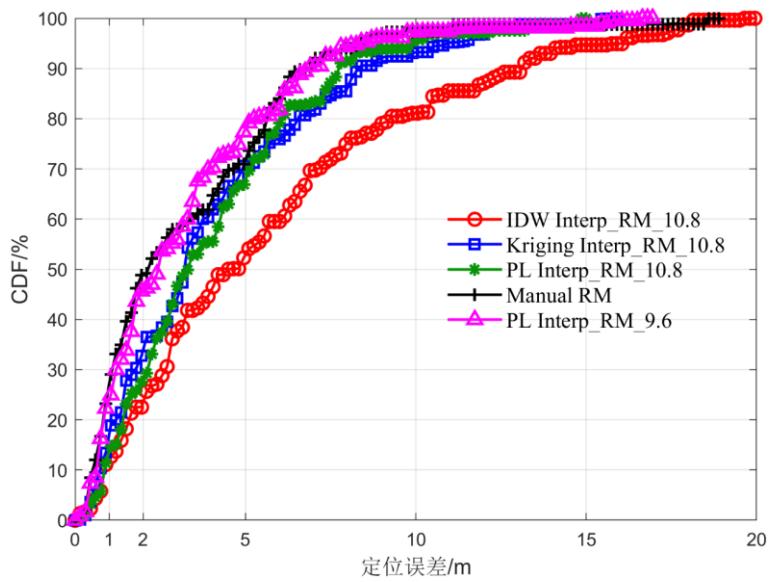


图 3-9 不同指纹库定位误差累积概率分布

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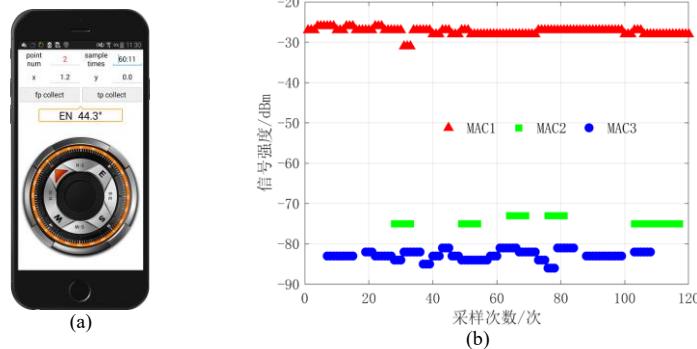


图 4-1 WiFi 指纹采集软件及信号缺失现象

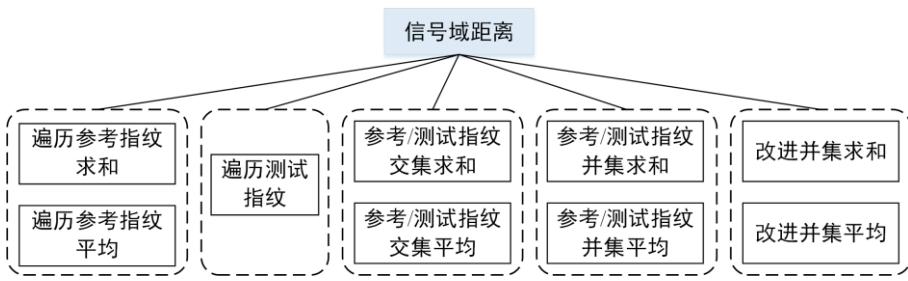


图 4-2 信号域距离分类

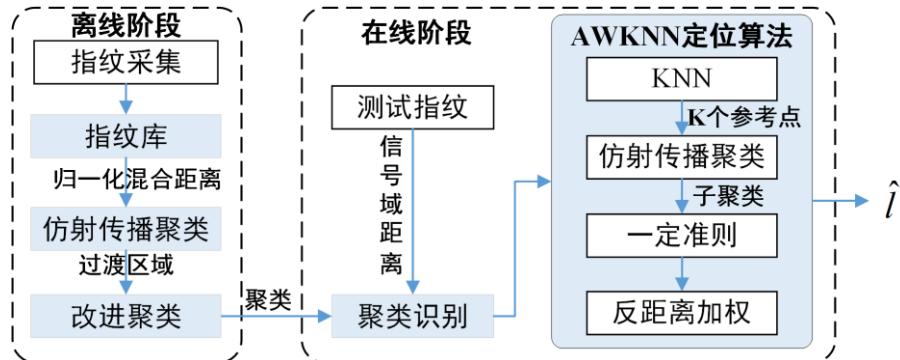


图 4-3 AWKNN 定位方法

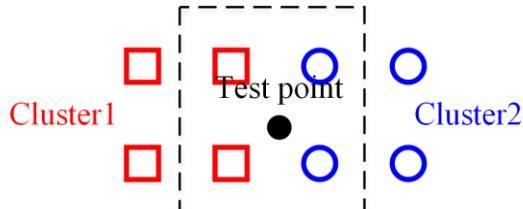


图 4-4 相邻聚类过渡区域

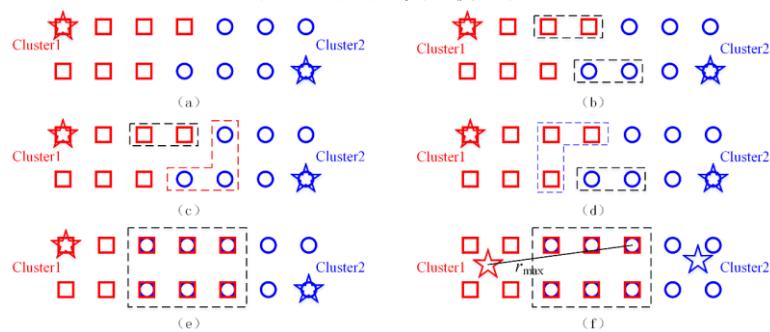


图 4-5 基于过渡区域的改进聚类示意图

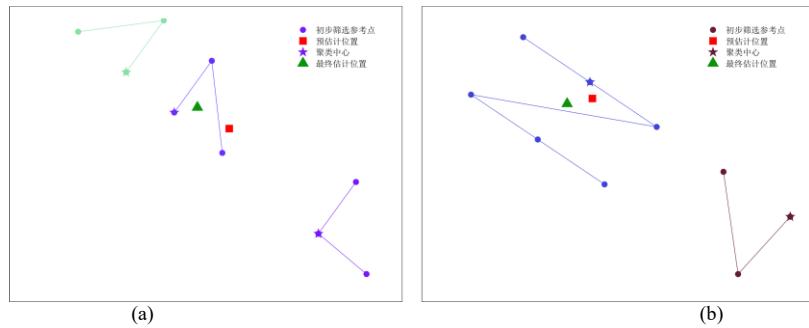


图 4-6 基于仿射传播聚类的 AWKNN 定位示意图, (a)子聚类个数为 3 时的示意图, (b)子聚类个数为 2 时的示意图

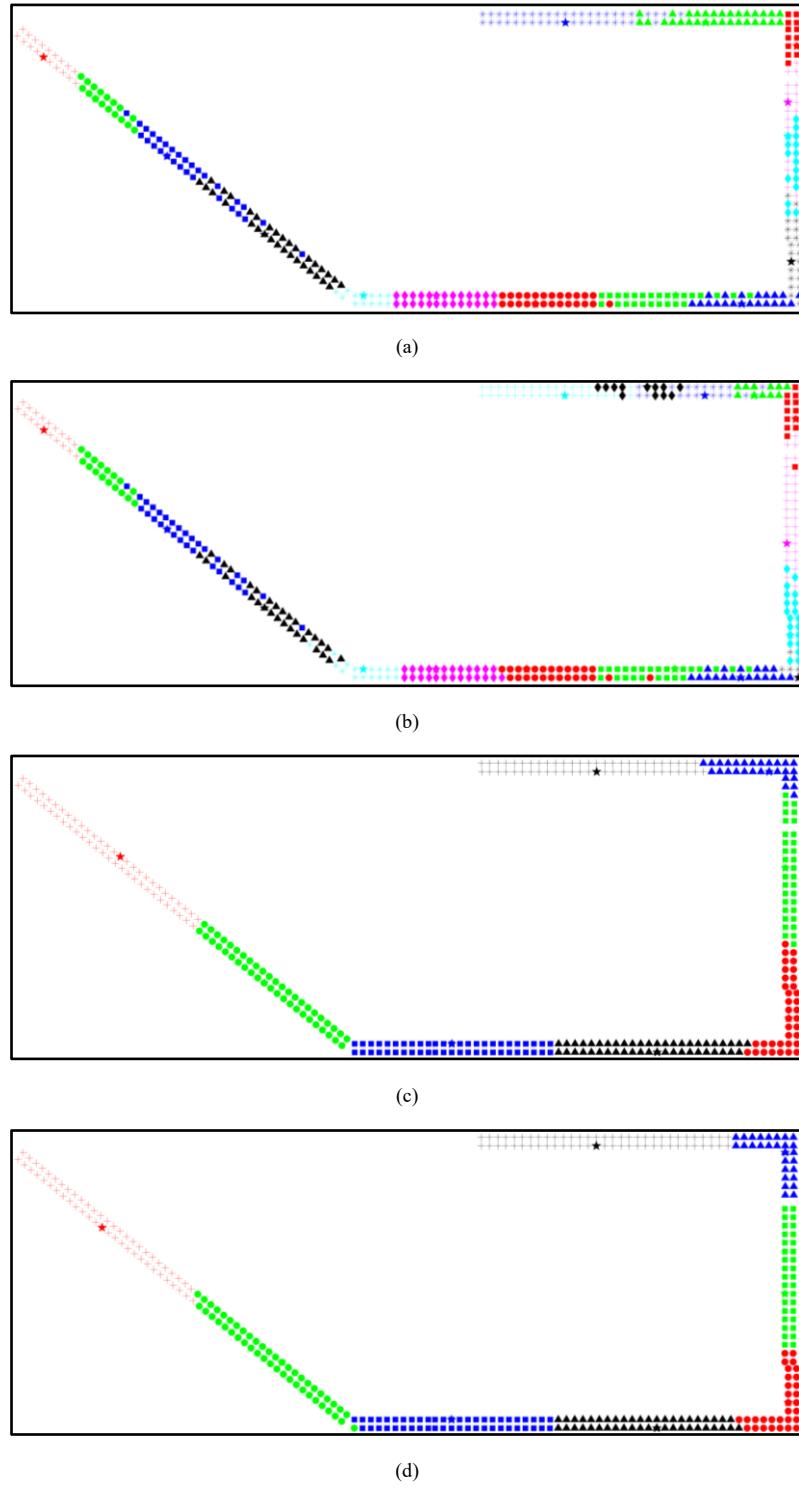


图 4-7 聚类结果, (a)基于 TRFSD 的聚类结果, (b)基于 TRFMD 的聚类结果, (c)基于 TRFSD 和位置域距离归一化混合距离的聚类结果, (d)基于 TRFMD 和位置域距离归一化混合距离的聚类结果

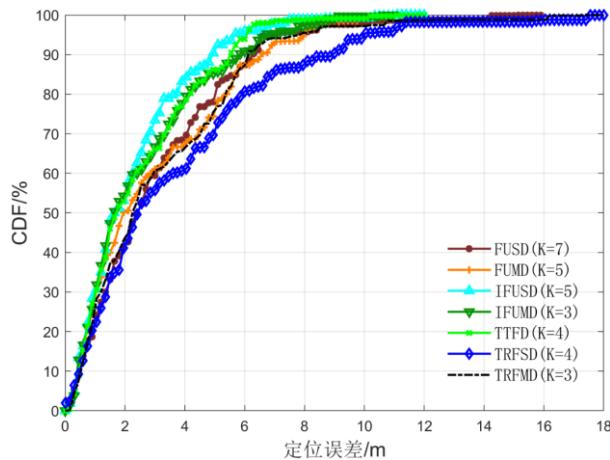


图 4-8 无聚类不同信号域距离定位误差累积分布

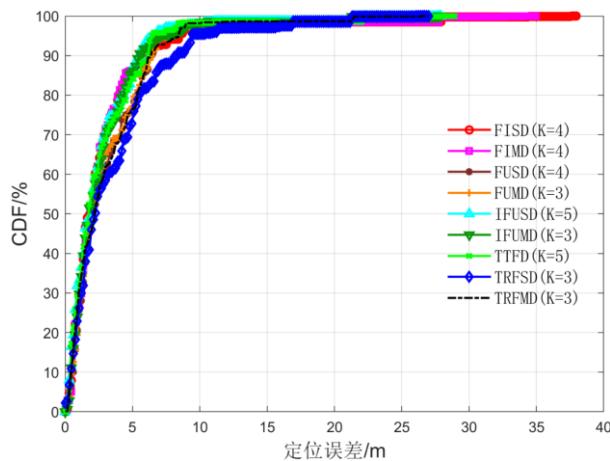


图 4-9 基于聚类识别结果不同信号域距离定位误差累积分布

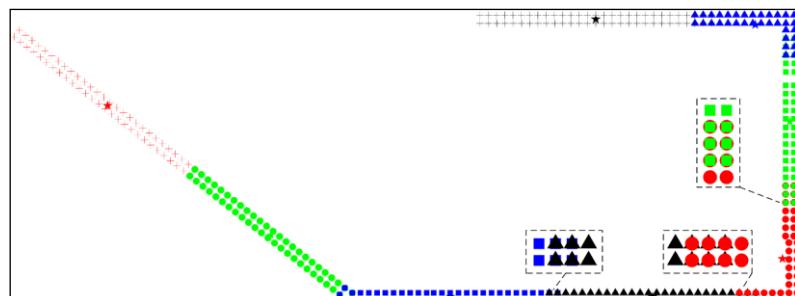


图 4-10 改进聚类结果

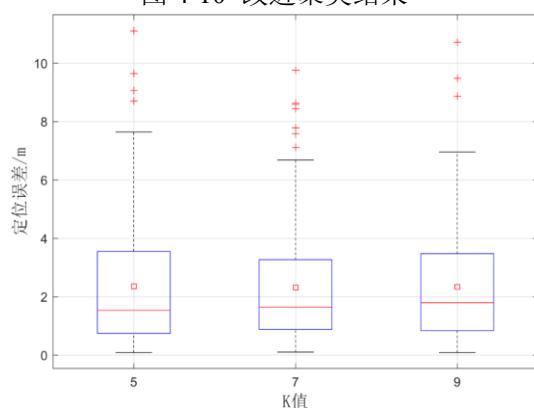


图 4-11 不同 K 值定位误差箱形图

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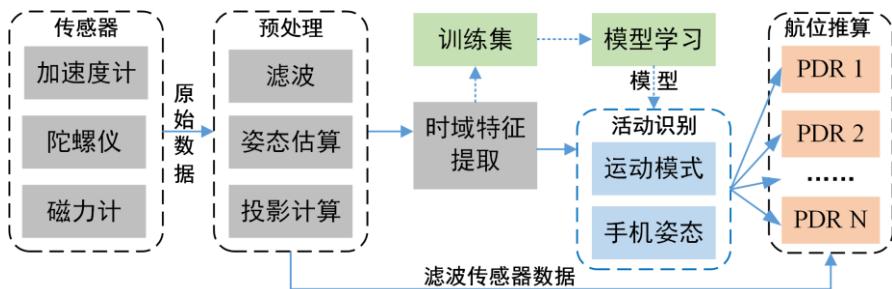


