
Camera-based Health Monitoring in Hospitals

Special Issue Proposal for IEEE Journal of Biomedical and Health Informatics

1. Motivation

Relevance. Measuring physiological signals from the human face and body using cameras is an emerging research topic that has grown rapidly in the last decade. Avoiding mechanical contact with the skin, remote cameras have been used to measure vital signs (e.g., heart rate, heart rate variability, respiration rate, blood oxygenation saturation, pulse transit time, body temperature, etc.) from an image sequence registering pieces of human skin or whole body segments. This enables long-term, contactless, continuous and comfortable health monitoring, which substantially improves patient comfort and clinical workflow efficiency, also eliminating potential risks of infection/contamination caused by contact-based biomedical sensors (e.g., electrocardiogram, photoplethysmography). Camera-based imaging methods for recovering vital signs also present new opportunities for machine vision applications that will allow a better understanding of human behavior (e.g., affective computing and cognitive recognition). In addition to physiological measurement, cameras also enable the analysis of high-level image/video semantics and context by leveraging Computer Vision (CV) and Artificial Intelligence (AI), such as facial expression analysis for pain/discomfort/delirium detection; emotion recognition for depression analysis; body motion for sleep staging; activity recognition for patient actigraphy or gait analysis; clinical workflow monitoring and optimization; etc. Context monitoring and understanding is the unique property of cameras as compared to contact-based biomedical sensors. Therefore, camera-based monitoring will bring a rich set of compelling healthcare applications that directly improve human's life and patient care experience, such as in hospital care units (e.g., neonatal care unit and intensive care unit), sleep centers, assisted-living/nursing homes, telemedicine and e-health, home-based baby/elderly care, fitness and sports, driver monitoring in automotive, AR/VR therapy and entertainment, etc. Camera-based health monitoring is gradually matured into products (e.g., baby monitoring and elderly care) and it has great potential to be used in clinics as a medical device.

Need and Viability. The development of camera-based health monitoring has profited a lot from biomedical and health informatics and presents new opportunities. A large and growing number of researchers has entered this research space in recent years, and we have observed an increasing number of papers submitted to/accepted by IEEE journals on this topic. It has gradually formed a stable community consisting of researchers from multidisciplinary fields, such as biomedical optics, health informatics, computer vision, pattern recognition and AI, signal and image processing. To encourage the growth of this community and unite the researchers from this field to discuss the latest progress in an intensive and structured way, we organized two special issues on IEEE Journal of Biomedical and Health Informatics (JBHI), one is "Camera-based Monitoring for Pervasive Health Informatics" in 2020-2021 and the other is "Camera-Based Health Monitoring in Real-world Scenarios" in 2022-2023. For these two special issues, we collected 21 high-quality papers from **more than hundred submissions** after critical reviewing and selection procedure. After years-R&D of this technology, we feel it is the time to bring the setup and methods to hospital scenarios and demonstrate their values in clinics (e.g., for patient care and monitoring). Therefore, we plan to organize a new special issue (relevant but very different) that highlights the research of camera-based monitoring in *hospital*

scenarios with concrete use cases, i.e., instead of focusing on data processing and data science, give more attention to integral solutions, measurements and setups in hospital care units (e.g., intensive care unit), which we consider to be the promising direction of development for this community. The new special issue shall emphasize the novel scientific contributions and inventions that have been proven to work in real-life circumstances with clear application goals and values (e.g., clinical trials, pre-development showcases at homes or on roads), beyond the proof-of-concept in a lab setting and online benchmarking. Not only targeting at the biomedical and healthcare researchers, the new special issue also aims at uniting those who could directly, or indirectly, benefit from and/or contribute to it, including CV and AI researchers, doctors/clinicians, physicians, medical device manufacturers, etc. We believe that the new special issue is timely important and will attract broad researchers (for submissions) and audience in the community of JBHI.

