3D Metal Printing

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Project and Motivation

The purpose of this project is to create an alternative to the metal casting process which can be expensive and result in long lead times. The project goal is to create a 3D metal printer that is capable of quickly creating metal components at a lower cost. Depositing highly precise parts, is beyond the scope of this project.

A MIG (metal inert gas) welder will be combined with a CNC machine, as seen in Figure 1. Wire is fed though the nozzle of the MIG welder, which creates the weld pool. This wire will be used as the deposition material. Building upon previous layers of deposition, a 3D object will be printed.
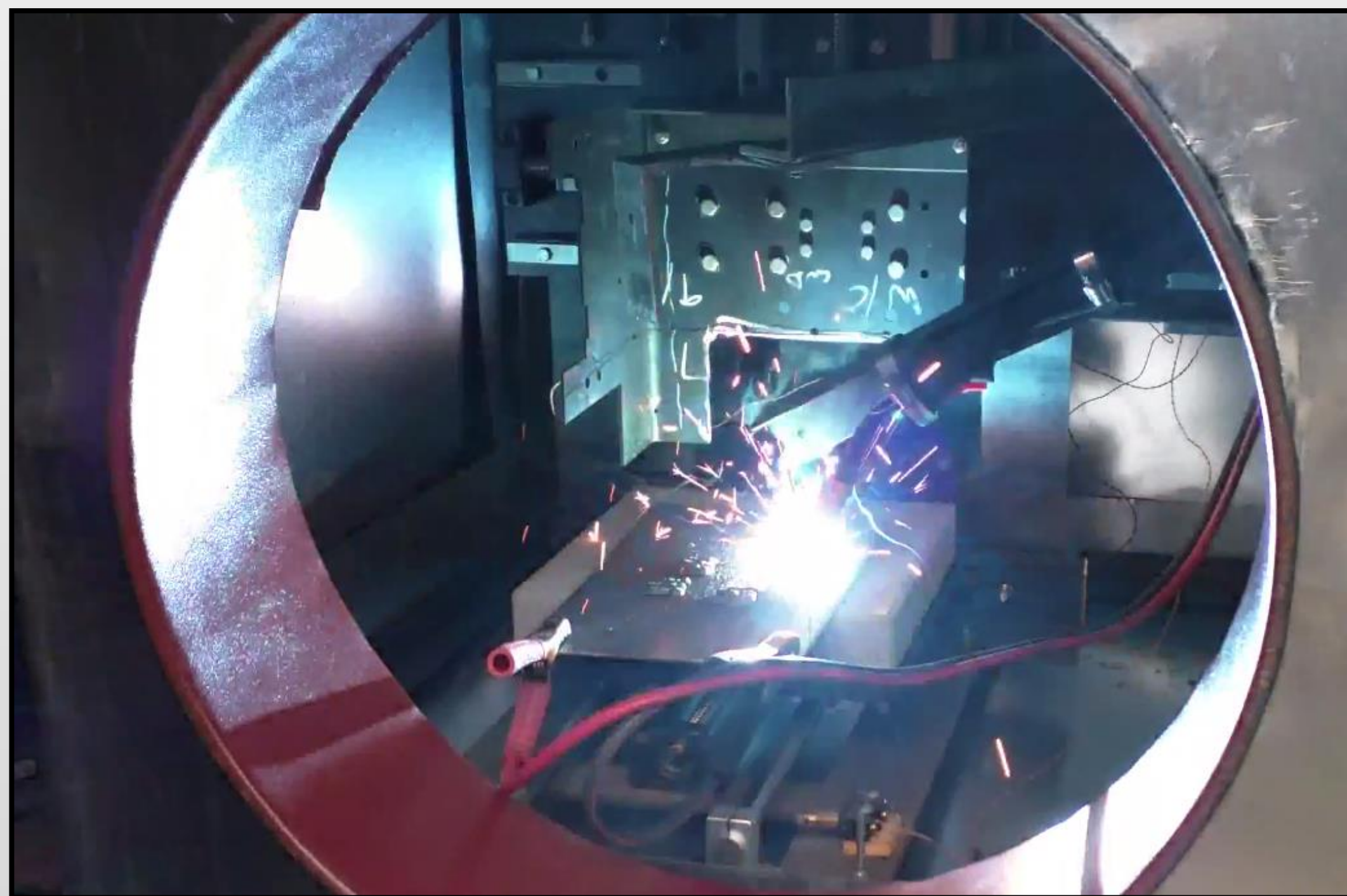

Fig 1. System in Deposition Mode

Goals

- Interface the MIG welder with CNC machine.
- Determine quality of deposition based on temperature and current.
- Control the MIG welder based on quality of deposition.
- Allow for future expandability