图 5-1 基于随机森林的室内行人活动识别方法

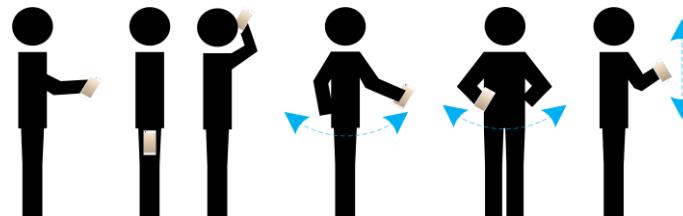


图 5-2 站立活动示意图

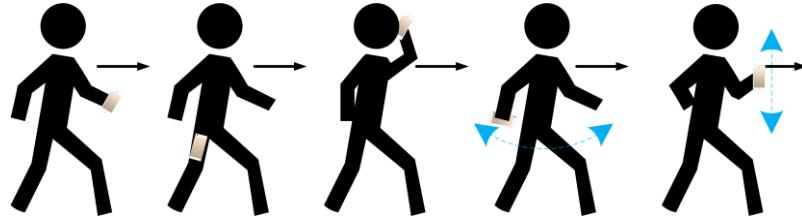


图 5-3 步行活动示意图

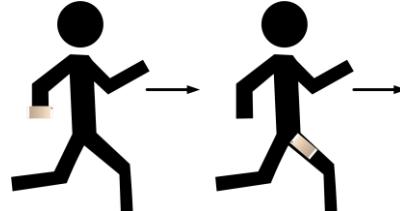


图 5-4 跑步活动示意图

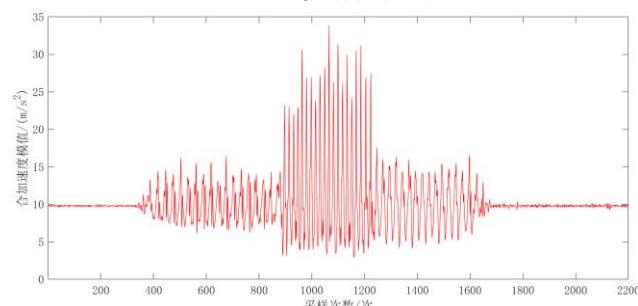


图 5-5 站立、步行和跑步活动中合加速度模值

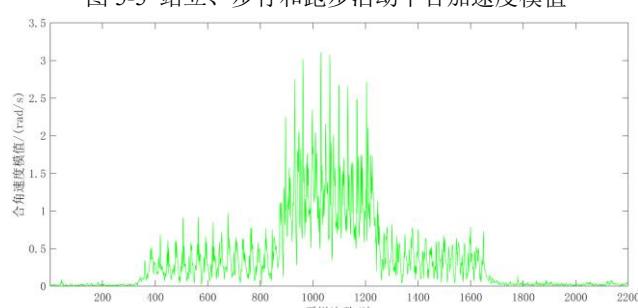


图 5-6 站立、步行和跑步活动中合角速度模值

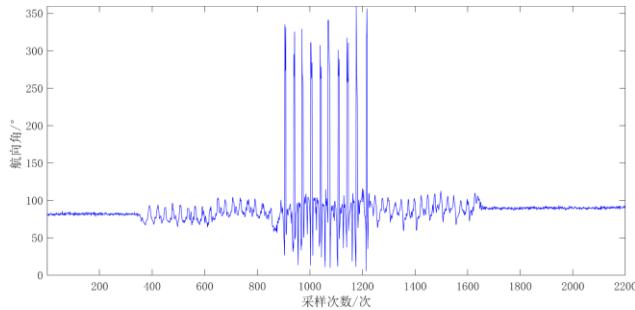


图 5-7 站立、步行和跑步活动中航向角变化情况

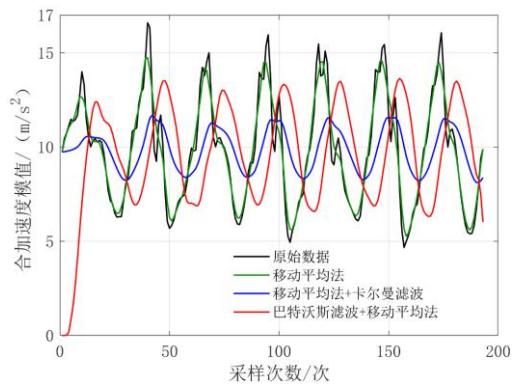


图 5-8 滤波前后合加速度模值对比

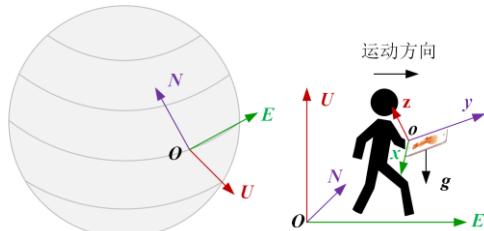


图 5-9 室内定位中的坐标系

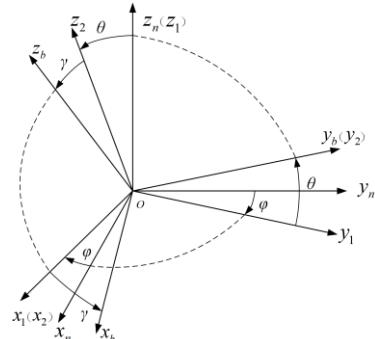


图 5-10 导航坐标系与载体坐标系之间的转换

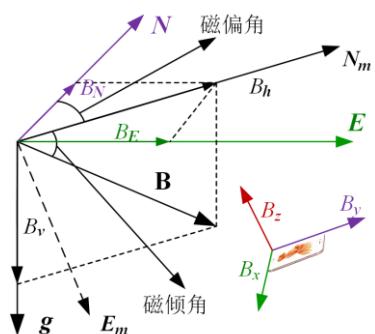


图 5-11 地球磁场强度转换关系

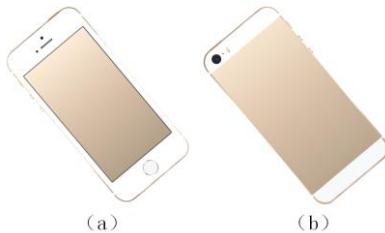


图 5-12 打电话时智能手机的姿态

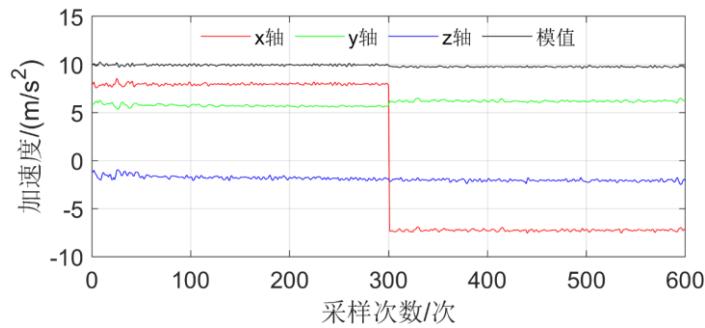


图 5-13 打电话时的加速度

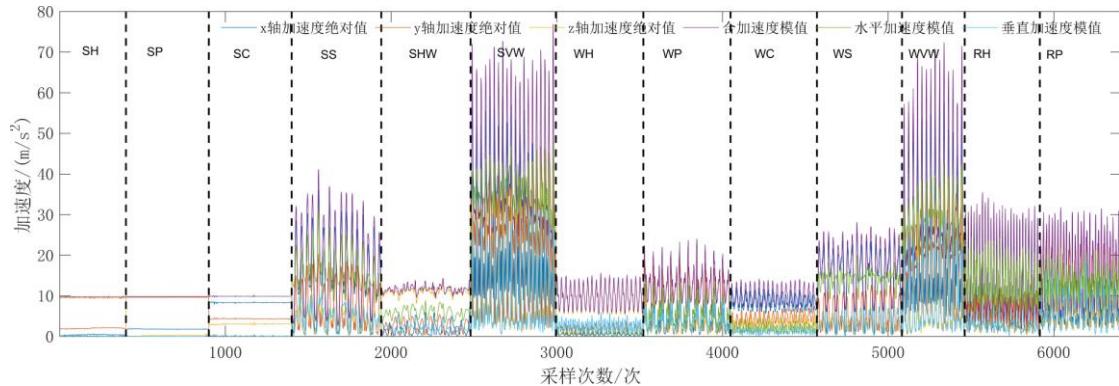


图 5-14 滤波后的加速度信息

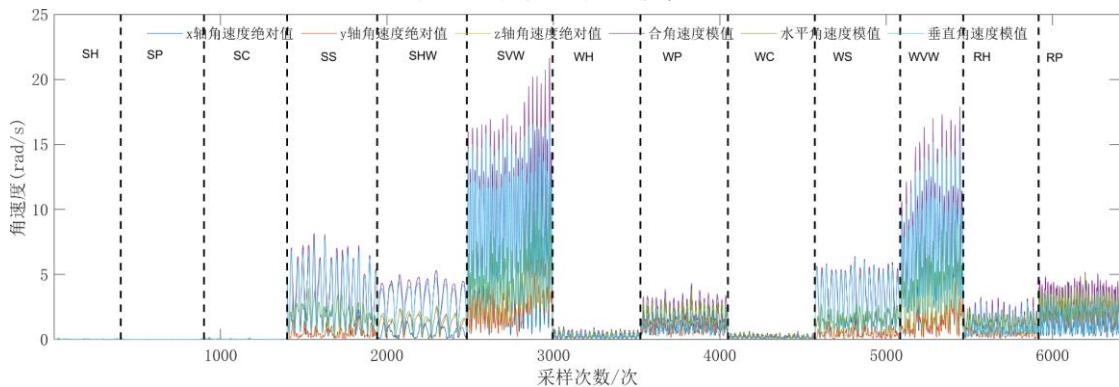


图 5-15 滤波后的角速度信息

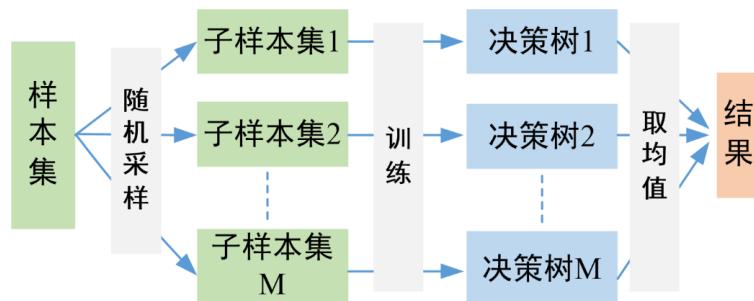


图 5-18 随机森林回归的构建过程

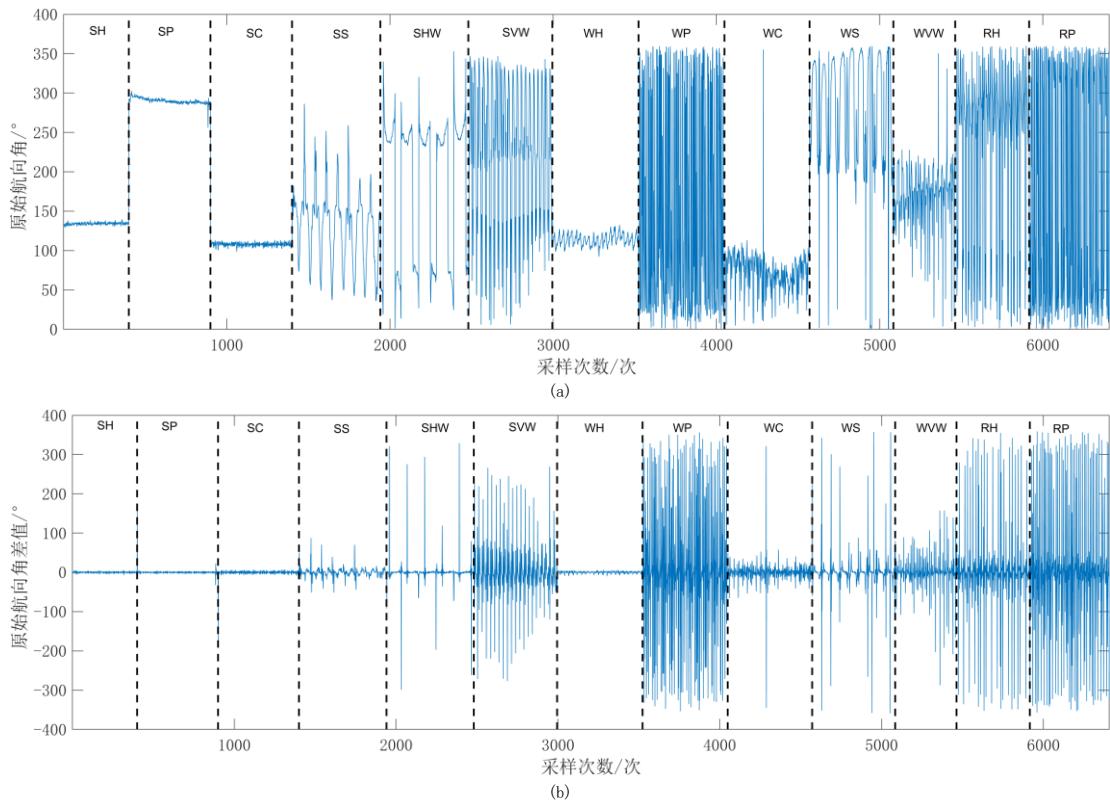


图 5-16 航向角及其差值, (a)航向角, (b)航向角差值

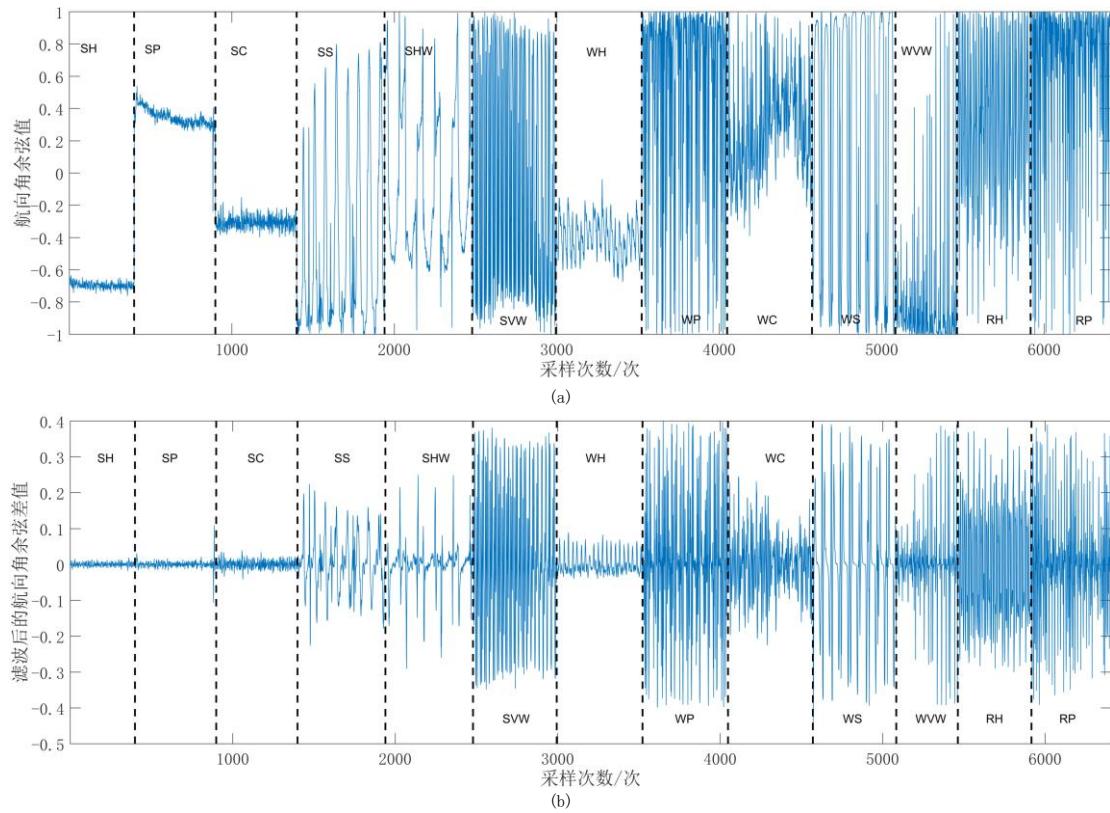


图 5-17 航向角余弦值及其差值的滤波值, (a)航向角余弦值, (b)滤波后的航向角余弦差值

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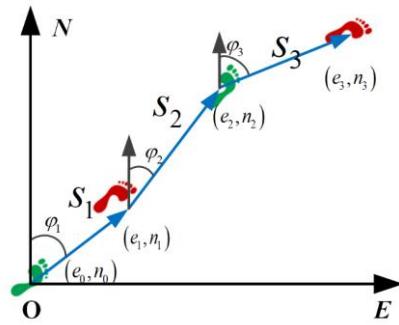