Organization. To secure the success of this special issue, we organized a guest editor team with active researchers from leading groups of camera-based monitoring, biomedical sensing and healthcare. The guest editors have solid research and industrial experience in this field (e.g., publications, patents, products), and editorial experience related to this topic. The core team has successfully organized two special issues on the similar topic, which can ensure the consistency and stability of the development of this field, and other relevant special issues, special sessions and workshops for premier IEEE journals and conferences. The team has an impact in this field and maintains good relationships with various research groups/institutes globally. The team is confident in reaching out to recruit high-quality submissions. The relevant special issues and workshops organized by the team members are shown below, to name a few:

- JBHI special issue 2020-2021: Camera-based Monitoring for Pervasive Health Informatics <https://www.embs.org/jbhi/camera-based-monitoring-for-pervasive-healthcare-informatics/>
- JBHI special issue 2022-2023: Camera-based Health Monitoring in Real-world Scenarios <https://www.embs.org/jbhi/special-issues/camera-based-health-monitoring-in-real-world-scenarios/>
- Wire-Free, Multi-Modal Non-Contact Physiological Sensing and Monitoring 2021 (Indian Institute of Technology Madras and RWTH Aachen University, Virtual) <http://hticlab.org/ioeworkshop/>
- CVPM workshop 2018 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm18/>
- CVPM workshop 2019 (on IEEE-ICCV) <http://www.es.ele.tue.nl/cvpm19/>
- CVPM workshop 2020 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm20/>
- CVPM workshop 2021 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm21/>
- CVPM workshop 2022 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm22/>
- CVPM workshop 2023 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm23/>
- CVPM workshop 2024 (on IEEE-CVPR) <http://www.es.ele.tue.nl/cvpm24/>

2. Call for papers

Remote cameras have been used to measure physiological signals from human face and body, thereby eliminating mechanical contact with the skin like wearable sensors. Advancements in biomedical optics, computer vision and AI enabled various camera-based measurements, including vital signs like heart rate, respiration rate, SpO₂, blood pressure, perfusion index and physiological markers/indicators that have diagnostic capabilities. Image and video analysis also permit the measurement of human semantics and behaviours that provide new insights into health informatics (e.g. facial analysis for pain or delirium assessment), which is an unique advantage of camera sensors as compared to contact-based biomedical sensors. Camera-based health monitoring will bring a rich set of compelling

healthcare applications that directly improve upon contact-based monitoring approaches in hospital care units (e.g. ICU, NICU), improving patients' care experience and quality of treatment. After years of R&D in this field, it is time to bring the concepts and prototypes (including setups and algorithms) one step further to the hospitals to demonstrate their actual performance and values via clinical trials. This is an important step towards the transformation of camera-based monitoring technology into a medical device. This special issue focuses on the latest developments and clinical showcases pertaining to *Camera-based Health Monitoring in Hospitals*, specifically on innovation, validation and demonstration in clinical environments.

Only high-quality and original contributions will be considered. Topics of interest include, but are not limited to

- Novel/improved camera sensors and sensor fusion for patient care and monitoring, and image/signal processing algorithms that create new measurements (e.g. physiological signals or contextual signals) for health informatics.
- Novel developments and applications of camera-based health monitoring in high-acute and low-acute clinical settings.
- Novel integration between cameras and existing medical devices like for MR/CT triggering and gating.
- Novel camera-based applications with medical purpose, including automotive, fitness, assisted-living homes, mobile healthcare, etc.
- Clinical trials of camera-based health monitoring in hospital care units, including Intensive Care Unit (ICU), High Dependency Unit (HDU), Neonatal Intensive Care Unit (NICU), Coronary Care Unit (CCU), Thoracic Surgery Department, Pneumology Department, Emergency Department, etc.
- Clinical trials of camera-based health monitoring in sleep centres, rehabilitation centres, confinement centres, senior centres, etc.
- Clinical trials of camera-based health monitoring in telemedicine that connect in-home monitoring with hospital services (e.g. chronic disease management).
- New benchmarks, datasets and literature reviews for camera-based healthcare applications in hospitals.

