

SOFTWARE-BASED AUTOMATION SYSTEMS FOR CRYSTAL GROWING PROCESS

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PROJECT PRESENTATION

RESEARCH IN COMPUTER SCIENCE

LEWIS UNIVERSITY

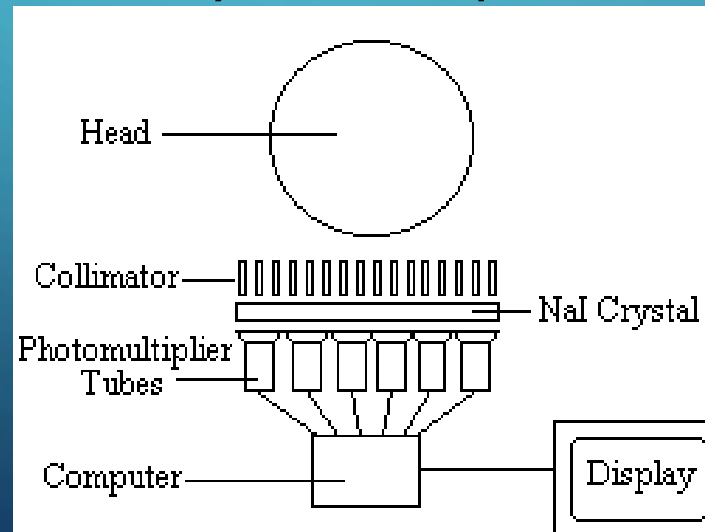
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INTRODUCTION

- Main goals are to use computer science as a means to update outdated processes within the Crystal Growth Department at Siemens Medical Solutions in Hoffman Estates, IL.
- Update Process Control for growth furnaces with new microcontrollers and implement KNN algorithms to aid in control.
- Update Crystal String Saw with embedded microcontrollers in lieu of analog logic.
- Update the environmental control of Dry Room. Implement microcontrollers with PID capabilities in place of the current ON/OFF control.