Control System

Control of the system is done using a PCI Express DAQ board from Sensoray CO Inc. The controller receives inputs from six signals that monitor the deposition. Based on these inputs, the controller will adjust wire feed speed to ensure a quality deposition. If at any point an error occurs, the system will pause and wait for corrections to be made.
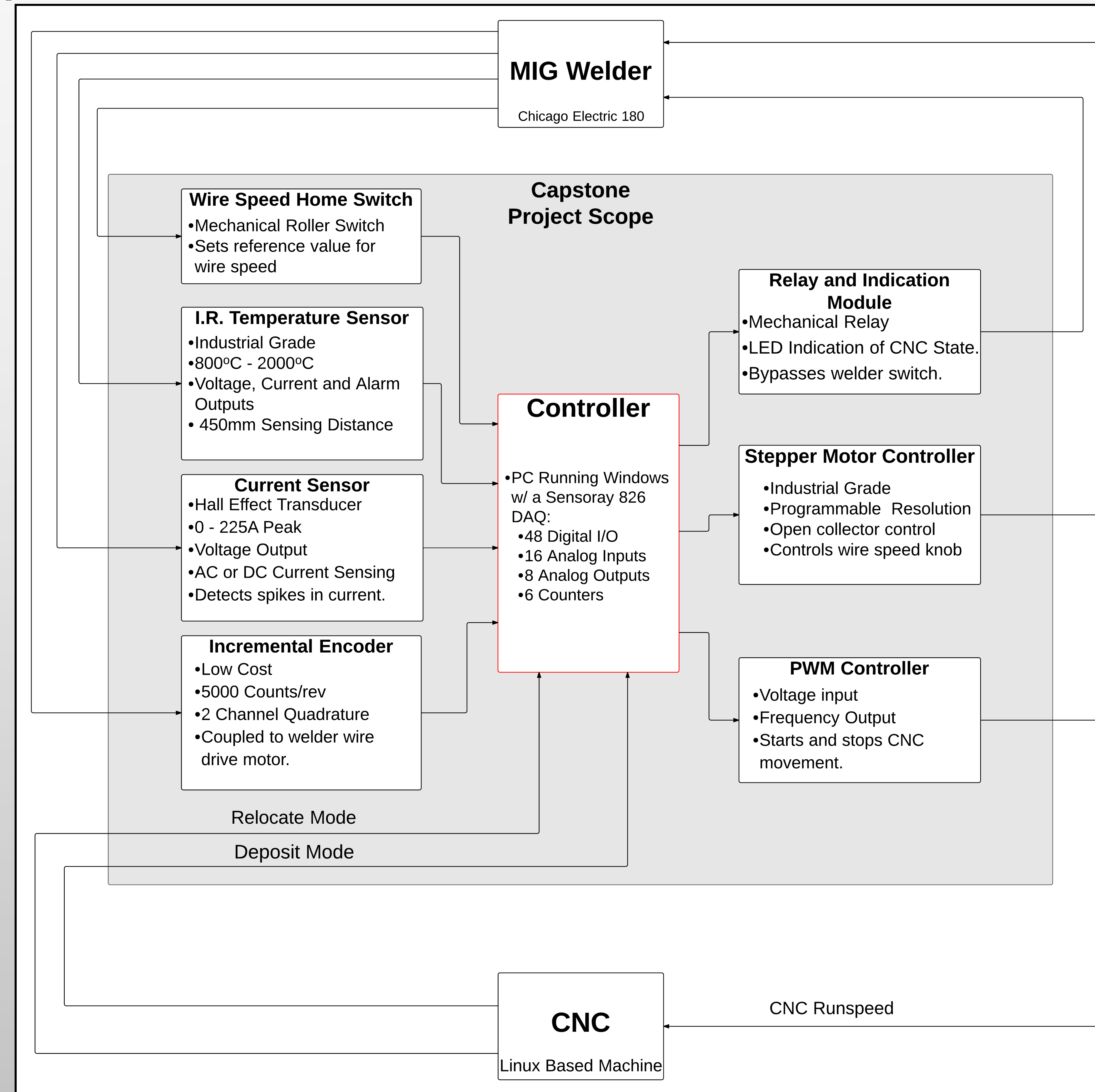

MIG Welder
Chicago Electric 180

Capstone Project Scope

Wire Speed Home Switch
- Mechanical Roller Switch
- Sets reference value for wire speed

I.R. Temperature Sensor
- Industrial Grade
- 800ºC - 2000ºC
- Voltage, Current and Alarm Outputs
- 450mm Sensing Distance

Current Sensor
- Hall Effect Transducer
- 0 - 225A Peak
- Voltage Output
- AC or DC Current Sensing
- Detects spikes in current.

Incremental Encoder
- Low Cost
- 5000 Counts/rev
- 2 Channel Quadrature
- Coupled to welder wire drive motor.

Controller
- PC Running Windows w/ a Sensoray 826 DAQ:
  - 48 Digital I/O
  - 16 Analog Inputs
  - 8 Analog Outputs
  - 6 Counters

Relay and Indication Module
- Mechanical Relay
- LED Indication of CNC State.
- Bypasses welder switch.

Stepper Motor Controller
- Industrial Grade
- Programmable Resolution
- Open collector control
- Controls wire speed knob

PWM Controller
- Voltage input
- Frequency Output
- Starts and stops CNC movement.

Relocate Mode

Deposit Mode

CNC
Linux Based Machine

CNC Runspeed

Fig 2. Block Diagram of System

Project Outcomes

Fig 3. Initial Z-axis Resolution Testing

The following outcomes were successfully completed:

- Selected a controller that minimized limitations of future expansion.
- Accurately measured speed of wire leaving the welder.
- Created a system that dynamically calculates and controls the wire feed rate.
- Determined welder settings in correlation with CNC settings to achieve a quality weld.
- Created a homing and calibration procedure for the welder settings.
- Controlled the temperature of the plate being welded to via feedback from the temperature sensor.

Fig 4. Deposition Testing

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