图 6-1 行人航位推算原理

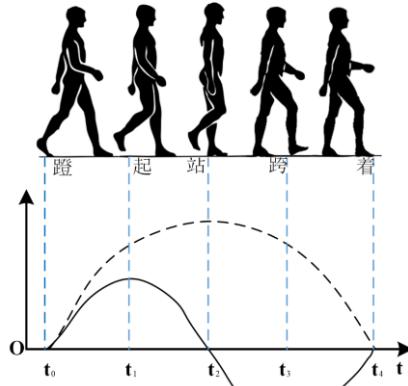


图 6-2 行走一步状态及运动参数变化

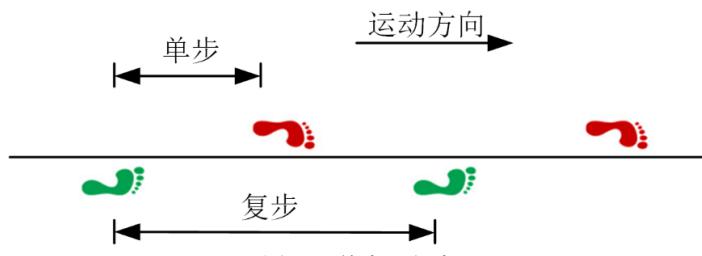


图 6-3 单步和复步

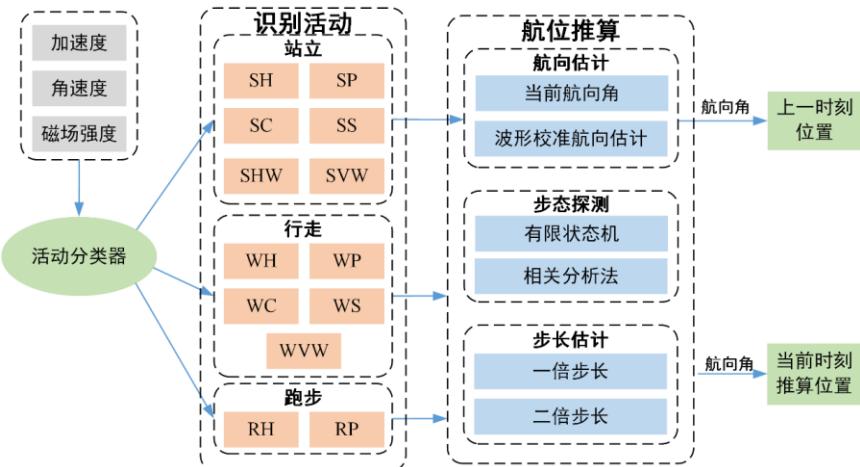


图 6-4 顾及活动识别的改进行人航位推算方法体系

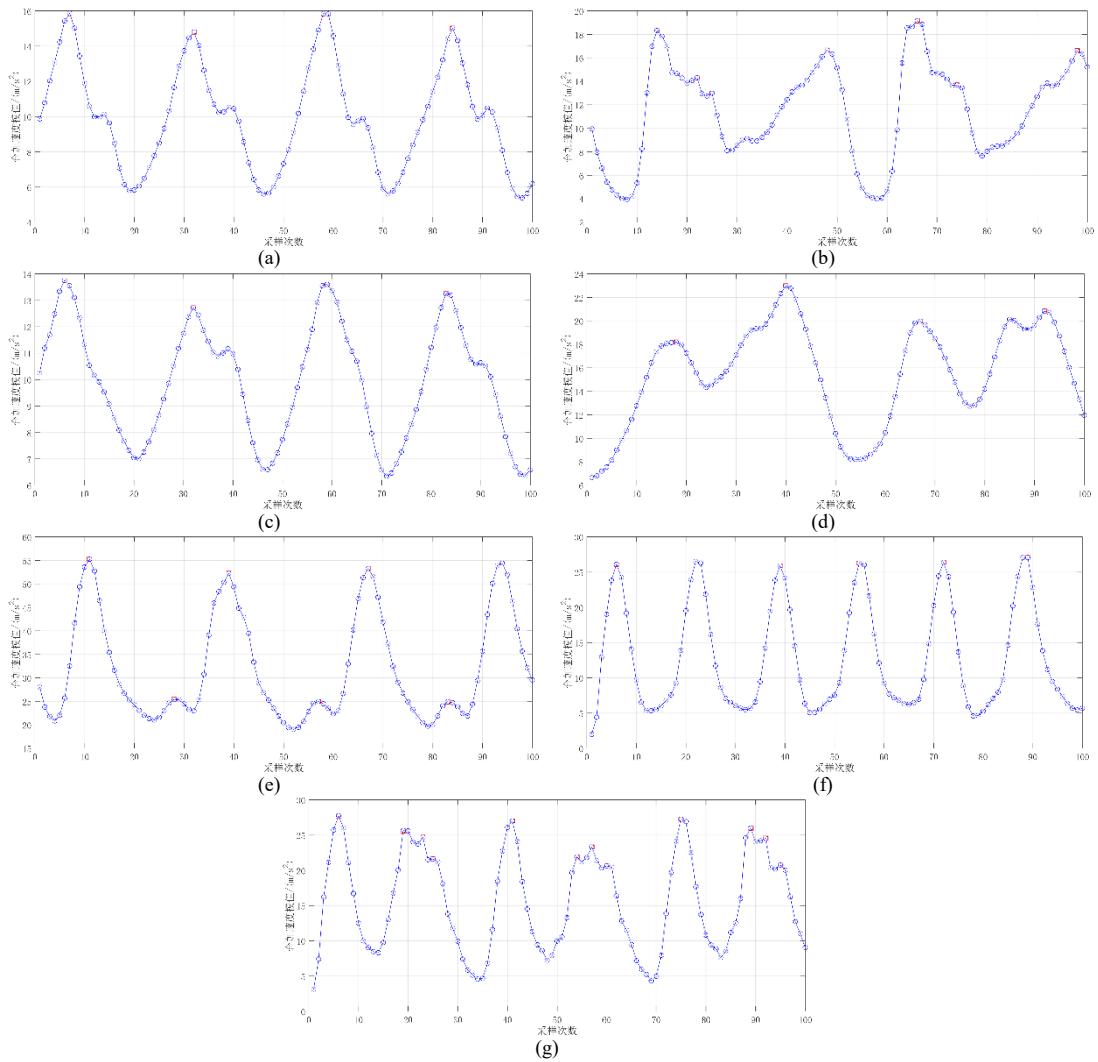


图 6-5 7 种活动下的合加速度模值变化情况, (a)WH, (b)WP, (c)WC, (d)WS, (e)WVV, (f)RH, (g)RP

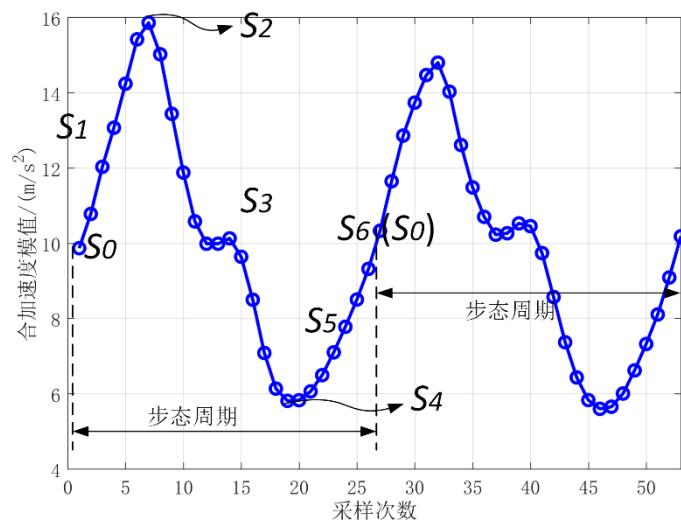


图 6-6 步行状态划分

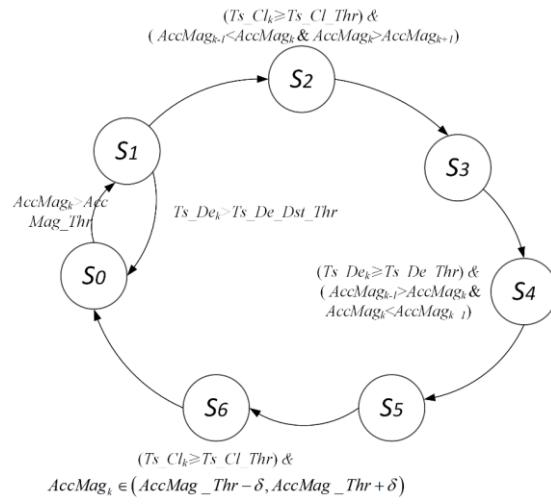


图 6-7 基于有限状态机的步态探测方法

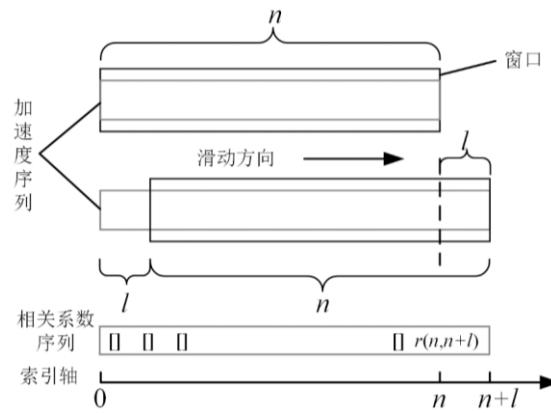


图 6-8 相关分析过程

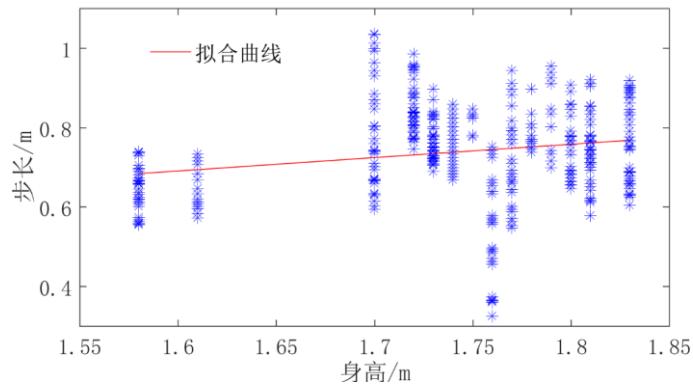


图 6-9 身高与步长的对应关系

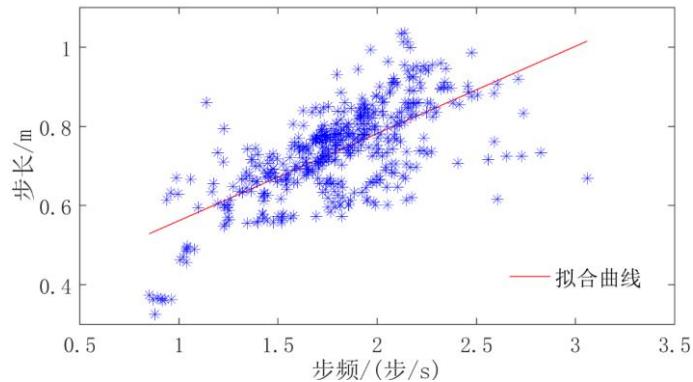


图 6-10 步频与步长的对应关系

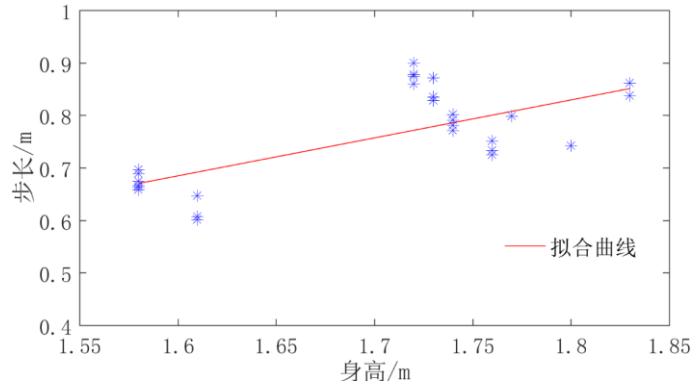


图 6-11 某频率范围内身高与步长的对应关系

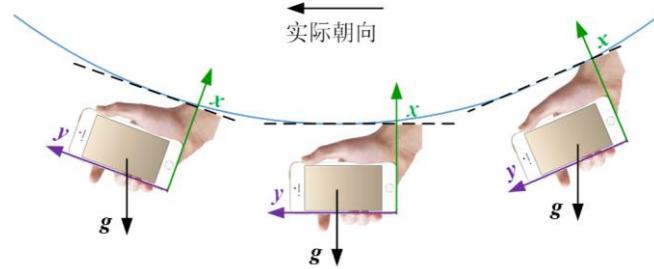


图 6-12 智能手机随手臂摇摆过程中的坐标轴变化

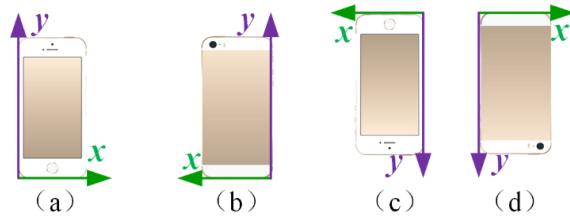


图 6-13 智能手机在口袋中的姿态

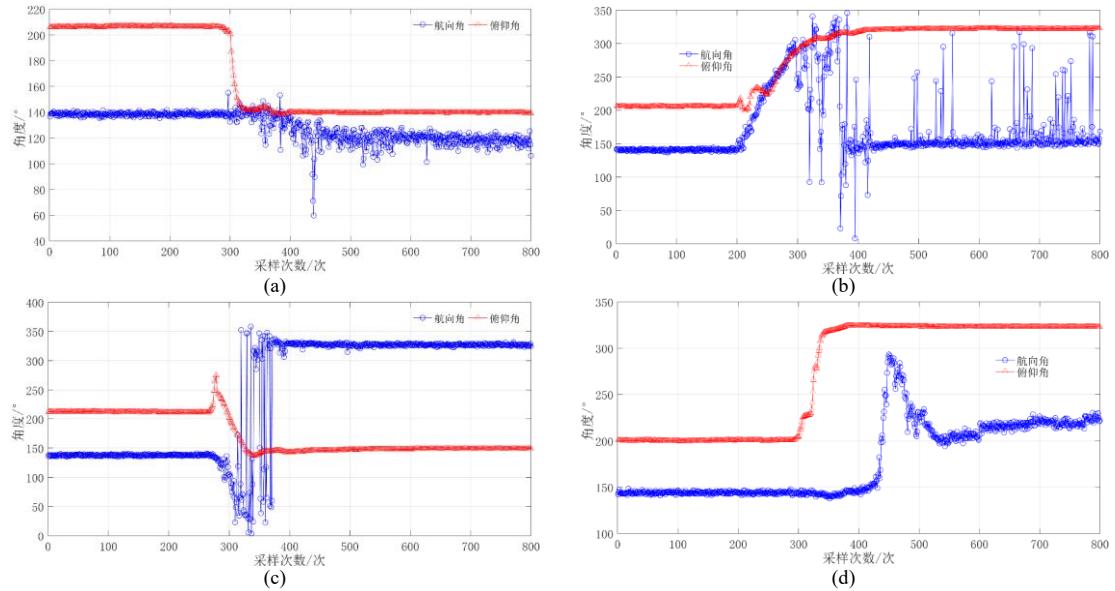


图 6-14 智能手机由水平变竖直的角度变化, (a)头朝上屏幕指向用户, (b)头朝上屏幕背向用户, (c)头朝下屏幕指向用户, (d)头朝下屏幕背向用户

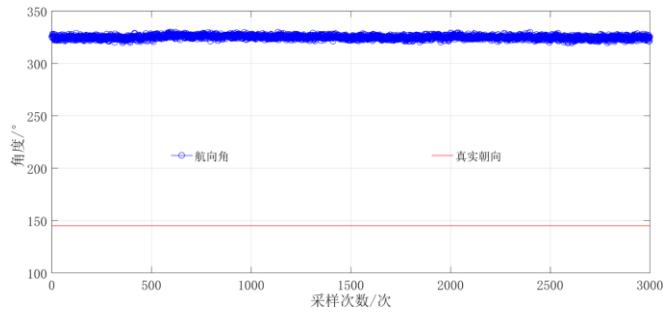


图 6-15 站立打电话时的航向角

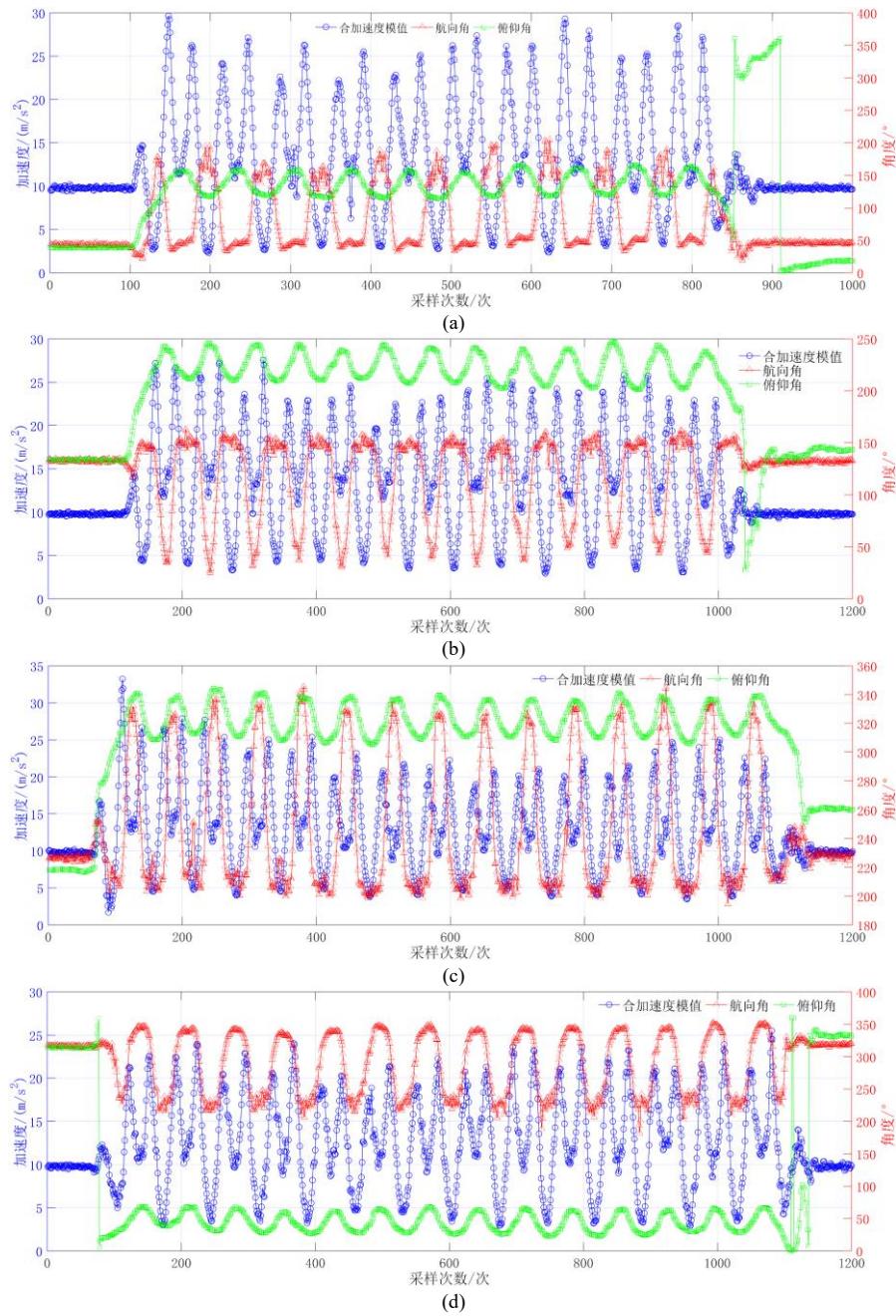


图 6-16 站立摇摆活动下合加速度模值、航向角和俯仰角的变化, (a)面朝东北向——站立摇摆, (b)面朝东南向——站立摇摆, (c)面朝西南向——站立摇摆, (d)面朝西北向——站立摇摆

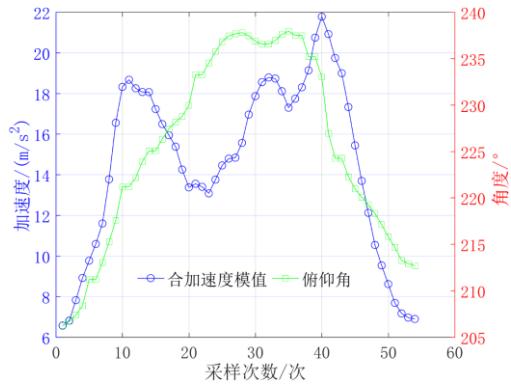


图 6-17 一个完整摇摆过程中合加速度模值的变化情况

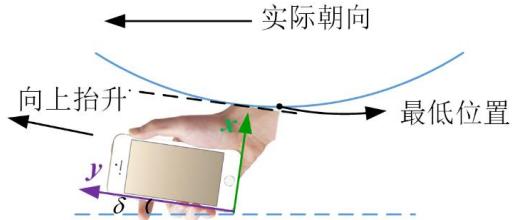


图 6-18 摆摆过程中最低位置处的朝向示意图

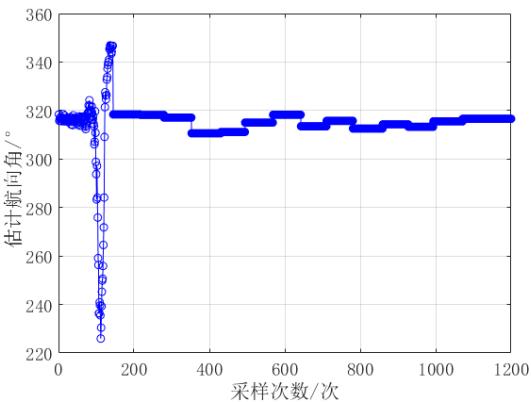


图 6-19 站立摇摆活动下波形校准法的航向估计

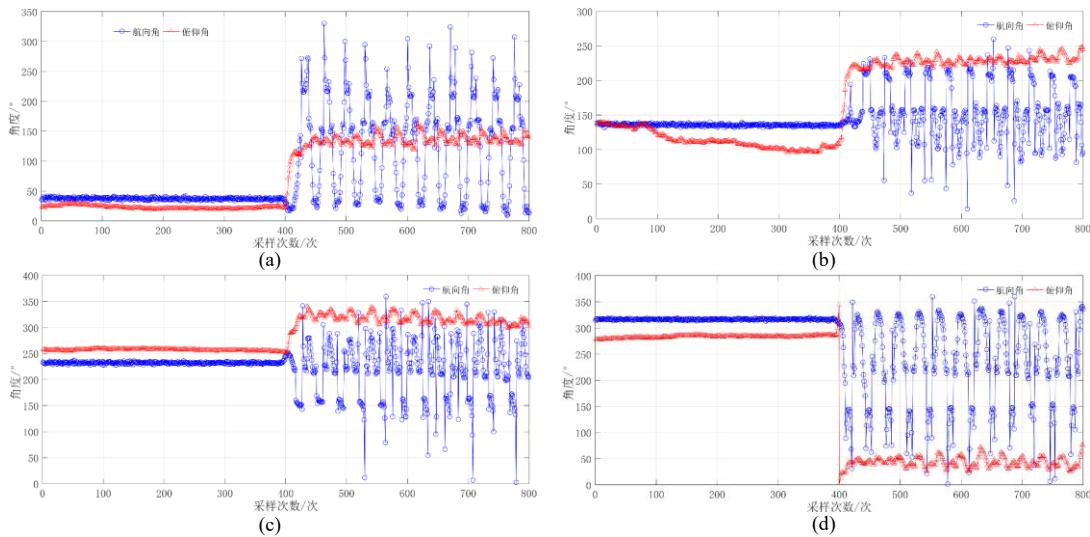


图 6-20 站立垂直晃动时航向角和俯仰角变化, (a)面朝东北向-垂直晃动, (b)面朝东南向-垂直晃动, (c)面朝西南向-垂直晃动, (d)面朝西北向-垂直晃动

