Lab 6

Design for COVID-19

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Summary: In this lab, you will design a embedded system / robot to solve a COVID-19 Challenge

Lab Description

In this lab, together with your team, you will complete a design challenge inspired by a societal issue that we all currently face - the Coronavirus disease 2019 (COVID-19) caused by the virus SARS-CoV-2. On the 11th of March, the global spread of this coronavirus has been declared a pandemic by the World Health Organization (WHO) [1]. Not only has the virus caused large-scale infection and deaths, but the pandemic presents extraordinary challenges to public healthcare systems, to the economy, and to social life. Using the theoretical and practical skills you have learned in this course, you will design a system to tackle specific challenges posed by COVID-19.

You have to choose and confirm the design challenge you are interested in on Moodle by **27th of April 2020**. Please make sure that only one person per group signs up for a challenge, the other two don't have to sign up at all. Not more than 5 groups can independently work on the same challenge.

Lab Report

The lab report should contain a design solution to any one of the challenges described below. We expect a lab report of 2 - 5 pages long. The report should contain:

- A written description of your system and its functionality (max. 1 page long).
- One schematic figure describing the architecture of your system.
- A simple cost analysis of the system and list of components.
- Pseudocode describing the functionalities of the system.
- Discussion on feasibility of design, scalability, ease of use and data privacy (as applicable to your system)

The lab report has to be uploaded as a group onto Moodle by the **5th of May 2020**. A week after the deadline, we will publish a compilation of lab reports (solution to design challenges) from all groups on Moodle.

[1] Link to WHO announcement

Presentation and Prize (Optional)

The groups who wish to, can present their design solutions to the whole class and participate to win an embedded programming kit. You have to present your solutions in 3 minutes using 2-3 Powerpoint slides via Zoom. The presentation will **not** impact your grade and is optional! We will select one winning solution based on your lab report and quality of presentation. Each member of the winning group will be awarded an Adafruit kit including an Arduino-compatible development board. Presentations will take place at the beginning of the Q&A session on the **18th of May 2020**.

Challenges

Challenge 1 - Crowd Control in Supermarkets

Even during a partial lockdown or quarantine, people need to go to get groceries and other essentials. This means that supermarkets are dense hubs with people of all ages and where the risk of Coronavirus transmission is fairly high. In order to lower the risk of contagion, several supermarkets have implemented measures to limit the amount of people that can be inside at the same time. These measures however are often based on employees controlling the inflow of customers, thus putting them at risk as well.

Design a system that could be installed at the entrances and exits of supermarkets to automatically limit the flow of people going in and out of the store to enforce a limit on the amount of people that are in the supermarket. As a bonus you can implement additional features: temperature sensors to prevent customers with high fevers (a symptom of coronavirus) from entering. Ideally, the total cost of system should not exceed 100 CHF.

Challenge 2 - Automated Disinfecting Machine for Essential Facilities

While numerous places have been closed due to COVID-19 some essential locations and establishments have to remain open, such as hospitals, supermarkets, doctor's clinics, and post offices, power plants, waste disposal plants, warehouses etc. In order to ensure the safety of the people working in these facilities, it is necessary to disinfect the workplaces and frequently touched surfaces (such as doorhandles, touchpads, etc) used as often as possible.

Design a system/robot that could automatize the disinfection of one or more of these essential facilities. The recommendation report [2] from Center for Disease Control and Prevention provides a preliminary background for this project. Ideally, the total cost of system should not exceed 700 CHF.

Challenge 3 - Hand Disinfection and Control System

One of the best ways to minimize the risk of contracting COVID-19 is by thoroughly washing every part of your hands for 20 seconds (see video [3]). It can however be hard to estimate how thoroughly the hands have been cleaned. Water being transparent and the virus so small, that there is no indication if a part of the wrist for example hasn't been cleaned.

Design a universal hand disinfection and control system that can be used everywhere, at home, in hospitals, in shopping malls, etc. The system should serve as a disinfectant dispenser and would control, rate and inform the user about the duration and quality of the handwash. Add any additional useful functionalities as you see fit. Ideally, the total cost of system should not exceed 150 CHF.

Challenge 4 - Wearable Device for Social Distancing

As people are getting used to the pandemic, they might also get less strict with the social/physical distancing rules that are necessary to flatten the epidemic curve. To make sure people stay alert and are keeping their distance from each other, we would like to implement a cheap, wearable device that can be distributed to the general population.

[2] CDC recommendations for cleaning and disinfection
[3] Federal Office of Public Health's recommendation for hand hygiene

Design a wearable device that tracks your physical distance from others (perhaps also by communicating with similar devices worn by others) in your vicinity. Your device should inform the user in an efficient and discrete way, if he is getting too close to other people. You could further add any additional useful functions (e.g. body temperature), that you believe could help in this pandemic. As such a device would have to be widely distributed for the general population, make sure to consider its cost and robustness. The total cost of the wearable device should not exceed 25 CHF.

Challenge 5 - Find your own challenge

COVID-19 has been creating many new, unexpected challenges in our society. Do you have know a challenging problem that you would like to design a solution for? If you would like to design and solve your own challenge, send us a description of the challenge before the **27th of April 2020**. We will get in touch with your group to see if it is within the scope of this lab.

Q&A and Mentoring

- If you have any questions about this lab, we will have a Q&A session right after the lecture on the **27th of April 2020**.
- Your hilfsassistants will mentor your design solutions. They will provide atleast 30 minutes of mentoring and will contact you to organize a zoom session with you.

Tips

- Costs
  - All components are much cheaper in bulk quantities than single quantities.
  - Bare microcontrollers and sensors cost much less than the ones with breakout boards used for prototyping
  - Check out the **hardware list** document on moodle and the lecture slides to find websites that sell electronic components.
- Tutorials and Inspiration for Building and Prototyping
  - https://learn.adafruit.com

Grading Criteria of Lab Report

Grading of this lab will be based on the following criteria:

- feasibility
- simplicity
- scalability
- data privacy (if applicable)
- cost
- ease of use
- quality of report