

A Mobile Robot Programmable Remote Laboratory for Engineering Education

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Abstract

During this pandemic, remote laboratories are pivotal for the educational and the research community. COVID-19 has made it impossible for students to gather together and perform experiments at closed proximity in a physical traditional laboratory setting, causing a massive gap in students' learning experience. That is why, now more than ever, it is crucial to understand the importance of remote laboratories. Over the years, new innovative remote laboratories platforms have been developed to provide a more interactive online learning environment. Hence, new opportunities to develop and implement new forms of experiments into a remote lab are being created, such as robotics-related experiments. A rising form of implementation of such an experiment into remote and virtual labs is mobile robot experiments. This increase of mobile robot experiments into online labs correlates, with the growth of mobile robots being used across the nation by many, such as military, hospitals, office buildings, including major companies such as Amazon and Wal-Mart. With the popularity growth of mobile robots used by leading companies, it is vital for engineering students to have a complete hands-on experience when learning about mobile robots, primarily through this pandemic. With the rapid growth of both, the use of mobile robots and improvements in remoted/virtual labs, it is no surprise that more online laboratory platforms are being reconfigured or developed to support mobile robot experiments. However, in most current implementations of remote laboratories for mobile robots, the tool, and control method they provide are extremely limited by basic control rules, such as simple inputs of modifiable parameters based on pre-programmed controlled algorithms which require minimal interaction. This limitation creates a gap in the learning experience of the students, especially during a pandemic, because online learning is all students rely on. This paper proposes the development of a new remotely programmable laboratory for mobile robots where students can design, implement, and execute their own control algorithms for real mobile robots through the web browser

without the need for other software plugins. The students will have access to a real code editor, real equipment to control in real-time, not a simulation, and show real-time video transmission during execution. Three modules will be created for a specific part of the programming process. AJAX will be the technology used by these modules, which transfers data between the web application and web server, making it possible to execute the code. This application is designed to provide students with interactive tools and a contextual learning scene, making this research of significant relevance to online engineering education by providing students with direct programming experience on a remote laboratory web application. Remote laboratories are necessary during COVID-19, but they will pave the way for remote education in the future. It gives students and researchers the ability to conduct experimental research using a real laboratory from anywhere in the world without having to expose themselves and their families to COVID-19. Remote labs are not only fundamental for educational purposes during this global crisis, but for the future to come.

Acknowledgements

This work was supported in part by RENEW which is a technology partner to POWDER. RENEW/POWDER is part of the National Science Foundation's PAWR program and is funded in part by NSF award CNS-1827940 and the PAWR Industry Consortium.

Biographies

Rafael Franco-Vera. Received the BS degree computer science from Texas Southern University (TSU). He started the MS degree in computer science from TSU Houston, Texas, in January 2019. Currently, he is a research assistant in the Department of Computer Science, Texas Southern University. His research interests include remote laboratory, remote controls, cognitive learning, and programming, robotics. He has 1 published conference papers.

Xuemin Chen. Received the BS, MS, and PhD degrees in electrical engineering from the Nanjing University of Science and Technology (NJUST), China, in 1985, 1988, and 1991, respectively. He started his academic career at NUJST in 1991. He was a postdoc fellow and then a research assistant professor in the Electrical and Computer Engineering Department at the University of Houston from 1998 to 2006. He joined Texas Southern University (TSU) in 2006. Currently, he is an associate professor in the Engineering Department at TSU. Upon joining the TSU, he actively engaged in the conception and implementation of next-generation remote laboratory. He initiated the Virtual and Remote Laboratory (VR-Lab) and served as founding director of VR-Lab at TSU in 2008. With the support of NSF HBCU-UP, the CCLI and IECCI programs, and a Qatar NPRP Cycle 4 award, he has established a state of the art VRLab at TSU. His research interests include virtual and remote laboratory development and wireless sensor networks. He is a senior member of the IEEE and member of the IEEE Systems, Man, and Cybernetics Society.

Wei Wayne Li. Received the BS, MS, and PhD from Shaanxi Normal University, University of Hebei Technology, Chinese Academy of Sciences, China, in 1982, 1987, and 1994, respectively. He started his teaching career as an associate professor at the Department of Operations Research and Cybernetics, the Chinese Academy of Sciences, Beijing, China, in 1995. Continuing on as an assistant professor (tenure track) at Department of Electrical and Computer Engineering, College of Engineering, the University of Louisiana at Lafayette (ULL), LA, USA in 1999-2002. Associate Professor (tenure track first and then early tenure awarded in 2006) and the Founding Director of Wireless and Mobile Network Laboratory at the Department of Electrical Engineering and Computer Science, the University of Toledo (UT), USA (2002-2007). As a Professor with tenure at the Department of Computer Science, TSU, Houston, TX, USA (2008-present).

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