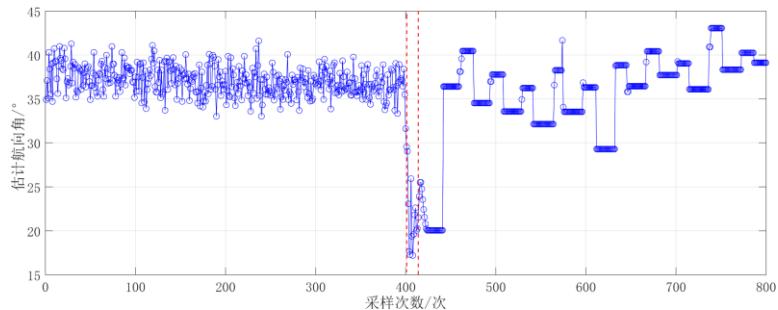


图 6-21 站立垂直晃动面朝东北向时的航向估计

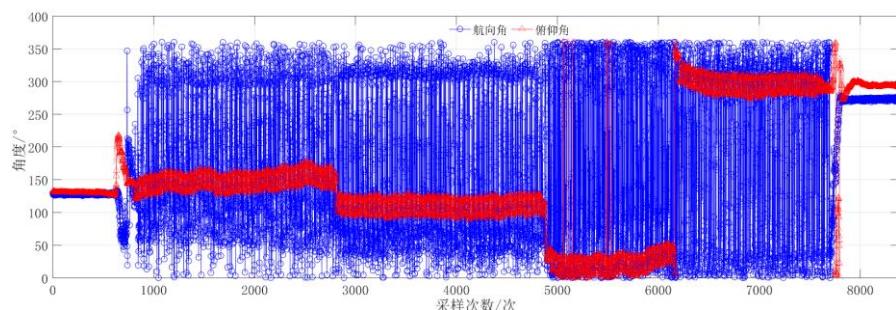


图 6-22 步行口袋下的航向角和俯仰角变化

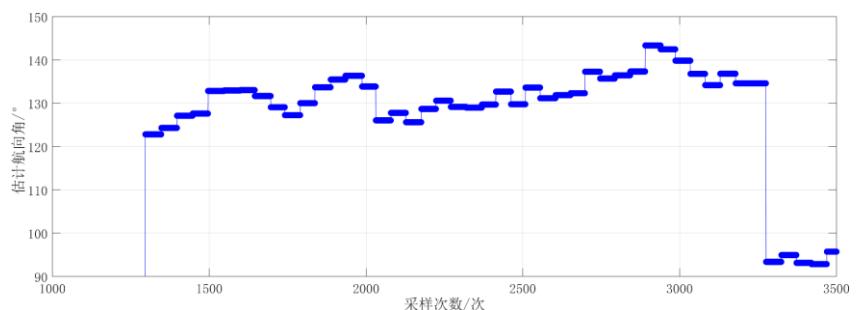


图 6-23 步行口袋下航向估计

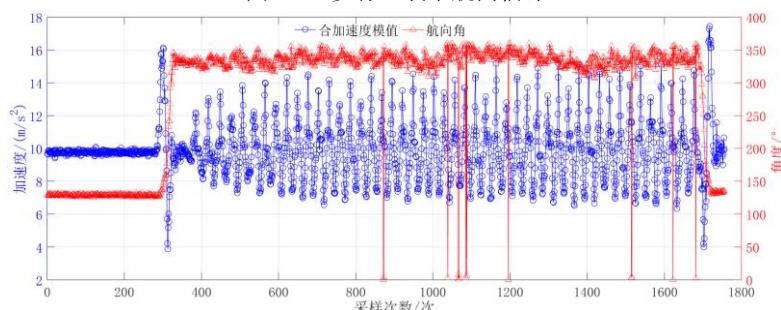


图 6-24 步行打电话时合加速度模值和航向角变化

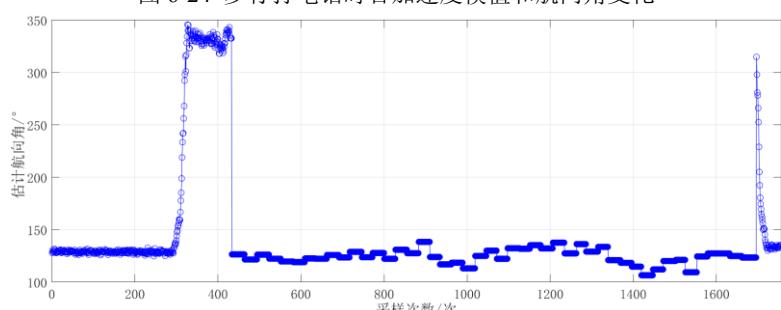


图 6-25 步行打电话活动下航向估计

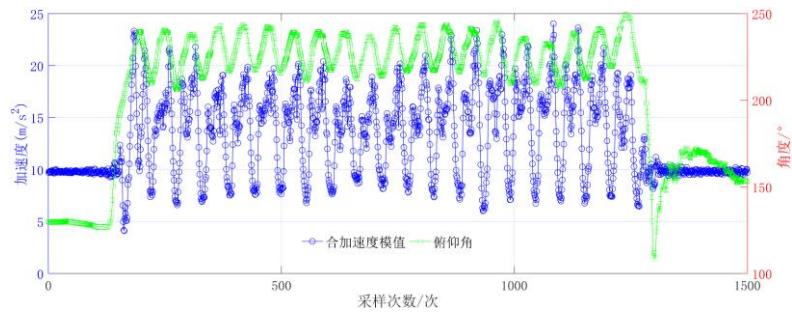


图 6-26 步行摇摆下合加速度模值和俯仰角的变化

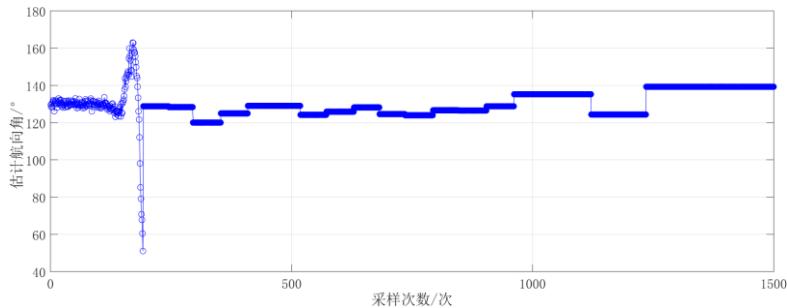


图 6-27 步行摇摆下航向估计

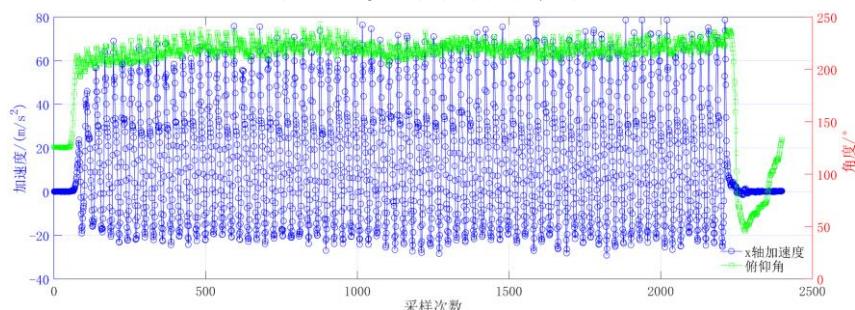


图 6-28 步行垂直晃动下的 x 轴加速度和俯仰角变化

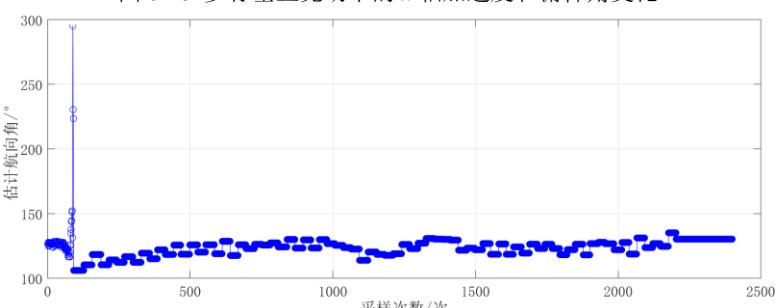


图 6-29 步行垂直晃动下的航向估计

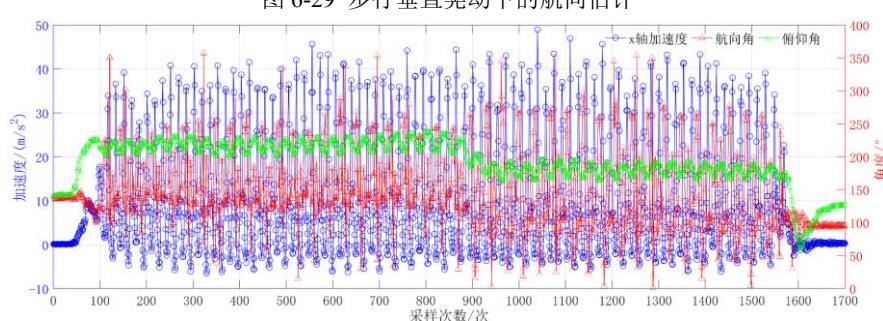


图 6-30 跑步紧握下的加速度和角度变化

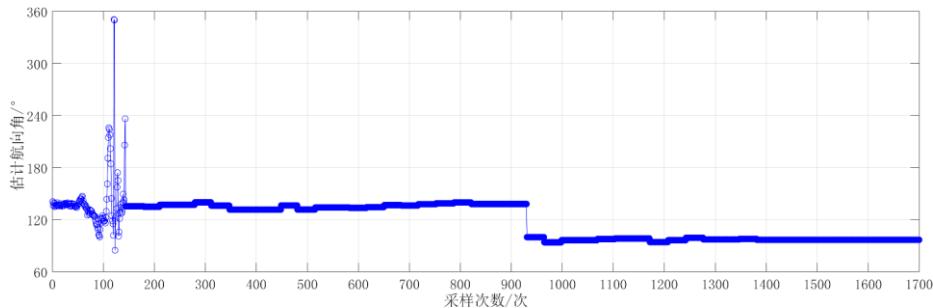


图 6-31 跑步紧握下的航向估计

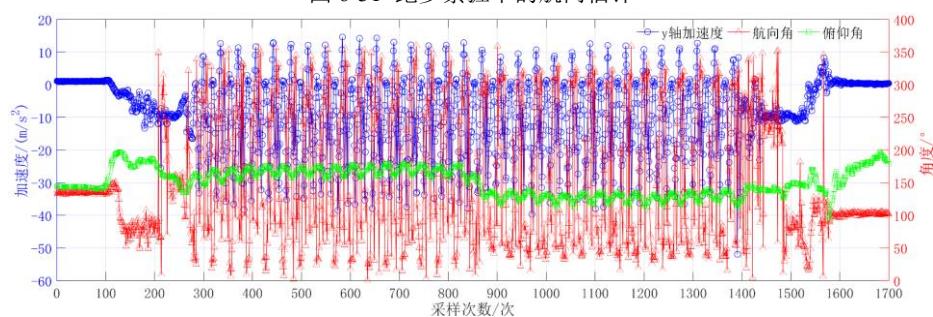


图 6-32 跑步口袋活动下的加速度和角度变化

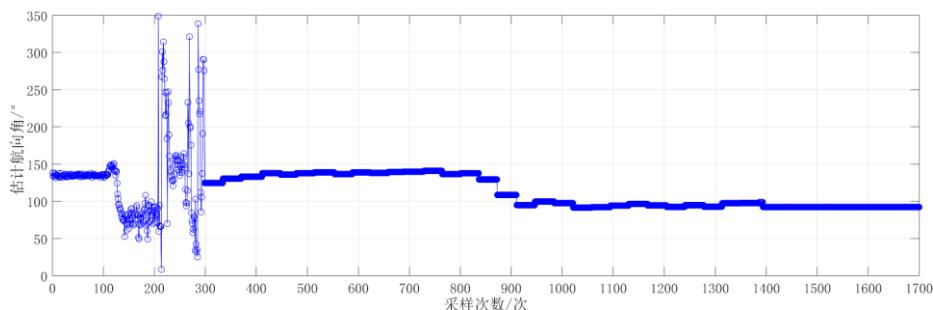


图 6-33 跑步口袋下的航向估计

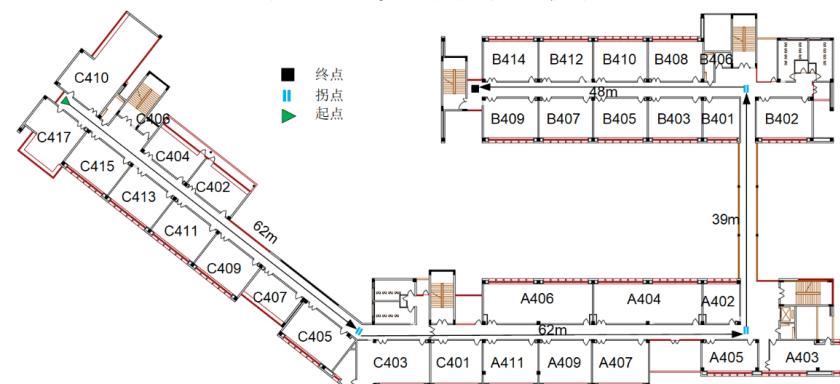


