Balance-Arm Tablet Computer Stand for Robotic Camera Control

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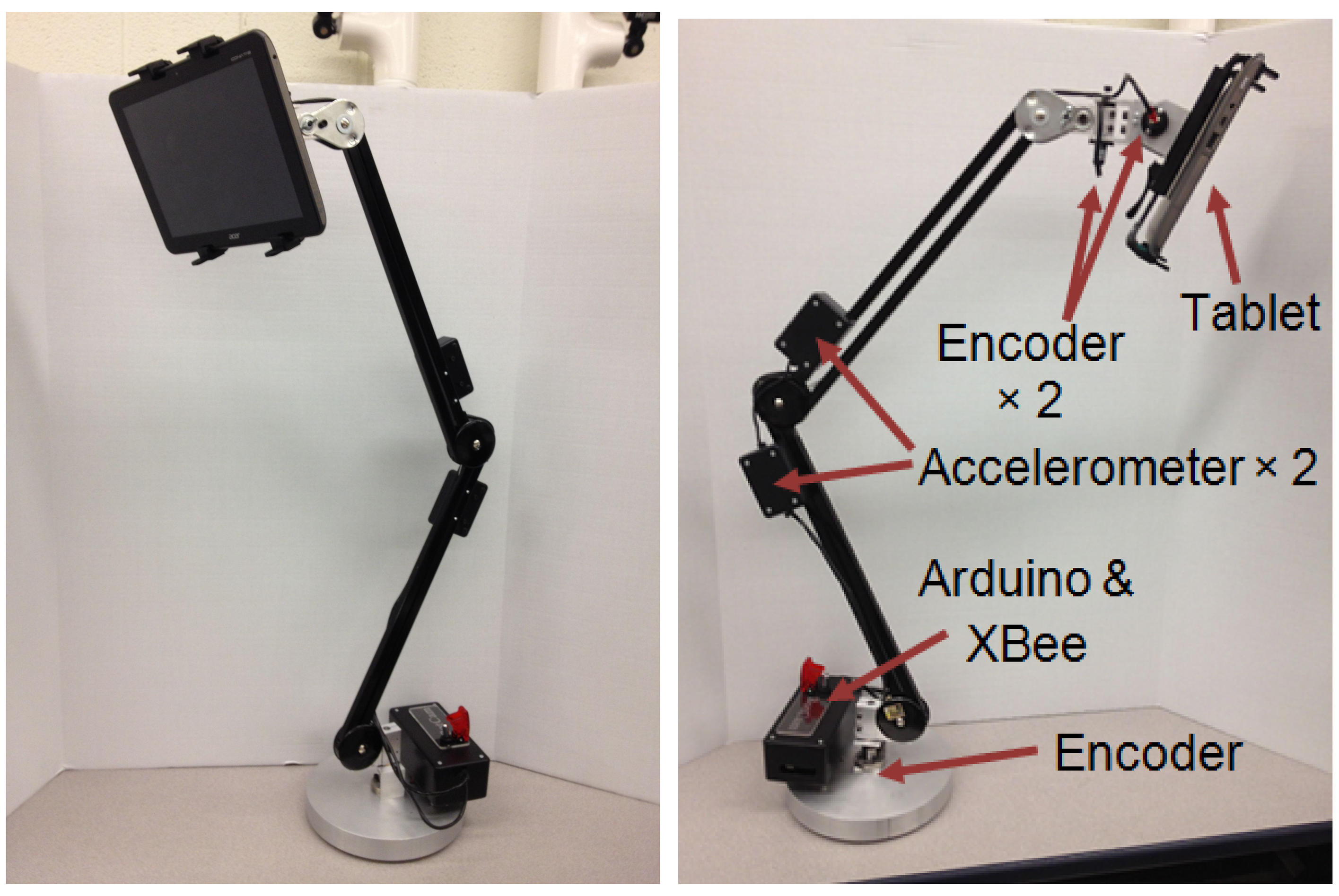
Project Overview

Traditional methods of camera orientation control for teleoperated robots involve gamepads or joysticks with the motion of analog sticks used to control the camera direction. However, this control scheme often **leads to unintuitive mappings** between user input and camera actuator output. **This paper describes a master-slave style camera position and orientation controller** with a tablet computer mounted on a balance-arm (acting as the control master), showing a video feed from the robot, **affording the user a one-to-one mapping** to control the viewpoint of a camera mounted on a robot arm (the slave). In this way, the **tablet computer acts as a virtual window to the robot's workspace**.

