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01 | 21

Intelligent robots for targeted combating of viruses and bacteria

Service robots can help ensure that buildings and means of transport are cleaned and disinfected regularly and with consistently high quality. Since October 2020, twelve institutions of the Fraunhofer-Gesellschaft have been working on the development of new technologies for this field of application. Led by Fraunhofer IPA, the partners are pooling their expertise in the "Mobile Disinfection" (MobDi) research project to contribute to a safe "New Normal" in times of pandemic. The project is part of the "Fraunhofer vs. Corona" action program.

One key in the fight against COVID-19 is to minimize the risk of infection. This challenge is being addressed by the "Mobile Disinfection" (MobDi) project, in which the involved Fraunhofer experts are developing new hardware and software solutions for mobile service robots. On the one hand, these should make it possible to disinfect potentially contaminated surfaces in buildings and means of transportation as needed and gently with a robot. On the other hand, the developments should help to automate the transport of materials in clinics and thus counteract the spread of germs by staff.

New disinfection and transport robots

The project partners are developing specialized service robots for disinfection in buildings and transportation. The technical basis for disinfection in buildings is Fraunhofer IPA's "DeKonBot", which the institute developed last year in the previous project of the same name. In the project, the researchers will further improve its tool for wipe disinfection and optimize the platform as a whole with regard to subsequent series production. The robot for disinfection in transportation vehicles is being developed at Fraunhofer IFAM. Particularly challenging is the development of a modular drive support for overcoming gaps and steps. For both robots, the project partners are creating various tools that disinfect by wiping, spraying, UV or plasma treatment. The robots can switch these automatically as required.

Fraunhofer IPA is also developing a new transport robot that can carry various hand carts, such as those typically used in clinics. Compared to existing products, the new development is characterized by small dimensions and a particularly maneuverable undercarriage. Fraunhofer IVV is providing support in the hygienic design of the various

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robots. The institute is also developing concepts for their self-cleaning. These prevent the machines themselves from becoming a contamination risk.

Improved perception capabilities

Thanks to intelligent perception capabilities, the disinfection robots will be able to clean in a targeted manner. A new multimodal 3D sensor from Fraunhofer IOF is used for this purpose. With the help of this sensor, during commissioning, the robots independently recognize all the objects they are to disinfect and the material they are made of. The object recognition system of Fraunhofer IPA and the material recognition system of Fraunhofer IPM evaluate the sensor data using machine learning methods. In this way, they achieve robust recognition, even if the objects look slightly different in each application environment.

A multilayer environment model developed by Fraunhofer IOSB brings together all the necessary information and thus enables the robots to plan cleaning sequences independently. It contains a map of the environment, the position of all objects to be cleaned, and their material. The environment data does not always have to be taught manually. Based on the work of Fraunhofer Italia, it will be possible to automatically load this information from the "Building Information Modeling" (BIM), a digital representation of key building components that already exists for many buildings.

In future, a perception function will also be used in regular operation before individual objects are disinfected: Based on the degree of contamination, the robots should be able to optimize the cleaning process and verify its success. In the project, Fraunhofer FEP is conducting the first fundamental investigations into how this contamination could be detected.

Analysis of the cleaning methods

For targeted and gentle cleaning, the project partners are conducting tests with the various cleaning and disinfection methods on widely used surface types such as stainless steel and plastics. In addition to analyzing the individual processes, they are also investigating possible combinations of different cleaning and disinfection methods. For example, the robots could first wipe a door handle and then use UV light to neutralize germs in hard-to-reach places as well. Fraunhofer ILT will specifically analyze the combined use of UV and plasma sources.
For the various processes, researchers at the Fraunhofer Institutes FEP and IFAM evaluate the disinfection success based on contamination with both bacterial and also viral samples. In addition, Fraunhofer IST is investigating possible material damage and Fraunhofer IWS the formation of harmful decomposition products. Thus, a methodology will be developed to select the most appropriate procedures for each disinfection method depending on the material and degree of contamination.