图 6-34 行人航位推算试验场

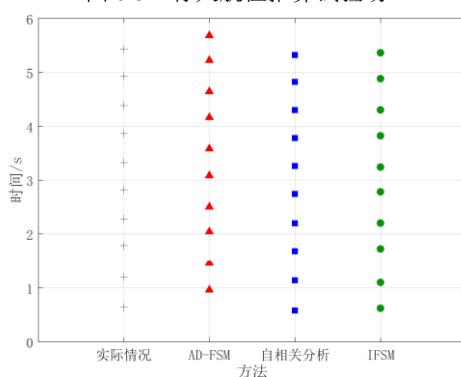


图 6-35 前 10 步的识别时间

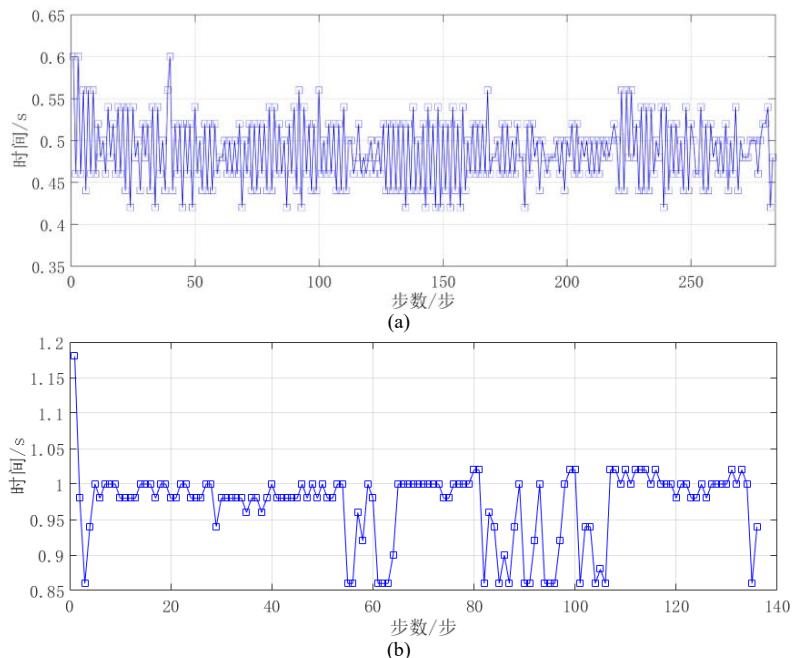


图 6-36 两种活动下的步态周期统计, (a)WH, (b)WP

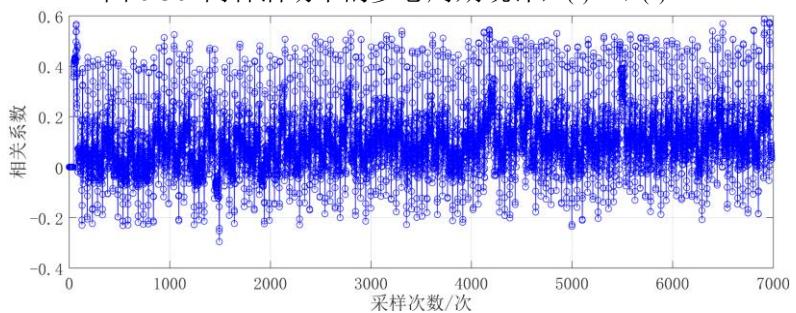


图 6-37 WP 活动下的相关系数统计

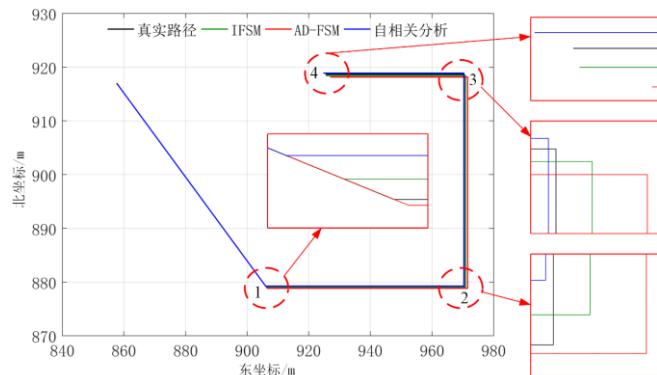
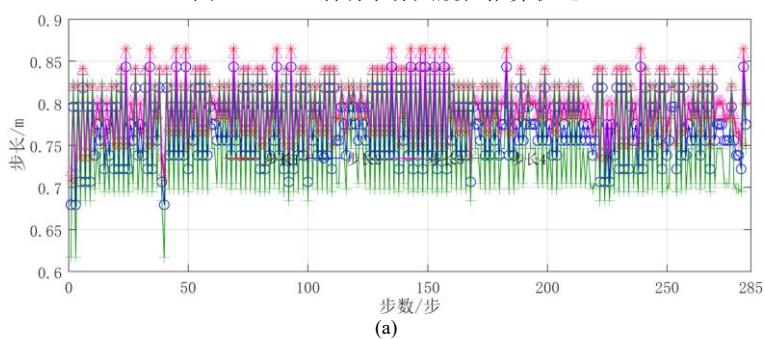
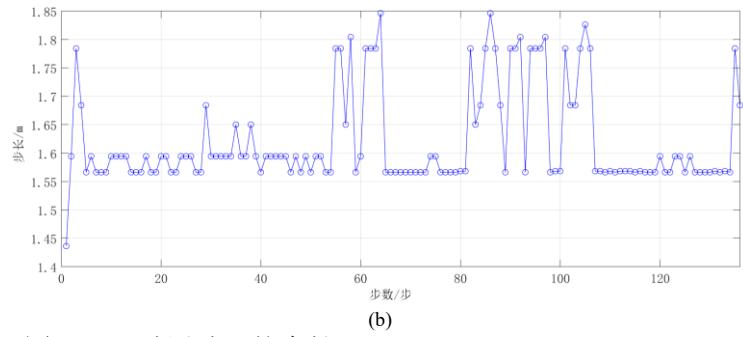


图 6-38 WH 活动下行人航位推算轨迹





(b)

图 6-39 2 种活动下的步长, (a)WH 活动下四种模型的步长信息, (b)WP

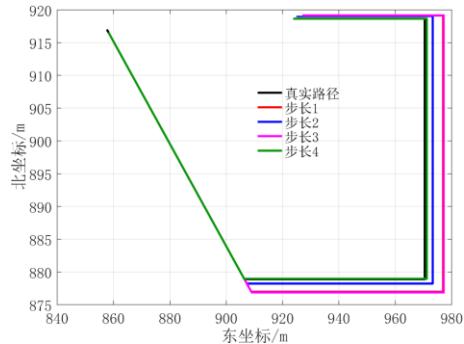
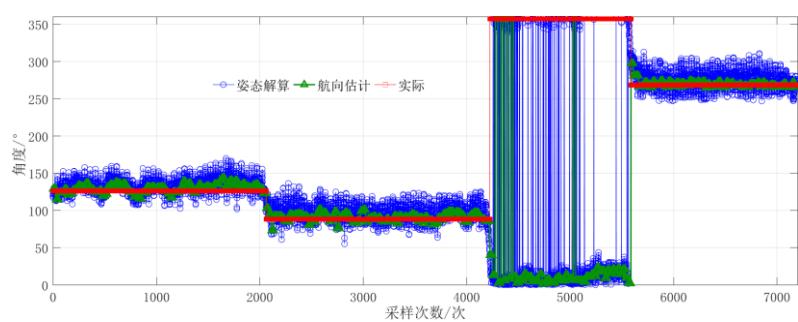


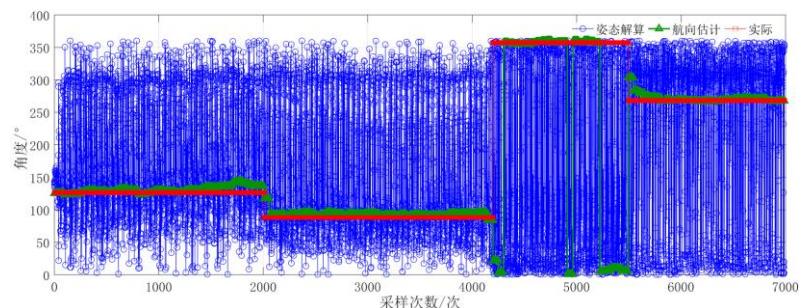
图 6-40 四种步长模型的运动轨迹



图 6-41 学院楼顶点之记



(a)



(b)
图 6-42 航向估计结果, (a)WH, (b)WP

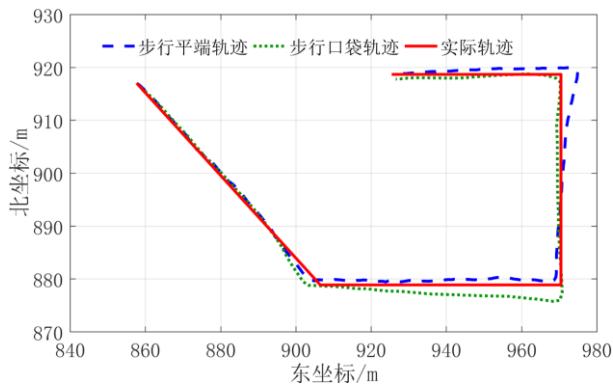


图 6-43 PDR 定位轨迹

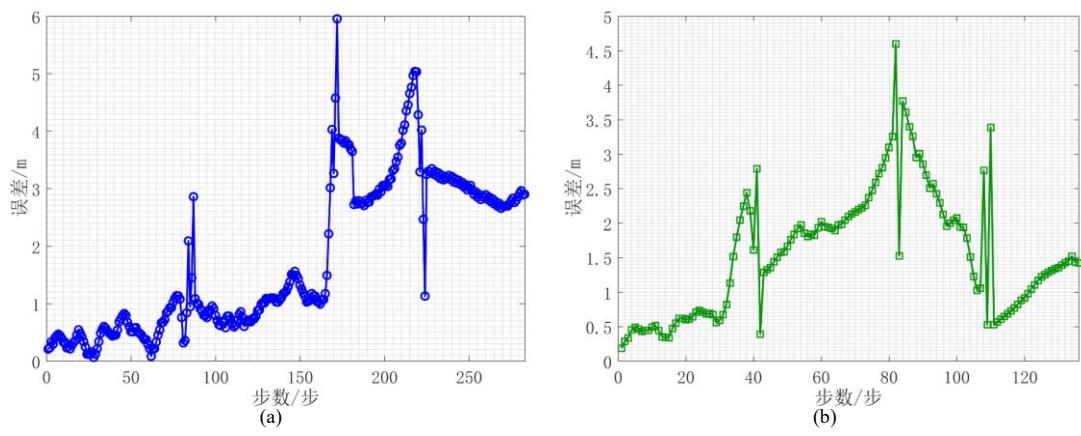


图 6-44 行人航位推算误差, (a)WH, (b)WP

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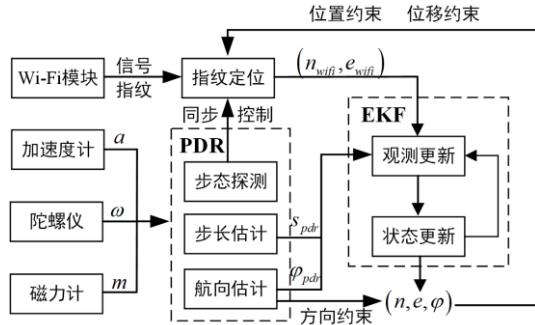