3. Strategy to recruit papers

Our strategy to recruit submissions includes, but not be limited to, the following approaches:

- This special issue can be associated with the workshops or special sessions we organized for top IEEE conferences (with audience > 10,000). The accepted CVPRW papers can be encouraged to extend to a journal paper with >70% extension on the content. The relationship between this special issue and conference workshops/sessions will be included in the Call-For-Paper (CFP) to attract submissions. We will also post the CFP on the website of conference workshops/sessions to attract submissions.
- The guest editors have a collection of 5000+ mailing list that includes the major researchers active in the field of camera-based monitoring in recent 5 years (from both academy and industry). We will distribute the CFP to our community via emails and circulate it in their networks/channels. We will send the CFP to neighboring communities (e.g. computer vision, signal processing, AI) that are relevant to our topics via the public mailing list such as ImageWorld (<http://imageworldlist.blogspot.com/>) and ACM SIGMM (<http://www.sigmm.org/>). We will also post CFP on other third-party websites that list latest academic events/proceedings, such as:
 - <http://conferences.visionbib.com/Iris-Conferences.html>
 - <http://www.wikicfp.com/cfp/>
 - <https://easychair.org/cfp/>

- We will use the academic and industrial news channel (official webpage) to promote this special issue to attract submissions and participations, internally and externally.

4. Guest editor team

- Prof. Wenjin Wang, Southern University of Science and Technology, China (wangwj3@sustech.edu.cn)
- Prof. Caifeng Shan, Nanjing University, China (cfshan@nju.edu.cn)
- Prof. Qian Liu, Hainan University, China (qliu@hainanu.edu.cn)
- Prof. Steffen Leonhardt, RWTH Aachen University, Germany (leonhardt@hia.rwth-aachen.de)
- Prof. Ramakrishna Mukkamala, University of Pittsburgh, USA (rmukkamala@pitt.edu)



Wenjin Wang is an associate professor at Southern University of Science and Technology, China, and an assistant professor at Eindhoven University of Technology (TU/e), The Netherlands. His current research is focused on contactless health monitoring and medical instrument development. He has authored 90+ peer-reviewed journal/conference papers and 20+ patents (grant, application), edited 1 book, and transferred multiple inventions to systems/prototypes/applications of video health monitoring. He was in the Stanford's List of World's Top 2% Scientists in 2023. He serves as the reviewer for several well-known journals and conferences. He chaired seven times of workshop at IEEE-CVPR/ICCV and three times of special session at IEEE-EMBC/BHI. He has organized two special issues for IEEE-

JBHI on the topic of contactless health monitoring.

Webpage: <https://sites.google.com/site/rppgwenjin/>



Caifeng Shan is currently a Full Professor at Nanjing University, China. He was a Senior Scientist and Project Leader with Philips Research, Eindhoven, The Netherlands. He was also a part-time researcher at Eindhoven University of Technology. He received the B.Eng. degree from the University of Science and Technology of China (USTC), the M.Eng degree from the Institute of Automation, Chinese Academy of Sciences, and the PhD degree in computer vision from Queen Mary, University of London. His research interests include computer vision, pattern recognition, image and video analysis, machine learning, bio-medical imaging, and related applications. He has authored 160 scientific papers and 80 patent applications (Google Scholar Citations: 10,500+). He was involved in multiple European and Dutch national projects, for example, Marie-Curie fellowship program. He has served as Associate Editor or Guest Editor for scientific journals, including *IEEE Journal of Biomedical and Health Informatics* (2019 -), *IEEE Transactions on Circuits and Systems for Video Technology* (2011 - 2016), *IEEE Transactions on Multimedia* (2010), *Neurocomputing* (2021 -), and *Journal of Visual Communication and Image Representation* (2014 -). He has organized several international conferences and workshops, and served as Program Committee Member and Reviewer for numerous international conferences and journals. He is a Senior Member of IEEE.

