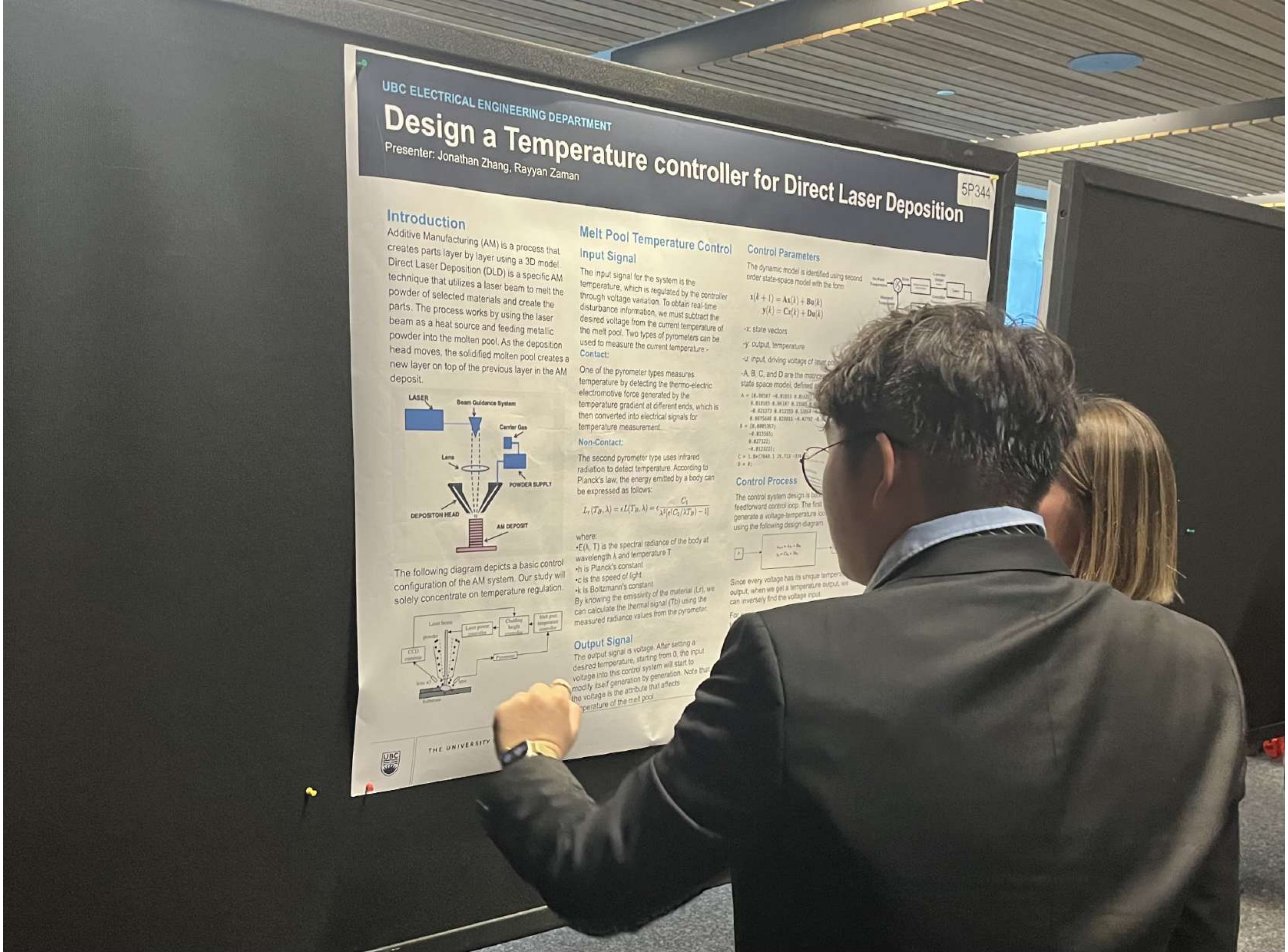
UBC ELECTRICAL ENGINEERING DEPARTMENT
Design a Temperature controller for Direct Laser Deposition
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Introduction
Additive Manufacturing (AM) is a process that creates parts layer by layer using a 3D model. Direct Laser Deposition (DLD) is a specific AM technique that utilizes a laser beam to melt the powder of selected materials and create the parts. The process works by using the laser beam as a heat source and feeding metallic powder into the molten pool. As the deposition head moves, the solidified molten pool creates a new layer on top of the previous layer in the AM deposit.
LASER
Beam Guidance System
Carrier Gas
Lens
POWDER SUPPLY
DEPOSITON HEAD
AM DEPOSIT
The following diagram depicts a basic control configuration of the AM system. Our study will solely concentrate on temperature regulation.
Melt Pool Temperature Control
Input Signal
The input signal for the system is the temperature, which is regulated by the controller through voltage variation. To obtain real-time disturbance information, we must subtract the desired voltage from the current temperature of the melt pool. Two types of pyrometers can be used to measure the current temperature:-
Contact:
One of the pyrometer types measures temperature by detecting the thermo-electric electromotive force generated by the temperature gradient at different ends, which is then converted into electrical signals for temperature measurement.
Non-Contact:
The second pyrometer type uses infrared radiation to detect temperature. According to Planck's law, the energy emitted by a body can be expressed as follows:
where:
•E(λ, T) is the spectral radiance of the body at wavelength λ and temperature T
•h is Planck's constant
•c is the speed of light
•k is Boltzmann's constant
By knowing the emissivity of the material (Lr), we can calculate the thermal signal (Tb) using the measured radiance values from the pyrometer.
Output Signal
The output signal is voltage. After setting a desired temperature, starting from 0, the input voltage into this control system will start to modify itself generation by generation. Note that the voltage is the attribute that affects
Control Parameters
The dynamic model is identified using second order state-space model with the form
-x: state vectors
-y: output, temperature
Control Process
Since every voltage has its unique temperature output, when we get a temperature output, we can inversely find the voltage input.
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