图 7-1 WiFi/PDR 混合定位方法优化技术路线

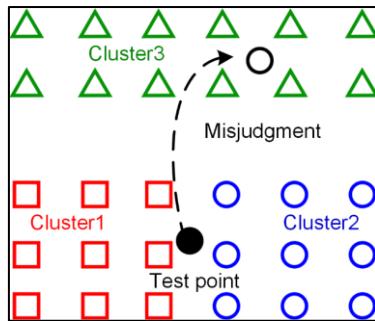


图 7-2 聚类识别误判现象

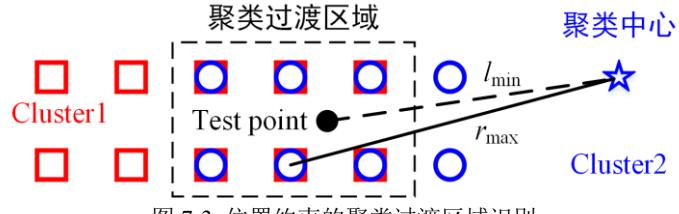


图 7-3 位置约束的聚类过渡区域识别

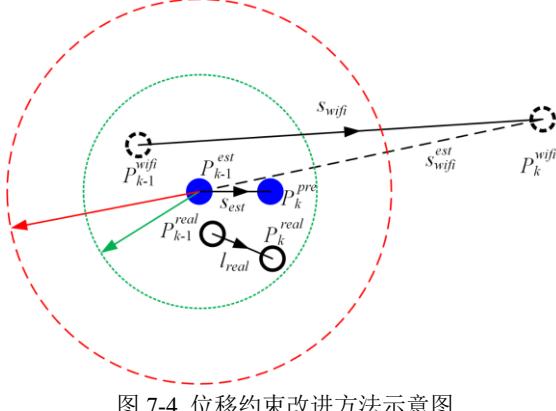


图 7-4 位移约束改进方法示意图

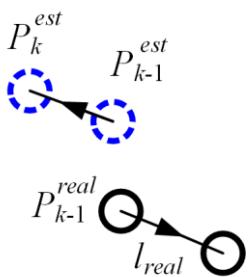


图 7-5 混合定位中的回跳现象

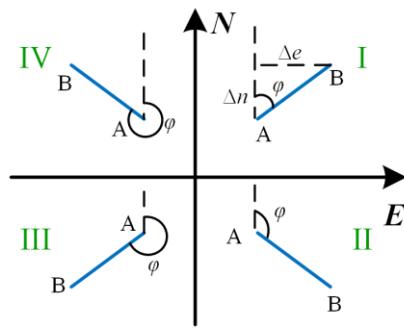


图 7-6 坐标方位角

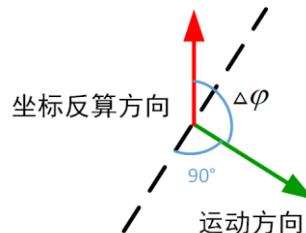


图 7-7 回跳现象判定依据

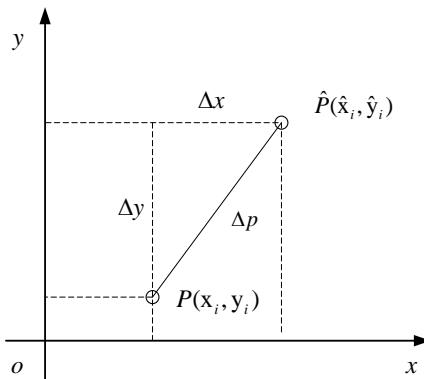


图 7-8 点位误差图示

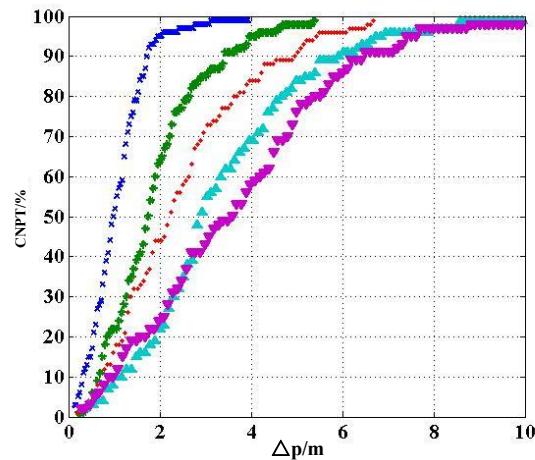


图 7-9 误差累积分布函数图示

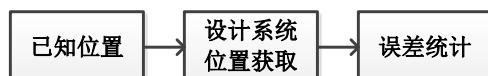


图 7-10 室内定位系统的静态精度评价方法



图 7-11 室内定位系统的动态精度评价方法

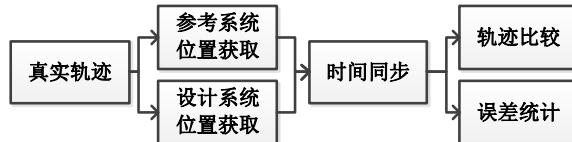


图 7-12 顾及动静态的室内定位系统精度评价方法

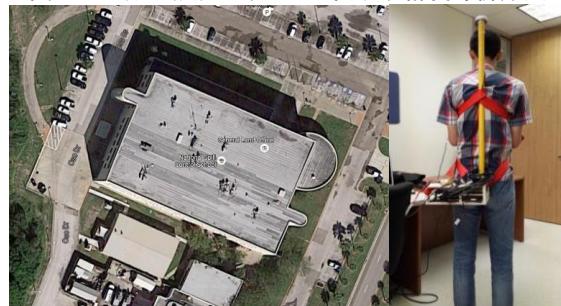


图 7-13 实验地点与真值参考系统配置



图 7-14 真值参考系统轨迹和设计系统定位位置

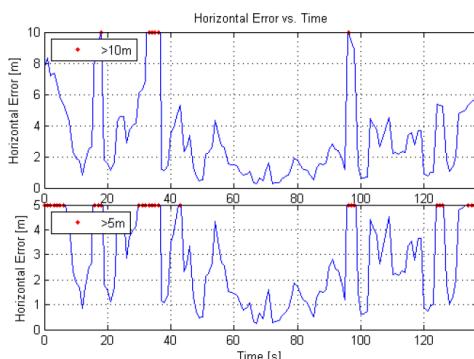


图 7-15 点位误差按时间展示图

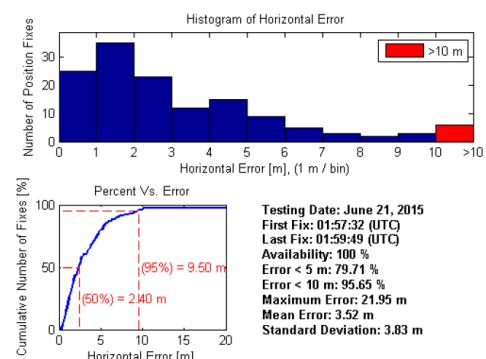


图 7-16 误差统计图

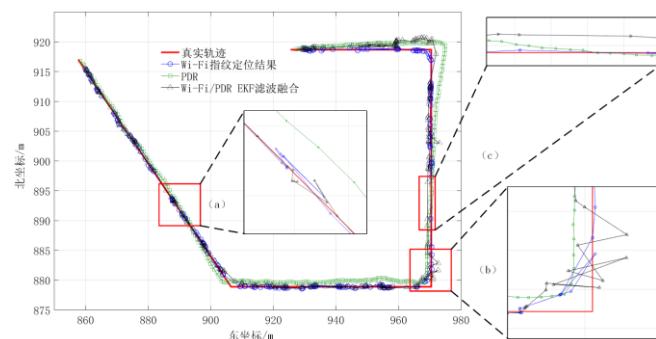


图 7-17 WiFi/PDR 扩展卡尔曼滤波融合定位轨迹

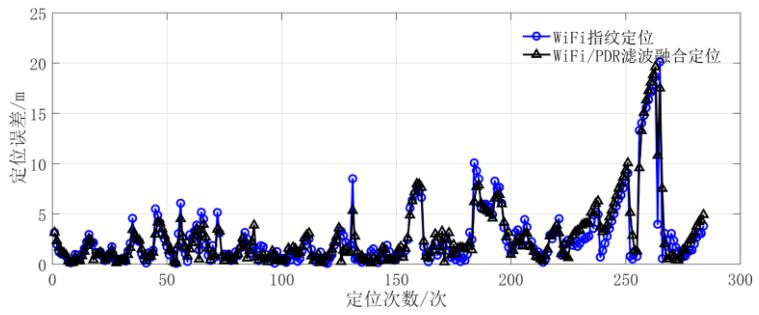


图 7-18 WiFi/PDR 扩展卡尔曼滤波融合定位误差

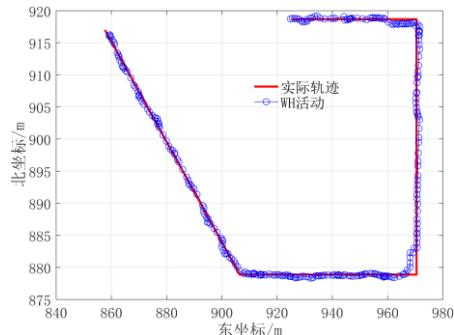


图 7-19 WH 活动 WiFi/PDR 混合定位方法优化结果

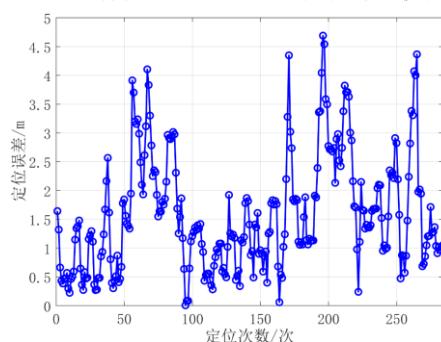


图 7-20 WH 活动 WiFi/PDR 混合定位方法优化误差

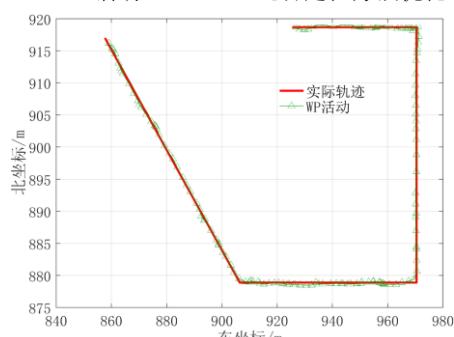


图 7-21 WP 活动 WiFi/PDR 混合定位方法优化结果

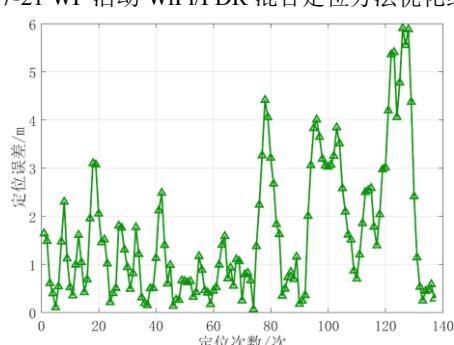


图 7-22 WH 活动 WiFi/PDR 混合定位方法优化误差

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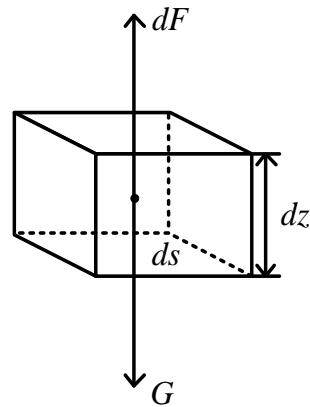