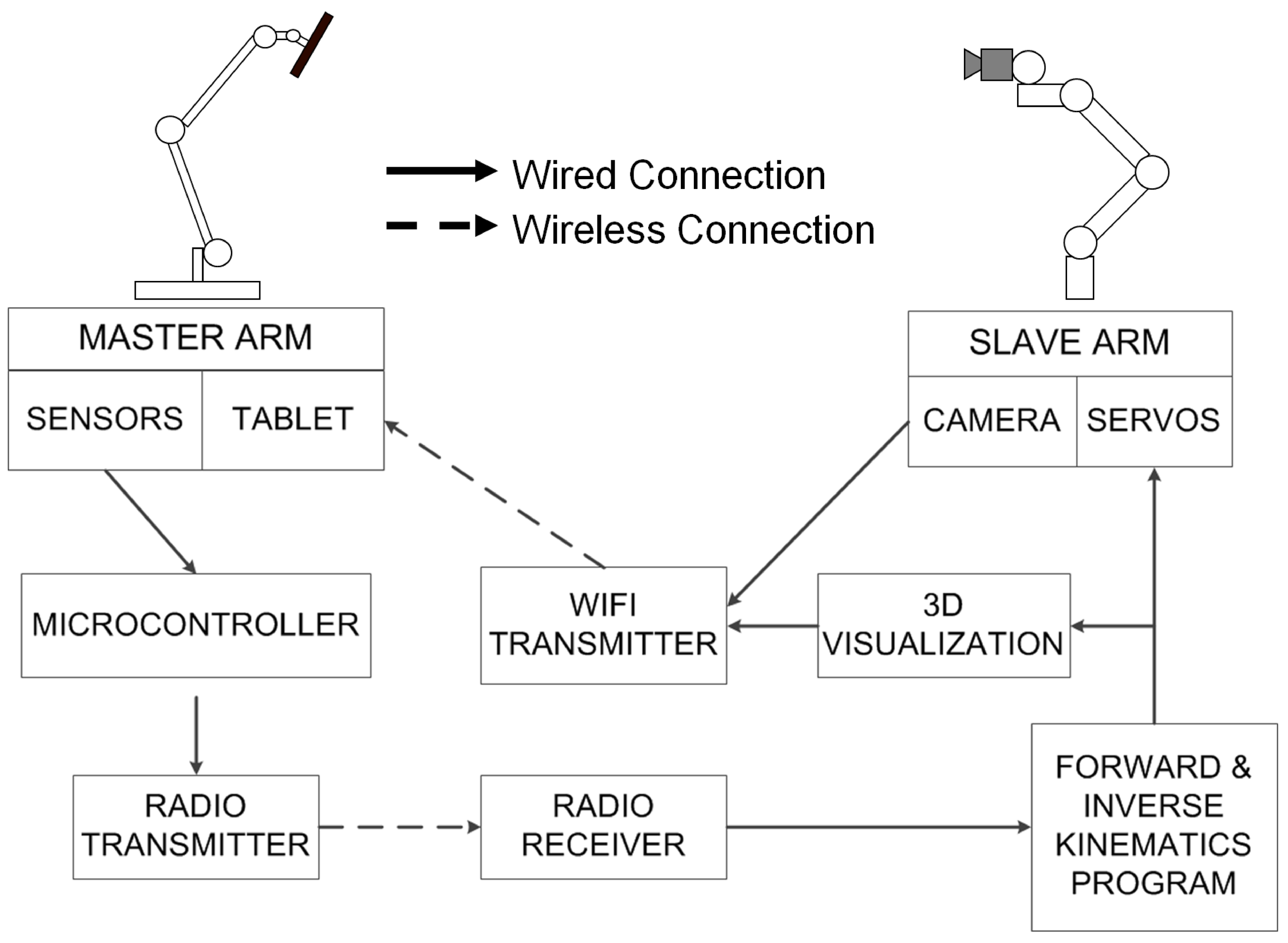
Master Arm



The master arm controller uses 5 sensors to measure the **5 degrees of freedom of the master arm**. With an encoder in the base and two accelerometers on the arm, the 3D position of the tablet computer can be calculated. Two encoders measure the pan and tilt orientation of the tablet. The tablet displays a **3D visualization of the slave arm** as well as **video from the slave**.