Webpage: <https://caifeng-shan.github.io/>



Qian Liu is currently a Full Professor at Hainan University, China, and a part-time professor at Huazhong University of Science and Technology. He received the M.Eng. & PhD degree of Biomedical Engineering from Huazhong University of Science and Technology of China. His current research is focused on non-invasive biophotonics imaging for plant phenotyping and medical devices. He developed the first commercial Confocal Endomicroscopy medical device made in China. He has authored 120+ peer-reviewed journal papers and 30+ patents. His career has been marked by numerous awards, among them are the China's National Major Talent Project, the National Young and Middle-aged Experts with Outstanding Contributions, the National Hundreds of Thousands of Talents Project, and the New Century Excellent Talents of the Ministry of Education.

Webpage: <https://bme.hainanu.edu.cn/info/1143/2397.htm>



Steffen Leonhardt holds a PhD in Control Engineering from the Technical University of Darmstadt, Germany, and an MD from the Medical School of Goethe University, Frankfurt, Germany. After almost five years of R&D management experience working at Draeger Medical AG & Co. KGaA, Luebeck, Germany, he was appointed Full Professor and Head of the Philips endowed Chair for Medical Information Technology at RWTH Aachen University, Germany, in 2003.

Dr. Leonhardt is a fellow of the NRW Academy of Sciences, Humanities and the Arts and a fellow of the German National Academy of Science and Engineering (acatech). He holds a Doctorate honoris causa from CTU Prague, Czech Republic, and became a "Distinguished Professor" at IIT Madras, Chennai, India, in 2018. Dr. Leonhardt was nominated as a distinguished lecturer by IEEE EMBS (2015/2016). Furthermore, Dr. Leonhardt serves as an associate editor of the IEEE Journal of Biomedical and Health Informatics and the IEEE Transactions on Biomedical Circuits and Systems.

Dr. Leonhardt has authored or co-authored more than 320 journal papers, 580 conference articles, 3 books and 20 patents, see <https://scholar.google.de/citations?hl=de&user=GZo4IYgAAAAJ>. His research interests include physiological measurement techniques, personal health care systems and feedback control systems in medicine.

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Webpage: <https://www.medit.hia.rwth-aachen.de/en/>



Ramakrishna Mukkamala is Leighton E. and Mary N. Orr Professor and Professor in the Departments of Bioengineering and Anesthesiology and Perioperative Medicine at the University of Pittsburgh. Dr. Mukkamala obtained graduate and post-doctoral training in Bioelectrical Engineering from MIT. He helped Retia Medical translate his early research on advanced hemodynamic monitoring into a cardiac output monitor that is now being used at top hospitals in the US. He is more known for his recent research on cuffless blood pressure measurement. He received various recognitions for this work including an IEEE EMBS Most Impactful Paper Award, the Michigan State University All-University Innovation of the Year Award, US NIH U01 and R01 grants, and worldwide media attention (e.g., from The WSJ, Newsweek, and Medscape). He is also a devoted educator with two teaching awards from MSU. In addition, Dr. Mukkamala currently serves as the Chair of the IEEE Biomedical Engineering Award Committee, Past Chair of the IEEE EMBS Cardiopulmonary Systems and Physiology-Based Engineering Technical Committee, and Associate Editor for IEEE Transactions on Biomedical Engineering.

Webpage: <https://www.engineering.pitt.edu/people/faculty/ramakrishna-mukkamala/>

5. Key dates

(Not fixed. The deadlines can be discussed/adjusted based on the schedule of JBHI)

- Deadline for submission: **December 1st, 2024**
- First reviews due: **February 1st, 2025**
- Revised manuscript due: **April 1st, 2025**
- Final decision: **June 1st, 2025**