图 8-1 大气微元块的静力平衡状态

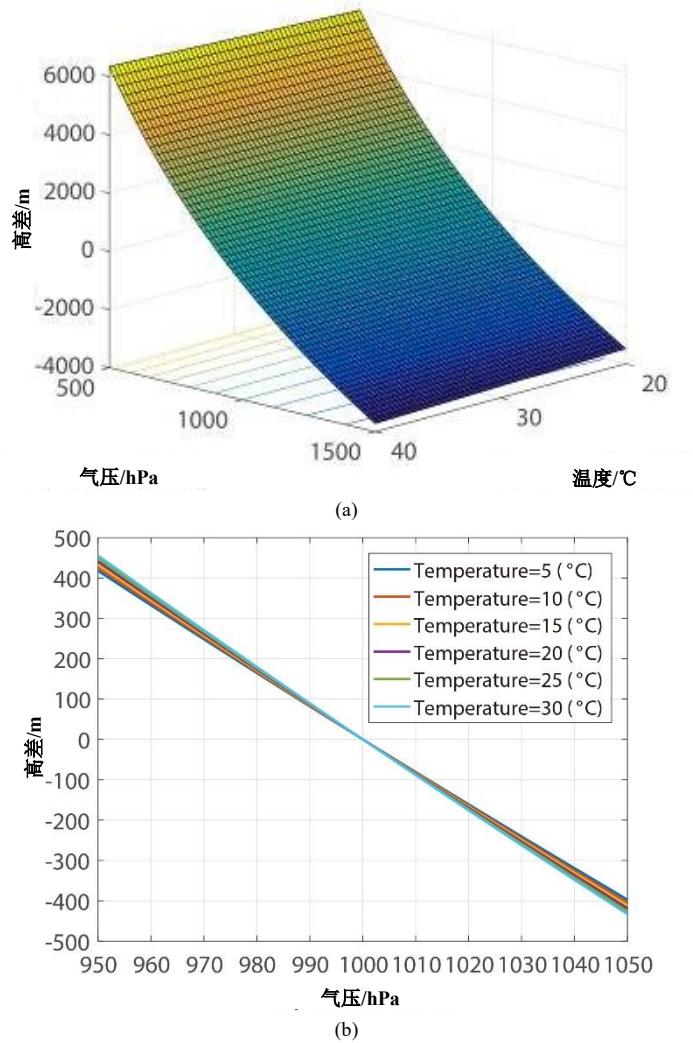


图 8-2 高差随气压在不同温度下的变化趋势, (a)高差随气压和温度的变化, (b)高差随气压的变化

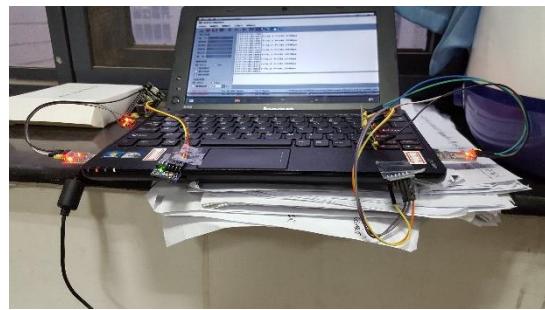


图 8-3 气压传感器模块与 PC 数据获取



图 8-4 数字气压传感器标定

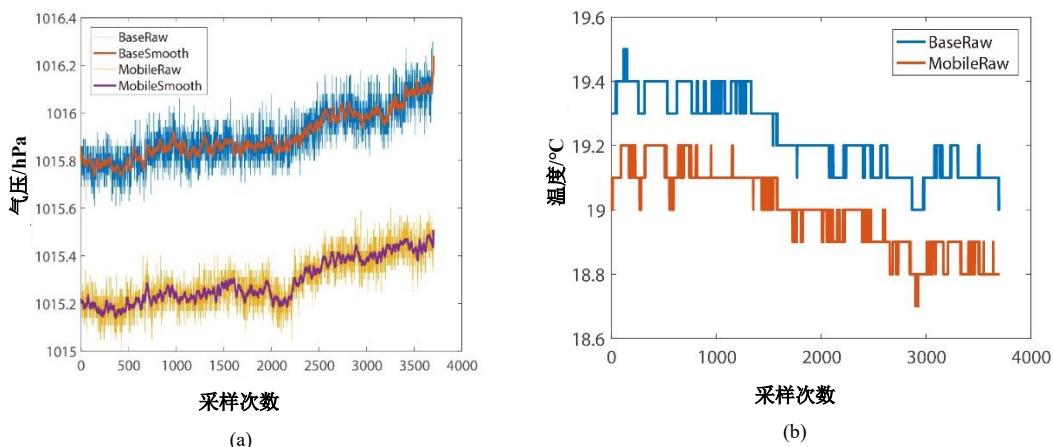


图 8-5 传感器标定时获取的数据图示

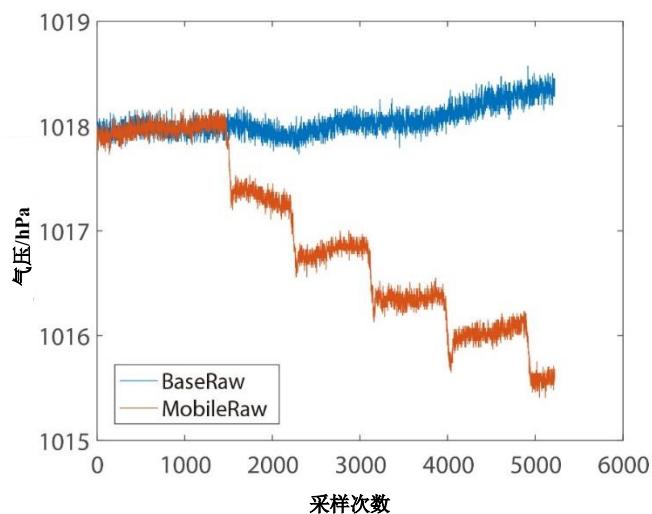


图 8-6 异高面的气压变化趋势

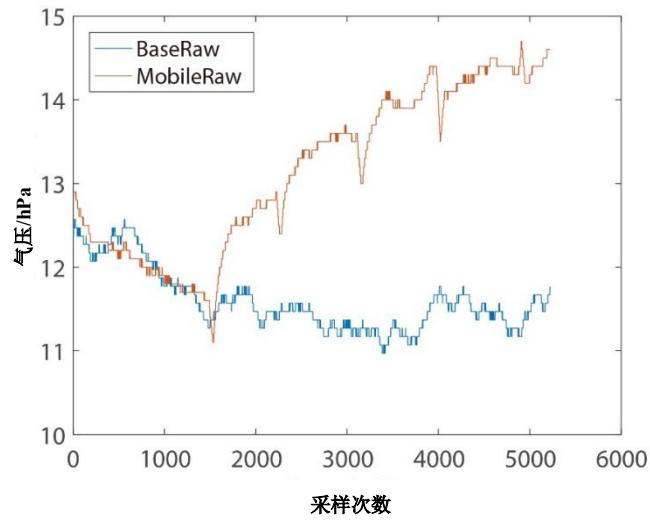


图 8-7 异高面的温度变化趋势

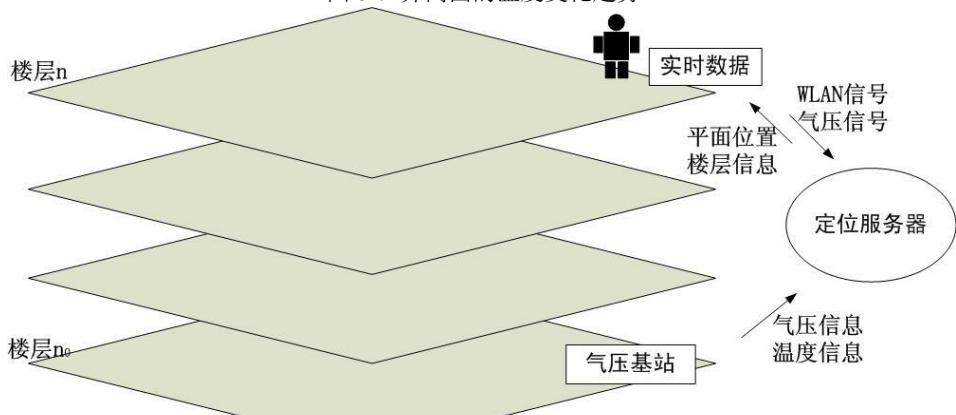


图 8-8 差分气压辅助楼层判定过程
基站 测站

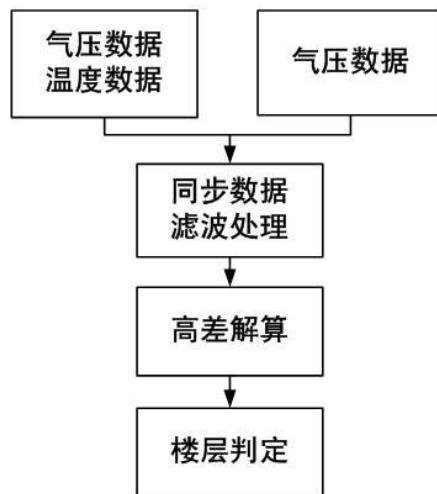


图 8-9 差分气压测高辅助楼层判定数据处理流程



图 8-10 实验大楼一层气压基准站与流动站部署情况

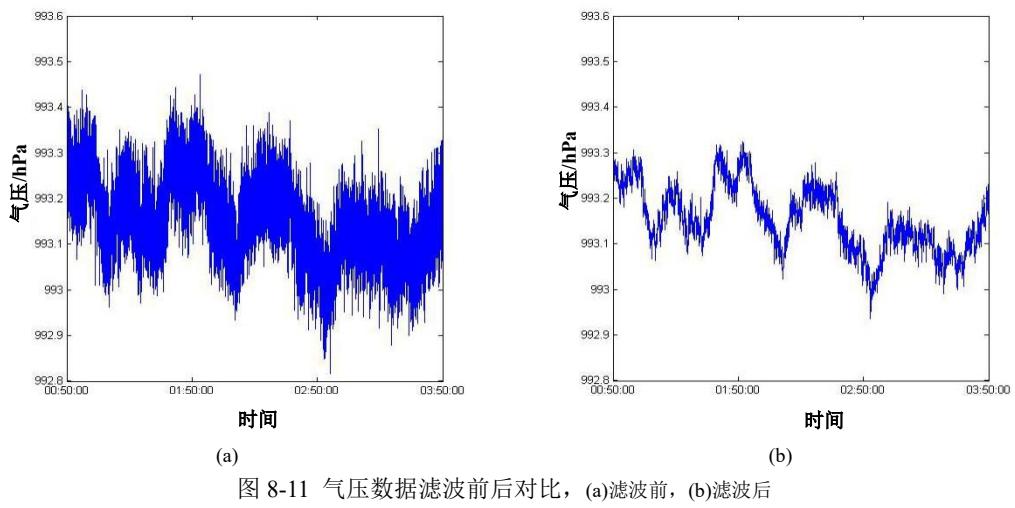


图 8-11 气压数据滤波前后对比, (a)滤波前, (b)滤波后

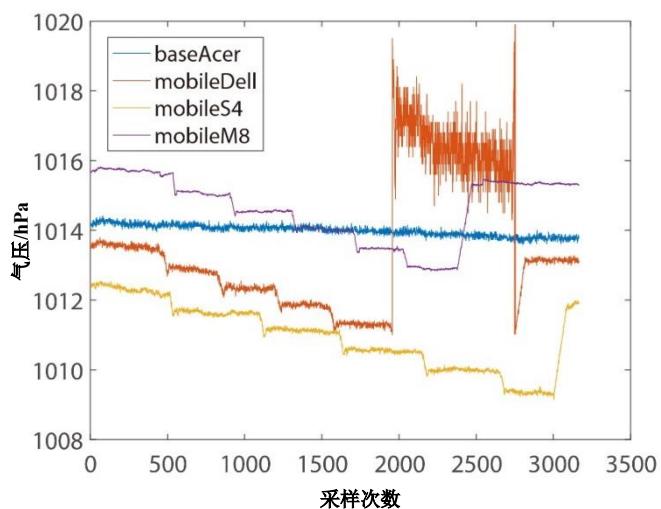


图 8-12 基准站和流动站的原始气压数据

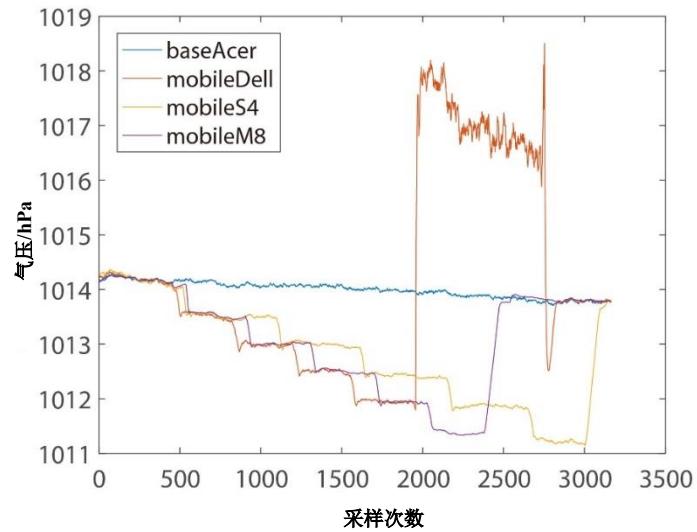


图 8-13 对气压进行校正和去噪后的数据

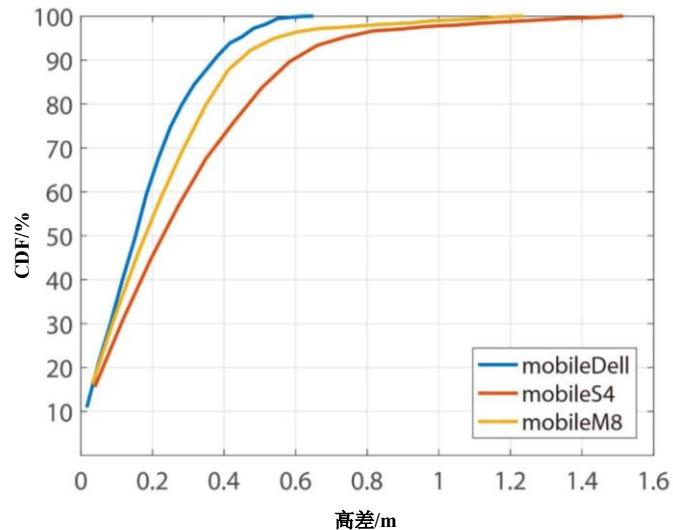


图 8-14 各流动站的误差累积分布图

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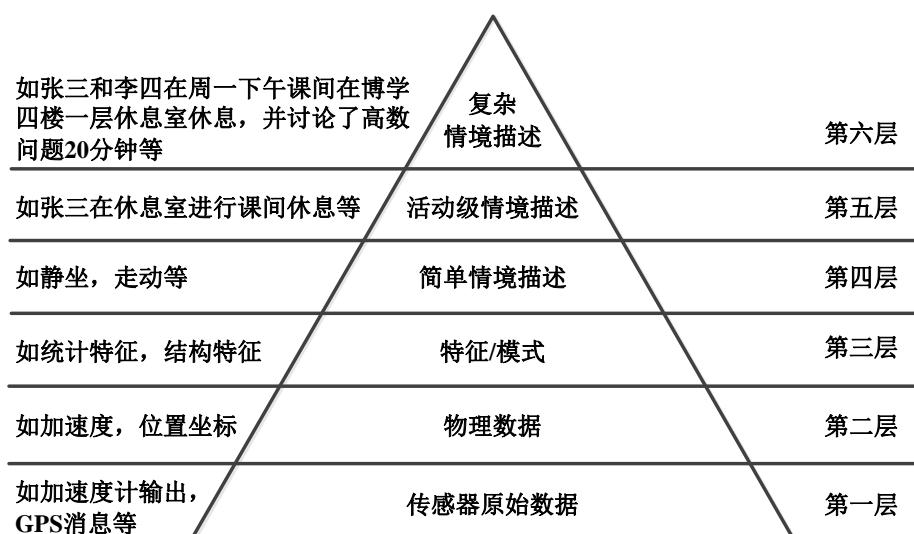


