Executive Project Summary

Group #33 | Power Management for Collective Ground Robots

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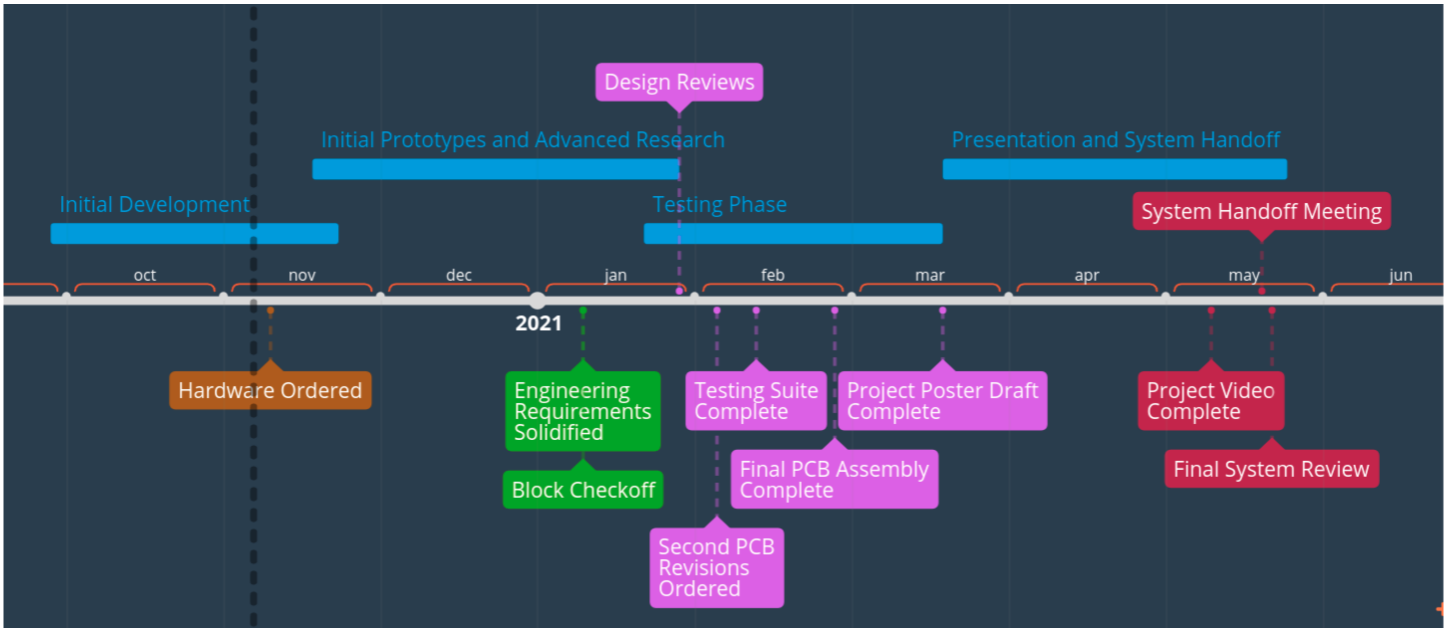
Industrial manufacturing and logistics are rapidly being robotized in manners made possibly only through tremendous leaps in information technology brought forth by what is commonly called the “fourth industrial revolution” [1]. As these transformations disrupt the shop floor, it becomes increasingly relevant to situate the human operator harmoniously within emerging cyber-human systems, which can quickly become costly and require extensive retraining [2]. We identify the maintenance and application of collective robotics to be one of the fastest emerging needs posed by this transformation, and we propose an augmentative solution in the form of a comprehensive power management system which harmonizes the live maintenance of swarm robotics with human supervision. Such a system will be instrumental to the research of Oregon State University’s Human Machine Teaming lab (HMTlab), overseen by the project partner Dr. Julie A. Adams. The utility of such a system is under immediate demand due to the already cumbersome maintenance requirements discovered by the lab thus far, and they have identified a distinct opportunity for automation within their workflow. By automating and augmenting power management for collective robotics, not only will the lab’s trial throughput be increased, but a future of highly self-managing swarm systems will come closer to reality.

The project consists of the development of a networked system distributed across three layers: A hub HCI device and server, a prototype Qi charging dock, and the collective robots themselves. A new communication channel is proposed to communicate robot status to a central server. By exploiting this data, the robots will automatically share electrical resources, subject to any set of arbitrary constraints, through interface with the charging dock and each other. This process is rendered visible to human operators through the server, where they can monitor the system and input relevant power-related directives. The data processing involves consumption prediction based on a multifactor approach of formulaic and statistical models taking into account robot and directive specifications. Hardware and lower level enabling power management technologies, especially as they relate to the charging dock, are implemented taking advantage of the team’s strong electrical engineering and robotics background. Data was processed and applied using the computer science background.

System architectural specifications and work package planning will continue through December, 2020. January to March will foresee the development of the primary prototype system which will be deployed in the HMTLab for evaluation. Rigorous testing and refinement of the prototypes will be conducted from March to May, preparing the system for long-term maintenance. In addition to the progress milestones presented as part of the ECE44X series, biweekly meetings with the project partner will ensure that development proceeds at an acceptable pace and according to all requirements. Weekly meetings with the HMTLab will furthermore assist in risk mitigation regarding the perpetual evolution of the robotic swarm systems which will occur concurrently to the capstone project. The system will be subdivided into discrete modules with clear interfaces early on in the project to promote concurrent and independent development activities.

When this project concluded, a charging dock capable of Qi charging several swarm UGVs concurrently was demonstrated and added to the tools of the HMTLab. Software updates were published to the swarm robots to enable them to recognize and utilize this station harmoniously. The primary user interface for the system will be deployed to a desktop PC as a server accessible through a web browser. All software will be scalable to other charging and robot solutions, and all source code will be placed in the HMTLab Gitlab. Together, this system will be integrated into the HMTLab in order to facilitate their research on swarm robotic design and algorithms. The user interface may be adopted by any willing organization and may be instrumental to future HCI research necessary for the advancement of cyber-human systems. The insights learned from this project have been well documented and will continue to support future research and development.

Project Timeline



References

[1] M. Wollschlaeger, T. Sauter, and J. Jasperneite, “The future of industrial communication: Automation networks in the era of the internet of things and industry 4.0,” *IEEE Ind. Electron. Mag.*, vol. 11, no. 1, pp. 17–27, 2017, doi: 10.1109/MIE.2017.2649104.

[2] F. Ansari, S. Erol, and W. Sihn, “Rethinking Human-Machine Learning in Industry 4.0: How Does the Paradigm Shift Treat the Role of Human Learning?,” in *Procedia manufacturing*, 2018, pp. 117–122, doi: 10.1016/j.promfg.2018.04.003.