Demand driven development

The technical developments in "MobDi" are based on requirements, benefit and economic analyses for which Fraunhofer IMW is responsible. To adapt the robots based on user needs and practical requirements, the project partners worked together with users right at the start of the project. They developed the scenarios that are to be implemented with the robots and derived the technical requirements from this. To this end, they held numerous discussions with logistics and hygiene experts in clinics, as well as operators and cleaning staff in buildings and in public transport. Users will also be involved in the project to develop intuitive user interfaces for setting up and daily operation of the robots.

By the end of the project in September 2021, the developed robots will also be evaluated in practical settings. The project partners will first test them in their respective laboratories and then in realistic operating environments such as in a public building, in passenger transport or in a clinic. They will compare the results with so-called "Key Performance Indicators" (KPIs). At the start of the project, these KPIs, i.e. criteria for successful use of the robots in the relevant field of application, were determined together with potential users.

Participation opportunities

Because the robots are modular in design and use commercially available interfaces, the technologies developed in "MobDi" are easily transferable to other machines and robots. This supports the rapid transfer of the research and development work into application. Interested manufacturers are welcome to contact the project partners if they would like to participate in the development. In addition to the transfer of individual technologies into existing products, it is also possible to transfer the developed robots as a complete system into a new product.

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Profile:

Full project title: Mobile Desinfection – MobDi

Duration: 01.10.2020 until 30.09.2021 **Website:** www.mobdi-projekt.de

Funding: The project is part of the "Fraunhofer vs. Corona" action program, which supports numerous other pandemic response initiatives.

Project partners and their contribution:

- Fraunhofer Institute for Manufacturing Engineering and Automation IPA:
  project management, development of the new transport robot, integration of new technologies and functionalities into the disinfection robot for use in public buildings, (further) development of the navigation and object recognition software.
- Fraunhofer Center for International Management and Knowledge Economy IMW:
  Process and demand analyses, identification of relevant performance parameters, user evaluation and economic feasibility studies
- Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB:
  3D mapping of the environment, layer-based environment model, UV-C source development and design.
- Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM:
  Development of a disinfection robot for public transport, a modular drive support to overcome gaps and steps as well as a cleaning end-effector, validation of the disinfection success
- Fraunhofer Institute for Surface Engineering and Thin Films IST:
  Development of plasma sources for cleaning and disinfection, evaluation of the effect and material compatibility of disinfection processes.
- Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP:
  Contamination detection, surface treatment with UV, validation of disinfection success
- Fraunhofer Institute for Applied Optics and Precision Engineering IOF:
  Development of a multimodal 3D sensor for reliable data delivery on different materials
- Fraunhofer Institute for Material and Beam Technology IWS:
  Post-cleaning concepts for the removal of reaction and decomposition products from the air
- Fraunhofer Institute for Physical Measurement Techniques IPM:
  Material recognition
- Fraunhofer Institute for Laser Technology ILT:
  Development of combined UV/plasma radiation sources
- Fraunhofer Institute for Process Engineering and Packaging IVV:
  Hygienic design concepts for newly developed hardware solutions
- Fraunhofer Italia Research s.c.a.r.l.:
  Integration of the Building Information Modeling (BIM) with the layer-based environment model

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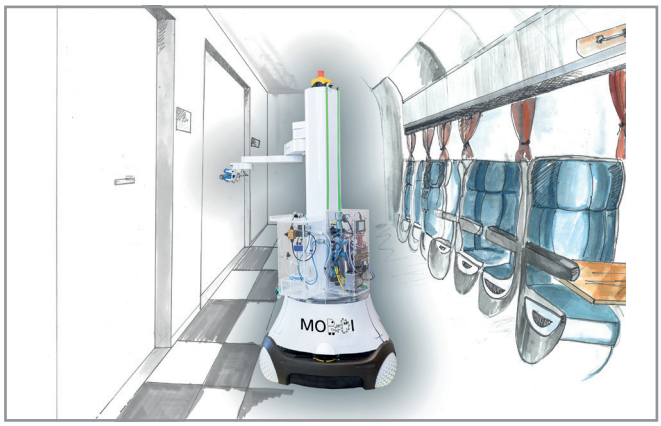

In the "MobDi" project, disinfection robots are being developed for use both in buildings (left side) and in transportation (right side).

Picture in printable resolution: www.fep.fraunhofer.de/press