Assessing the Energy Requirements of Actuators During Common Automation Tasks

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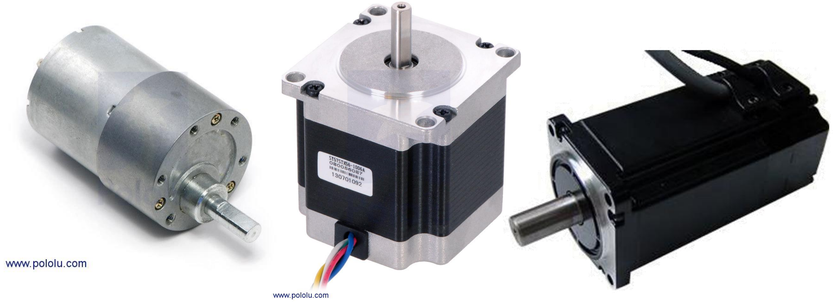
Objective: The goal of this project is to develop principles for the design of automation mechanisms that have reduced energy needs, common in assembly and manufacturing operations.

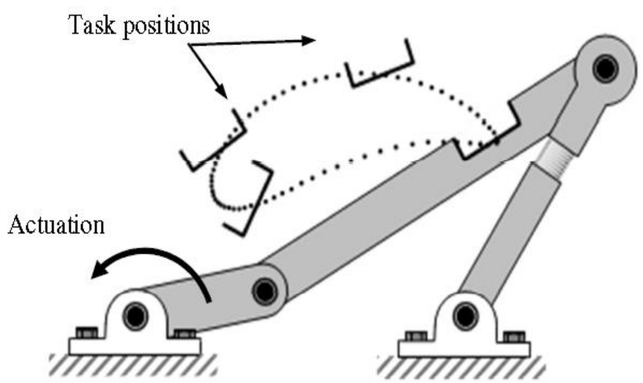
Motivation/ Introduction

Manufacturing operations are among the most energy intensive, using one third of the energy produced in the United States. In Industrial manufacturing processes, upwards of 70% of energy consumption in industry is by motors.

Automation machinery is typically actuated by dc motors with encoder, stepper motors, or servo motors.

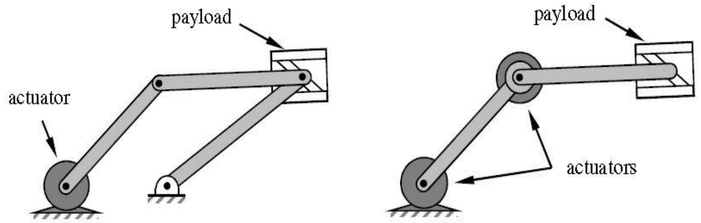


A single-degree-of-freedom positioning mechanism can be driven by programmable actuators. The controlled actuators can move and stop the mechanism in any configuration in its path.



Methodology

Experiments with virtual models, confirms that energy usage can be potentially decreased in pick & place applications by implementing the proper device architecture for the specified task, and optimally locating the actuators.



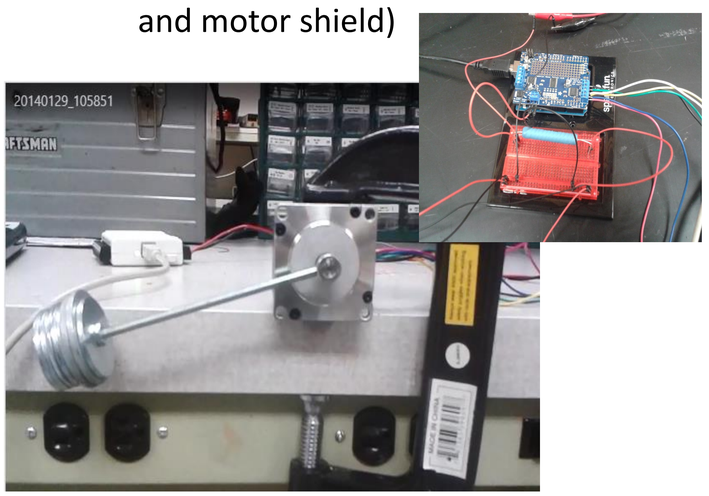
The articulated arm required five times more energy to lift a 5 lb. payload.

Research Challenges

Challenge1:

To determine relationships for energy used in controlled moves of common industrial automation actuators based on torque, prescribed motion, and time on task.

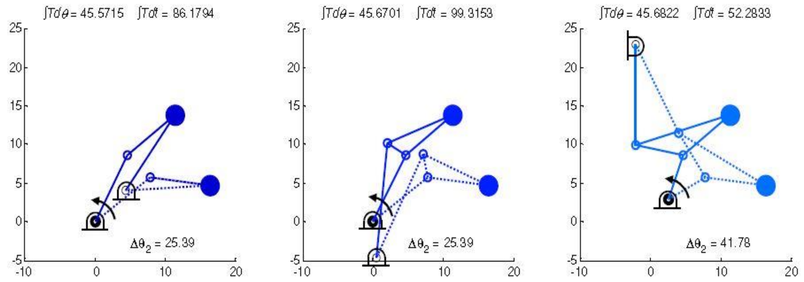
Controller (Arduino interface board and motor shield)



Experimentation with lifting motions

Challenge 2:

To generate a set of principles for the dimensional synthesis for automation mechanisms that have reduced energy needs.



Comparison of probable energy terms for closed chain lifting mechanisms having different dimensions but completing the same task.

Mechanism Assessment:

The work required to perform a task such as lifting a payload:

$$Wk_{i\to f} = \int_{\theta_i}^{\theta_f} T\, d\theta.$$

The total energy required of a rotary actuator during a controlled move may be represented by:

$$E_{e(i\to f)} = \frac{1}{\eta}\int_{\theta_i}^{\theta_f} |T|\, d\theta_2 + K\int_{t_i}^{t_f} |T|\, dt + C.$$