Modeling, Motion Planning, and Control of a Robotic Gong-Striking System

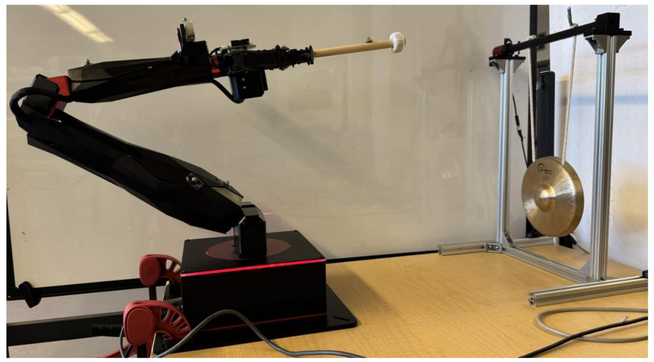
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MOTIVATION AND OBJECTIVE

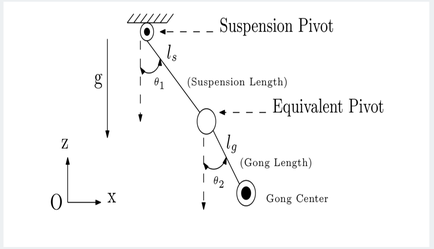
Watching a video of someone playing a gong made me wonder: Could a robot predict the gong's swing and strike it on cue with the right touch to recreate the musician's intended sound? This project takes a first step by controlling strike timing and mallet speed at contact.

METHODS



Quanser QArm and suspended gong

Model the gong



A Double pendulum model of the ropes and gong

Simulation Workflow

Simulate the gong swing

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Apply scheduled impacts at the assigned speed

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Estimate motion with EKF

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Plan repeated mallet paths

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Track the path with DMC

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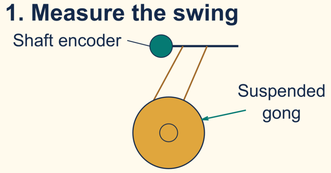
Simulated arm strikes and retracts

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Compare x and z tracking

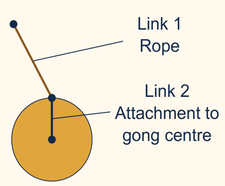
Hardware Workflow

1. Measure the swing



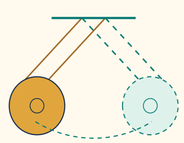
The encoder tracks the swing

2. Estimate the motion

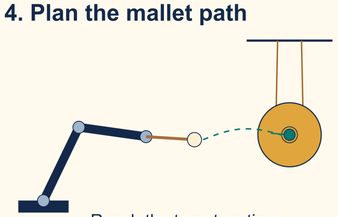


Estimates gong position and speed

3. Predict the strike point

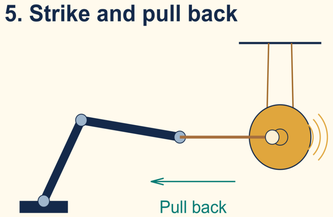


4. Plan the mallet path



Reach the target on time

5. Strike and pull back



6. Check the timing

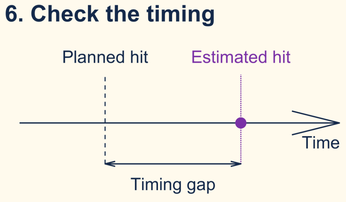
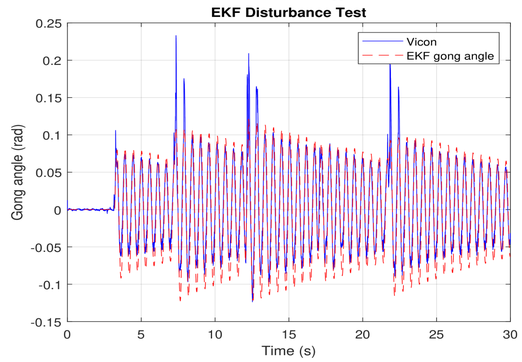


Illustration of one hit

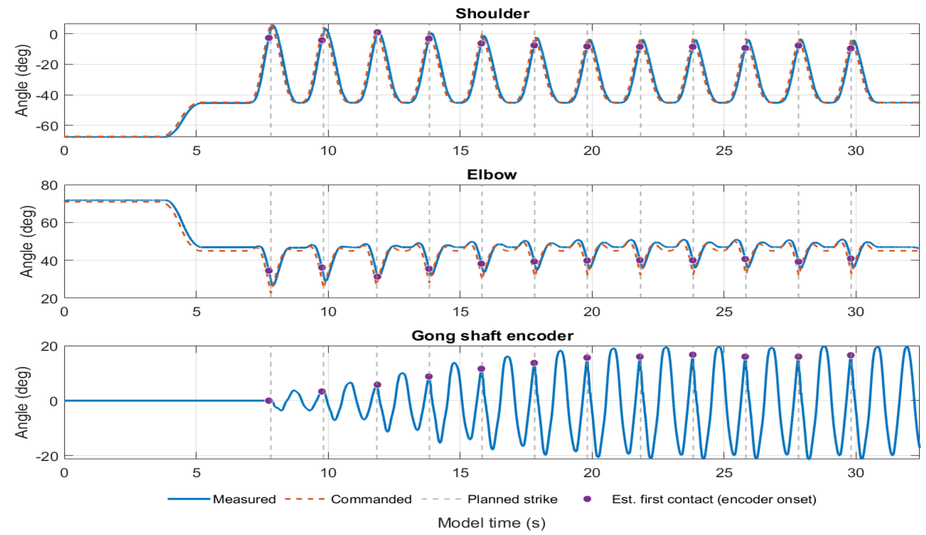
HARDWARE RESULTS

Measuring and Estimating Gong Motion



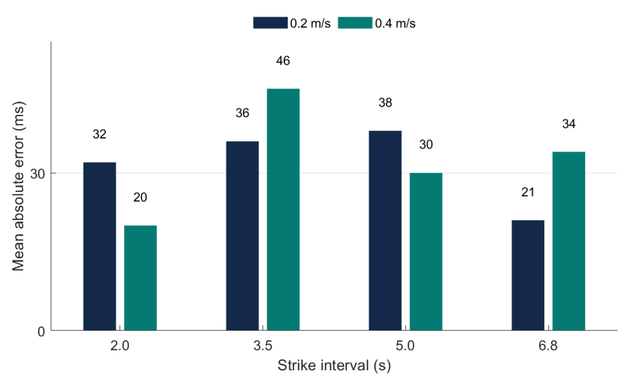
1.2° angle error during the disturbance test (RMSE)

Repeated striking on the QArm



Twelve strikes at a 2 s interval and 0.4 m/s target speed

Strike Timing Error



CONCLUSION

Lowest mean absolute timing error	**20 ms** over 12 strikes at a 2 s interval and a 0.4 m/s target mallet speed
Applications	Robotic percussion, swinging-load handling, and contact inspection