图 9-1 情境信息金字塔

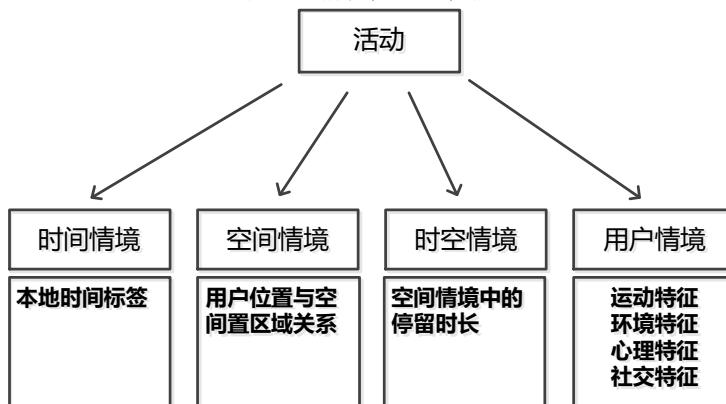


图 9-2 多维情境特征人类活动识别框架

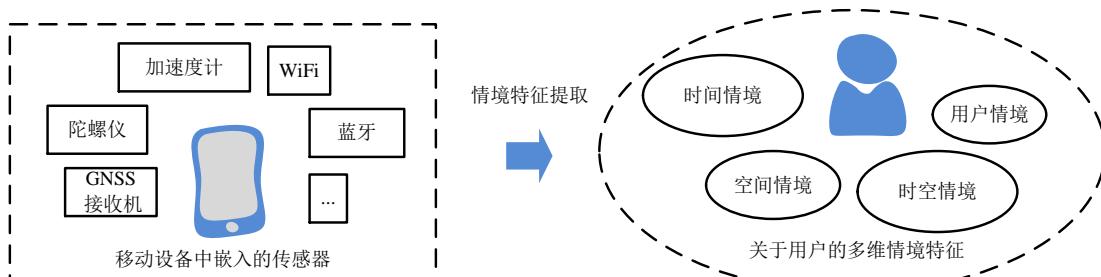


图 9-3 情境信息提取过程

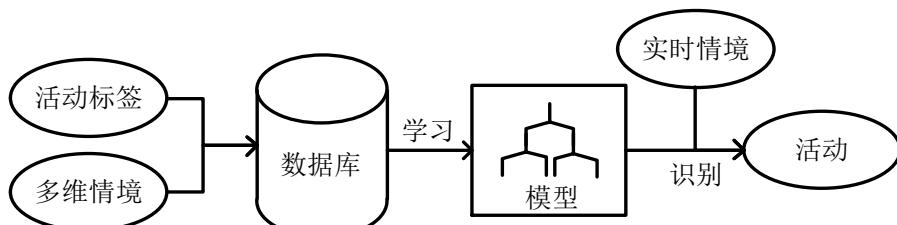


图 9-4 基于机器学习进行人类活动识别的流程图



图 9-5 感兴趣区域的地理位置图示

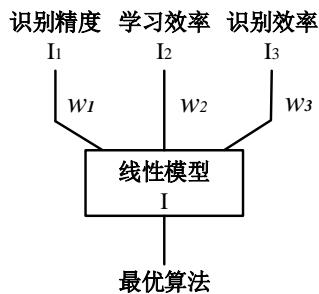


图 9-6 基于线性模型的算法优选框架

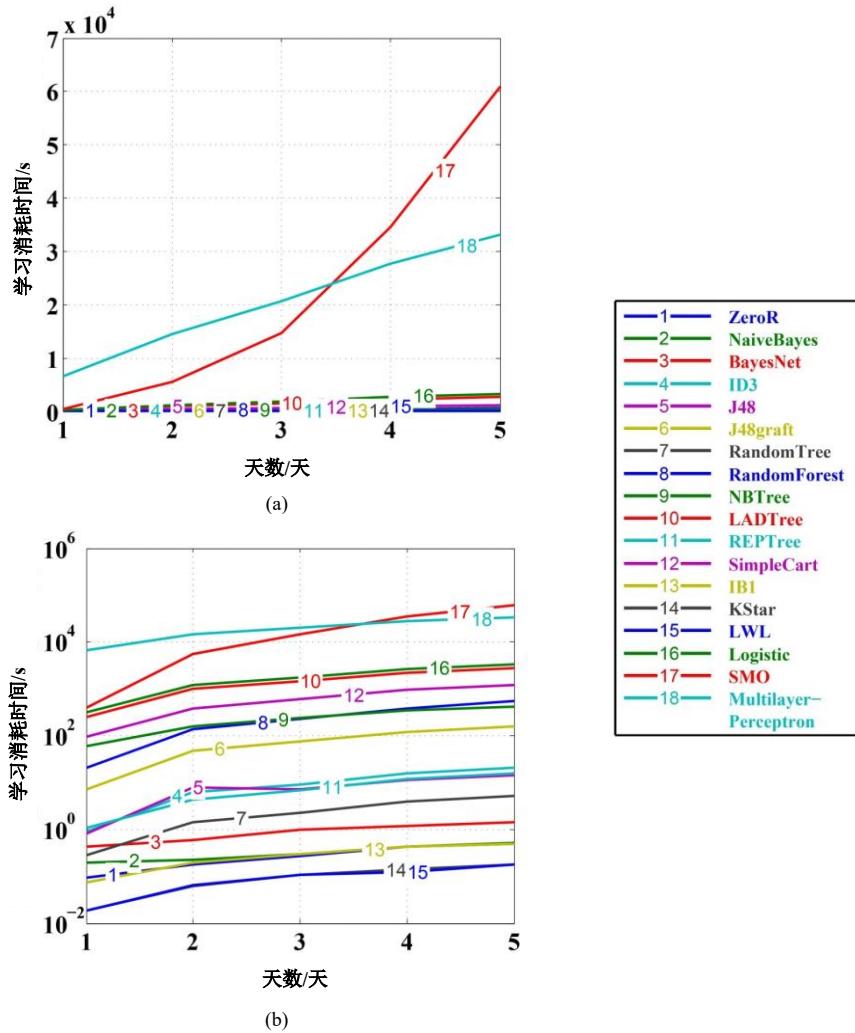


图 9-7 在数据集递增时算法的学习效率性能表现, (a)时间消耗以线性坐标图示, (b)时间消耗以对数坐标展示

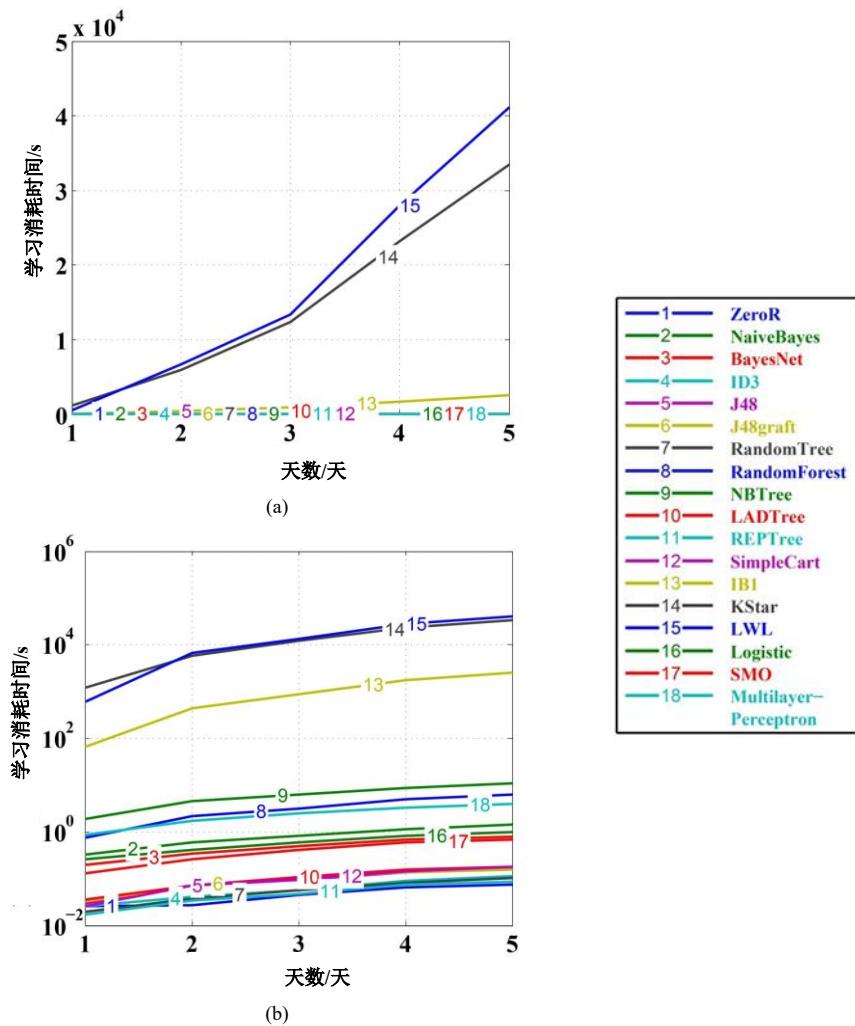


图 9-8 在数据集递增时算法的活动识别效率性能表现, (a)时间消耗以线性坐标图示; (b)时间消耗以对数坐标展示

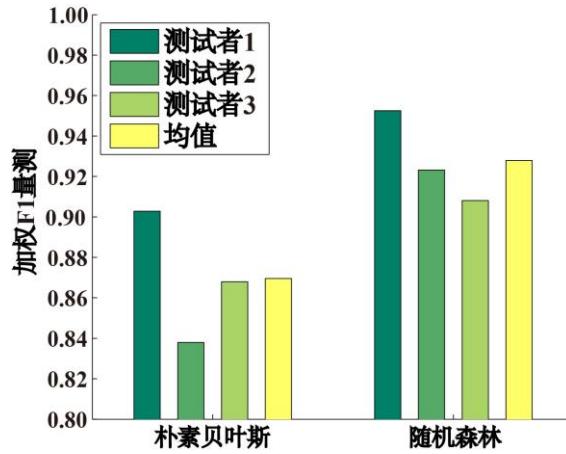


图 9-9 朴素贝叶斯和随机森林在三个数据集上的加权平均 F1 量测值

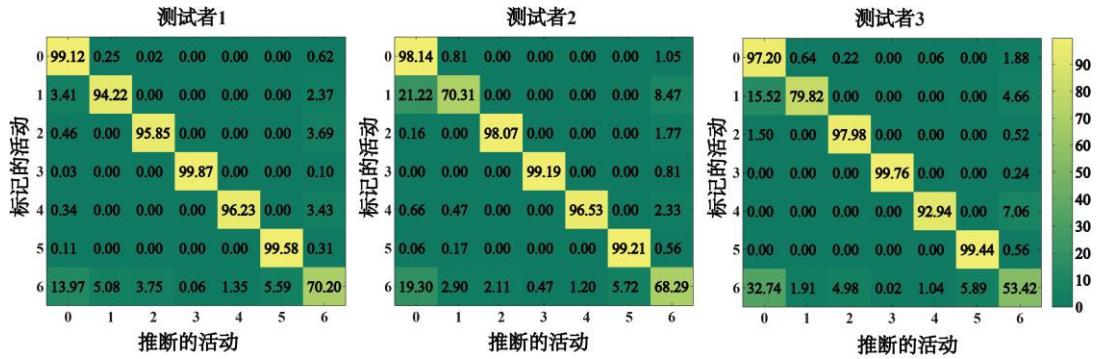


图 9-10 随机森林算法在三个数据集上归一化后的分类混淆矩阵

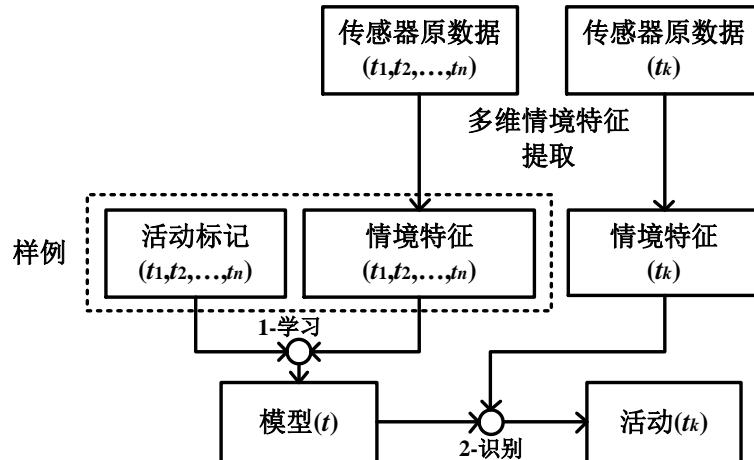


图 9-11 离线学习方式下的多维情境活动识别框架

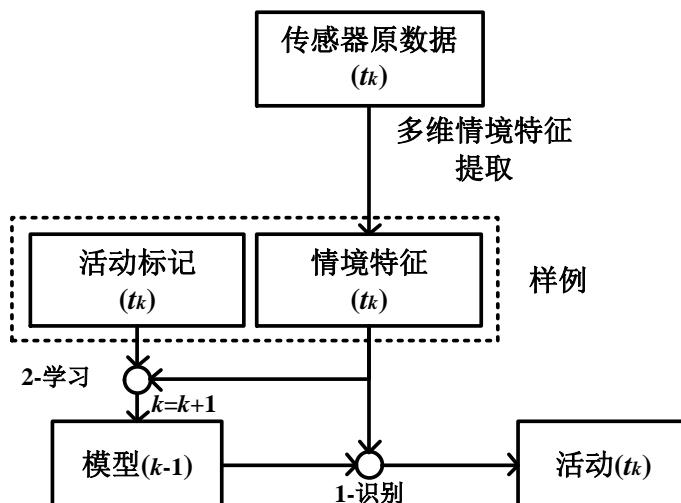


图 9-12 在线学习方式下的多维情境活动识别框架

Dataset	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Fold 6	Fold 7	Fold 8	Fold 9	Fold 10
Day 1										
Day 2										
Day 3										
Day 4										
Day 5										
Combined set 1	Test 1									
Combined set 2	Train 2	Test 2								
...										
Combined set 10									Test 10	

图 9-13 测试者 1 收集到的数据分割与组合

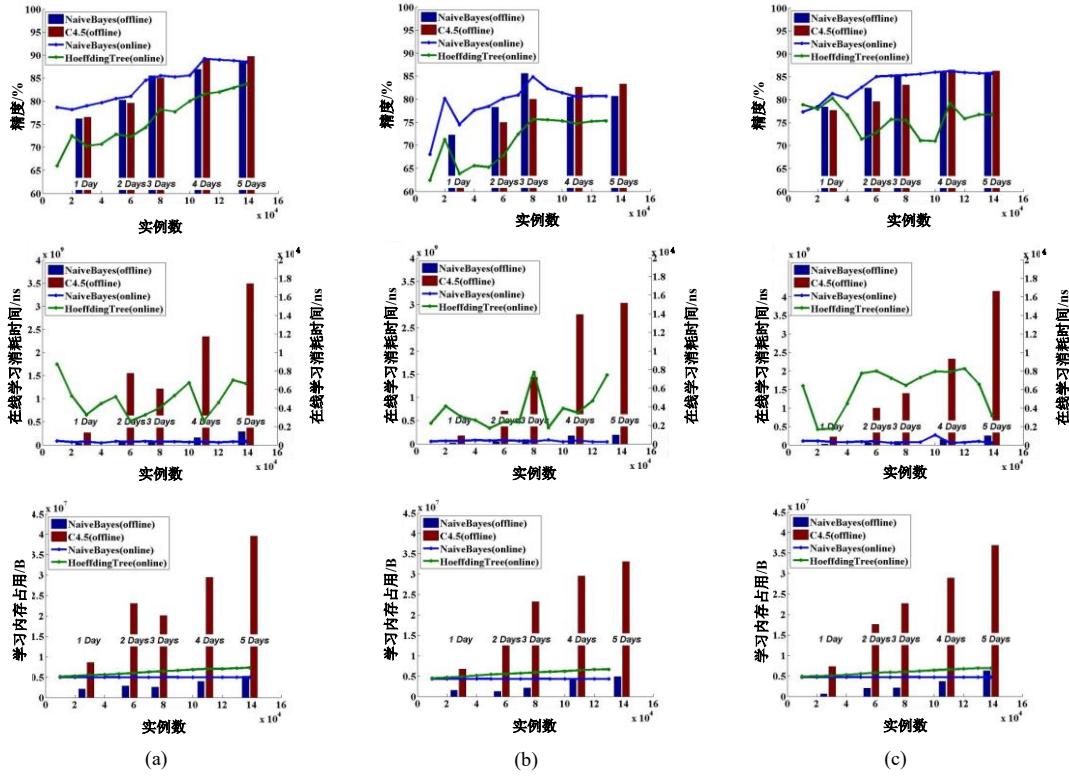


图 9-14 使用离线和在线学习算法的 10 折交叉验证测试的性能, (a)测试者 1, (b)测试者 2, (c)测试者 3

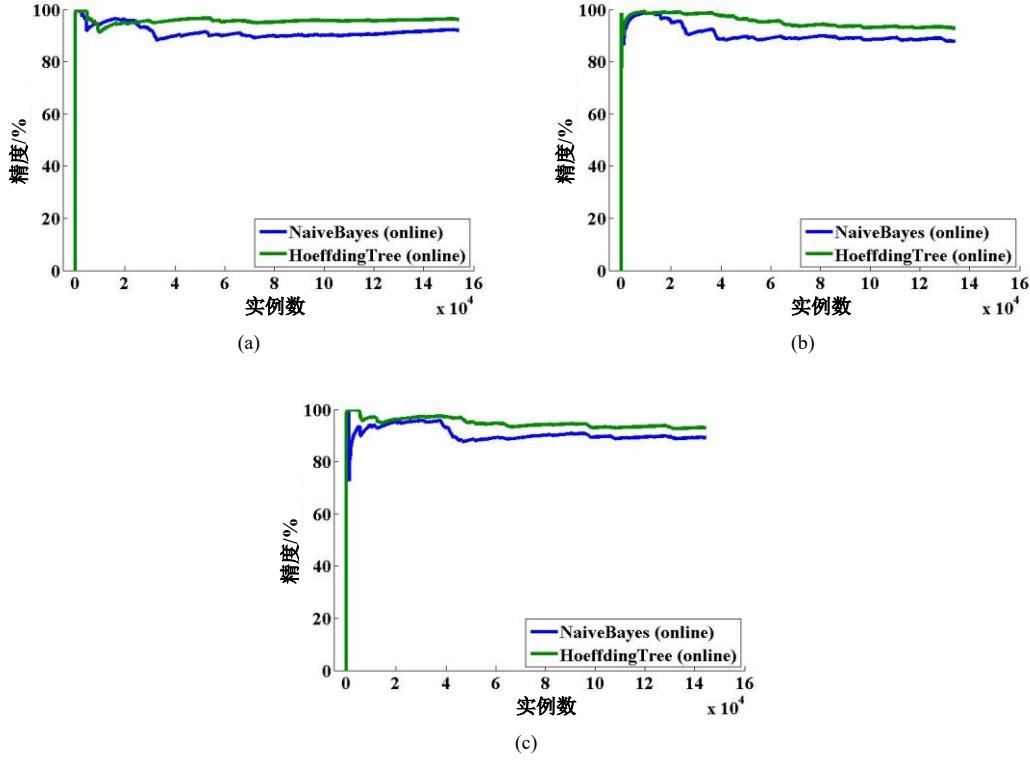


图 9-15 使用在线算法进行先测试后训练交叉测试的精度, (a)测试者 1, (b)测试者 2, (c)测试者 3