Software and Data Flow

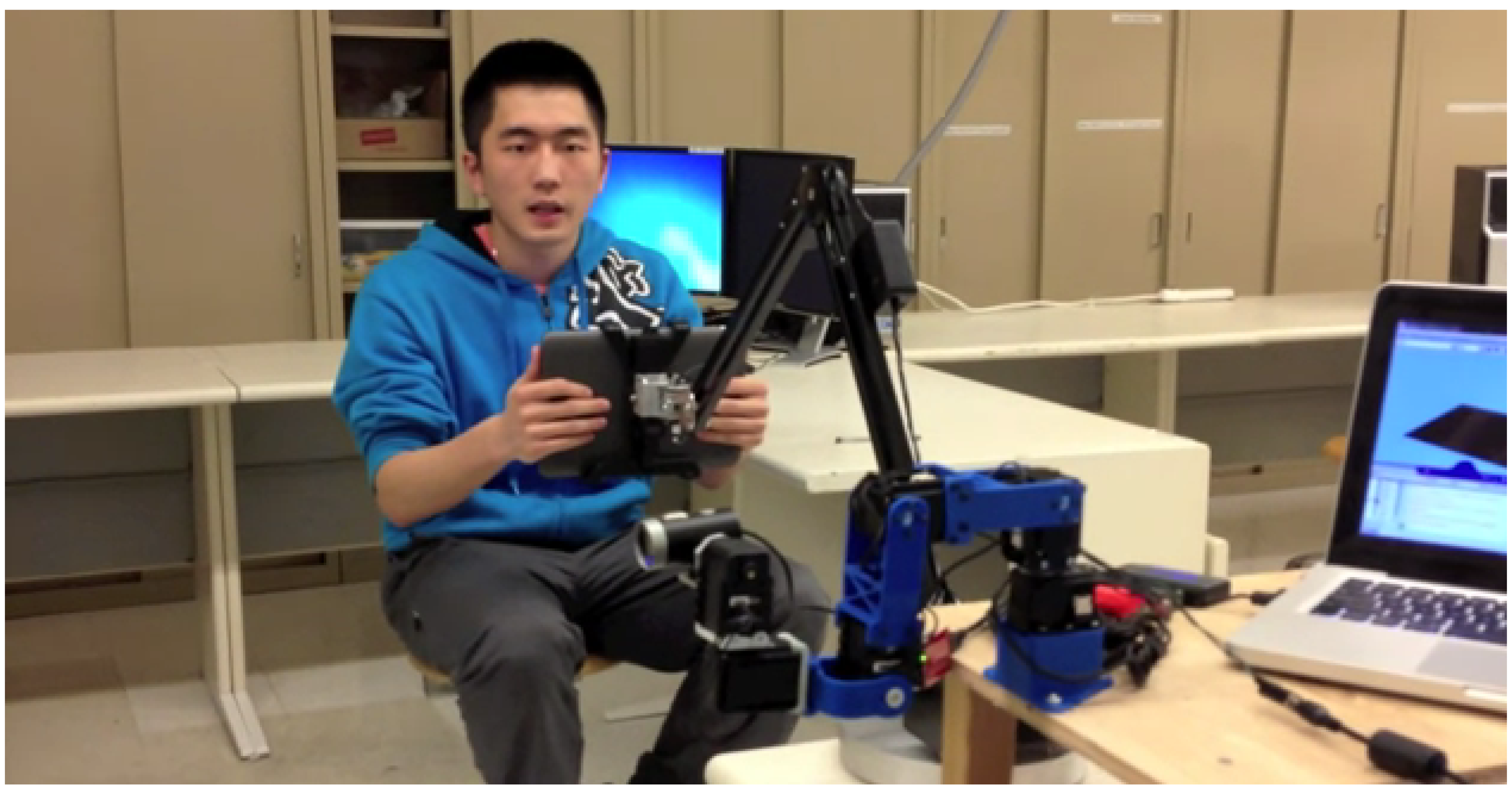
The microcontroller reads in analog data from the sensors, which is transmitted via wireless radio to a laptop. A Java program calculates the position and orientation of the master arm and the inverse kinematics for the slave arm. A webcam on the slave is connected to the laptop, and the video feed and slave arm visualization is broadcast to the tablet to be viewed by the user.



Slave Arms

The master controller only specifies the desired camera position and orientation, so **any slave arm with a suitable workspace could be controlled** with this input system by calculating the inverse kinematics. One arm used for demonstration of this control system is shown above. A different arm is shown in the photo in the box to the right.

Master Arm Characterization



The **performance of the master arm** was characterized with respect to **kinematic accuracy** and **system delay** to determine whether it could be used as a viable controller for a slave robot arm.

Summary of characterization of master arm performance.

Error Type	Average	Maximum (Worst-Case)
Position Error	1.2cm	2.4cm
Angular Error	0.7°	2.2°
Filter Delay	0.17s	0.23s
Processing Delay	0.06s	0.08s

Ongoing Work

This project was originally conceived as a standalone proof-of-concept, but in the future it may be **integrated into other studies on improving human-robot interaction** currently underway. The slave arm is being redesigned for greater reach and load capacity, as well as an integrated camera mount and new gripper. The new slave arm will be mounted on a mobile chassis and used in a series of trials comparing the ease of use of various controllers. This will allow a **quantification of any performance advantages** that the system gives the user.

References

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