

Minitrack: Healthcare in Motion: Innovations in Mobility-integrated Health Systems

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Abstract

This Minitrack delves into the intricacies of mobility-integrated health systems, where cutting-edge technologies intersect with the evolving landscape of transportation. From engine-powered vehicles such as cars, motorcycles, e-scooters, and pedelecs to non-human transportation devices like drones, this Minitrack spans a spectrum of mobility modes. This includes healthcare applications for vehicles beyond driving assistance.

Keywords: Well-being, Mobility, Health Monitoring, Biosensors, Drones.

1. Scope

Today, cutting-edge health technologies intersect with the evolving landscape of transportation. From engine-powered vehicles such as cars, motorcycles, e-scooters, and pedelecs to non-human transportation devices like drones, our Minitrack spans a spectrum of mobility modes for mobility-integrated health systems.

Recent system research addresses healthcare applications for vehicles beyond driving assistance. Individuals can therefore take advantage of technology benefits to improve their health and well-being with monitoring systems integrated into vehicles providing long- and short-term recommendations or warnings of potential health issues.

For example, the vehicles are equipped with sensors to measure vital signs such as heart rate, respiratory rate, blood pressure, body temperature, and other biomedical parameters such as electrocardiography, electro-dermal activity, skin impedance, glucose, or stress levels. In shared mobility systems, health data is subject to special privacy and security concerns as well as particularly designed analysis concerning possible regulatory aspects such as risk analysis, usability, or evidence in healthcare or well-being. Further challenges arise from sensor calibration, network connectivity, and energy efficiency.

Furthermore, there are health-supporting systems that integrate non-human mobility such as drones and telemedical applications for mobile individuals. For example, drones are sent to accident sites to allow a better and faster reaction of the rescue team when approaching the site or to deliver drugs and vaccines in rural areas.

To address innovations and challenges and to promote research and new developments in the field, we selected research papers to explore a wide range of topics, including:

- Healthcare systems embedded into mobility
- Health sensor systems including image/video-based health sensing
- System architectures, data platforms, healthcare ecosystems, and energy efficiency
- Acceptance and success models
- Privacy protection, security management, authentication sensors, and wireless networking
- Data analytics, data integration, and cross-domain data usage
- Artificial intelligence (AI) and explainable/understandable AI
- Shared mobility applications.

2. Papers of the Minitrack

Out of seven submissions, we selected three papers for presentation by a multi-stage and blinded peer review process.

2.1. A comparative analysis on using low earth orbit and geosynchronous orbit satellite communication systems to support telemedical networks in austere environments

2.1.1. Authors. Victor Buhl, Sean Kennedy, Don Barber, Murali Tummala, James McEachen, Darren Rogers, John McEachen.

2.1.2. Keywords. Low latency communication, networking, satellite communication, throughput, telemedicine.

2.1.3. Summary. This paper comprehensively compares satellite communication in remote locations for telemedical backhaul. The authors analyze low earth orbit (LEO) and geosynchronous orbit (GEO) satellite communications links, in particular Starlink LEO, Viasat GEO, and terrestrial internet service provider links as a baseline. While GEO links add latency impacts to interactive communication that cannot be mitigated, the protocol stack for telemedical applications can be selected or designed to optimize performance over LEO satellite communication links. For vital sign monitoring, LEO outperforms GEO, because GEO will not reach the required latency below the 500 ms threshold, even with a better implementation of the performance enhancement proxy.

2.1.4. Key contributions. The paper provides not only detailed technical data on upload and download data rates and latencies but also maps the quantitative measurements into their meaning for a vital sign monitoring telemetry application.

2.2. Mobilizing health monitoring: the development and integration of a health-eScooter system

2.2.1. Authors. Joana Warnecke, Julian Bollmann, Lukas Ryll, Himanshu Singh, Thomas M. Deserno.

2.2.2. Keywords. Mobile health monitoring, signal fusion, artificial intelligence, shared mobility, escooter.

2.2.3. Summary. Continuous health monitoring is essential for preventive medicine. This paper presents an innovative approach using eScooters equipped with sensors for electrocardiography (ECG) and photoplethysmography (PPG) to monitor vital signs during commutes. Integrating rental identity management with biomedical analytics ensures secure and private health data collection from shared devices. A comprehensive field test with twenty subjects shows

that around 65 % of the driving time is utilizable for medical analysis.

2.2.4. Key contributions. The Health-eScooter exemplifies how everyday transport can serve as an effective tool for health monitoring, offering convenience and mobility, thereby paving the way for mobile and everyday health technology.

2.3. Driver behavior detection using multimodal physiological signals and regularized deep kernel learning

2.3.1. Authors. Pavan Kaveti, Nagarajan Ganapathy.

2.3.2. Keywords. Multimodal physiological signals, textile technology, driver behavior assessment, kernelized convolutional neural networks

2.3.3. Summary. Driver behavior is a critical factor affecting road safety. This paper combines video with ECG and respiration data collected from a textile vest that delivers about 100 features in the time, frequency, and time-frequency domains. Based on leaving one subject out experiments on 15 subjects, the proposed approach classifies driver behavior states (normal driving vs. phoning while driving) with an average accuracy of 71 %.

2.3.4. Key contributions. While driver behavior so far is mainly extracted from video analytics of in-vehicle cameras, the authors combine multimodal physiological signals including ECG and respiration data.

3. Conclusion

Mobility-integrated health systems are innovative and cover meanwhile a wide range of applications. This Minitrack presents such applications for vital sign monitoring in remote locations, such as the battlefield, as well as when commuting in smart cities. Furthermore, vital sign monitoring is applied to drivers behavior detection in smart cars. In future, more of such health systems will be established for our better health and well-being.