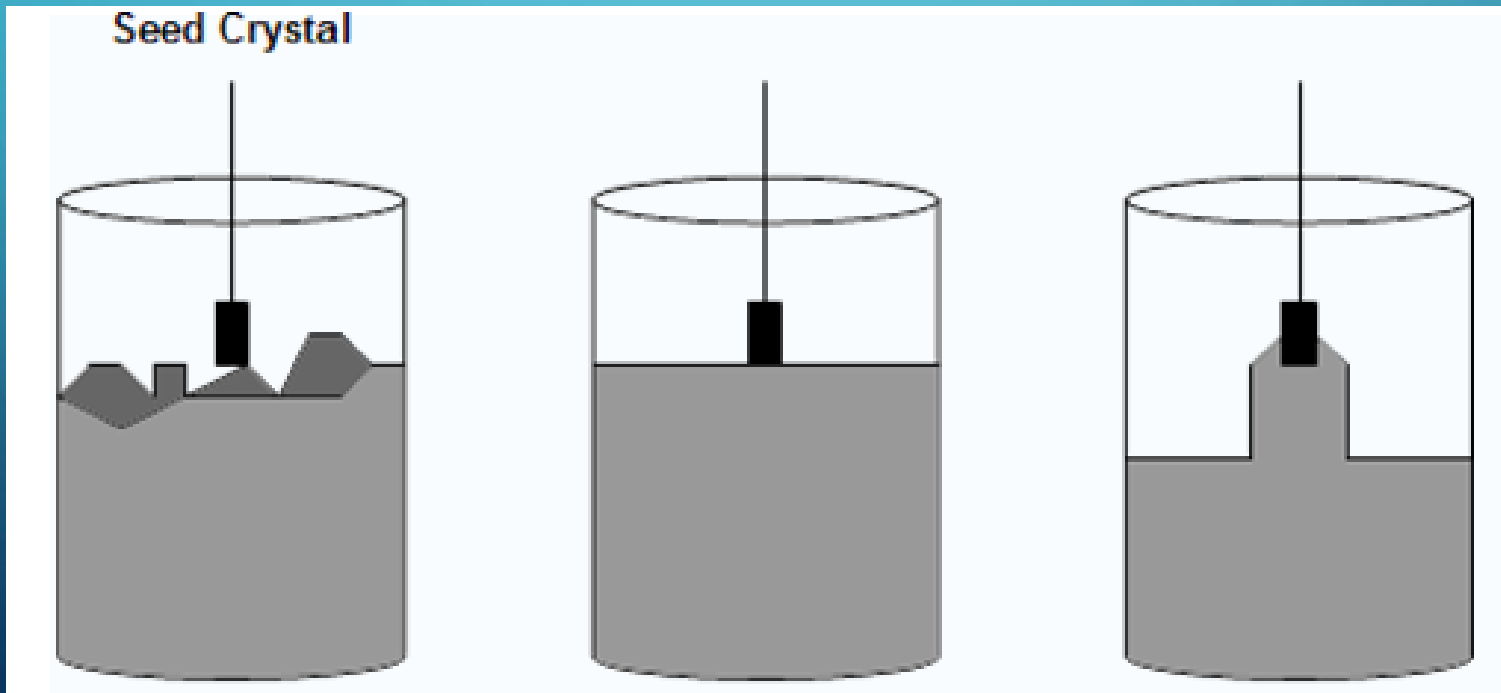
NAI(TI) CRYSTALS

- Grown into large blocks called ingots.
- Are sliced into thin plates and installed into metal frames encompassed in glass.
- Mounted on gamma camera within SPECT and PET devices.
- Used to capture gamma radiation emitted from radio tracers.
- Flashes captured by crystal and photomultiplier tubes get converted into images and are then studied by medical professional.



CZOCHRALSKI PROCESS

- Temperature within furnace is near 1000°C .
- Crystal seed is dipped into melt and slowly lifted.
- Rotation during lifting allows for controlled extraction.



CRYSTAL GROWTH DEPARTMENT

- Grows NaI(Tl) scintillation crystals for use with SPECT scanners.
- Crystals are grown in large furnaces.
- Control systems on furnaces are mainly comprised of analog controls coupled with digital controllers.

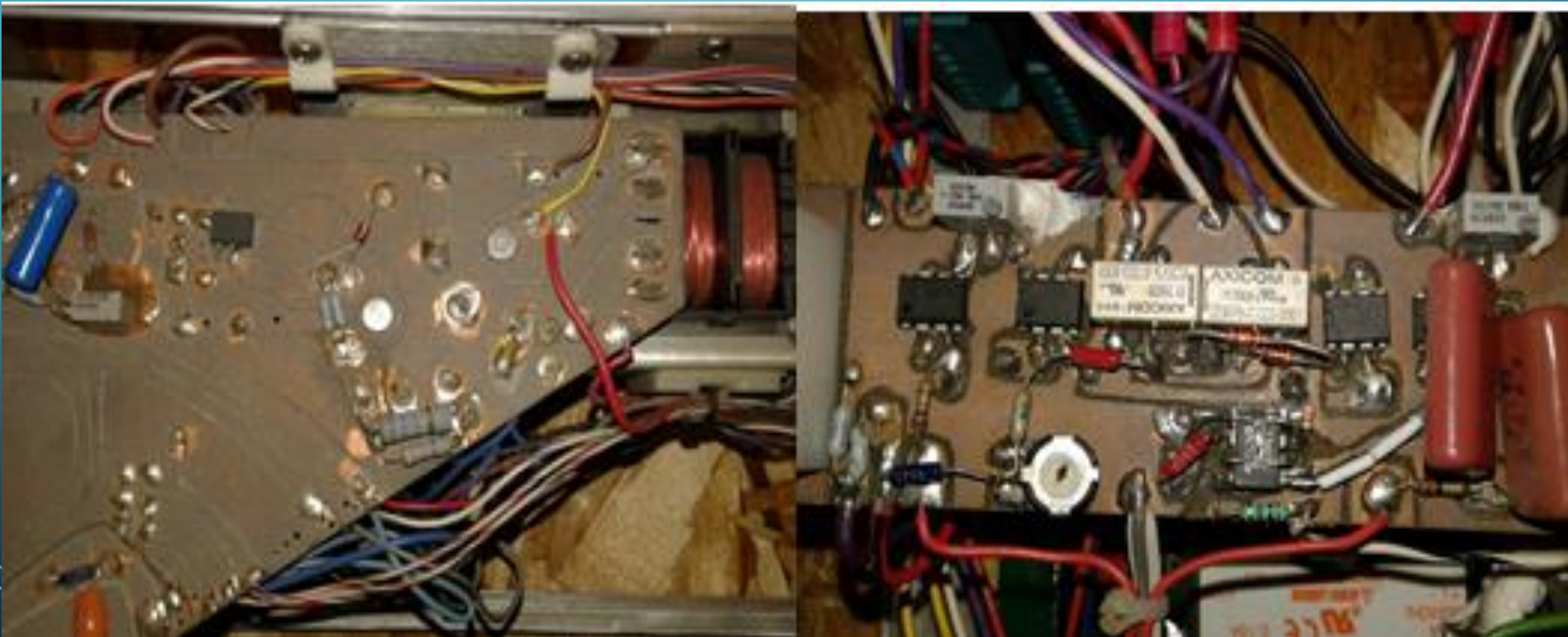


FURNACE CONTROL BOX



MOTIVATIONS FOR PROJECT

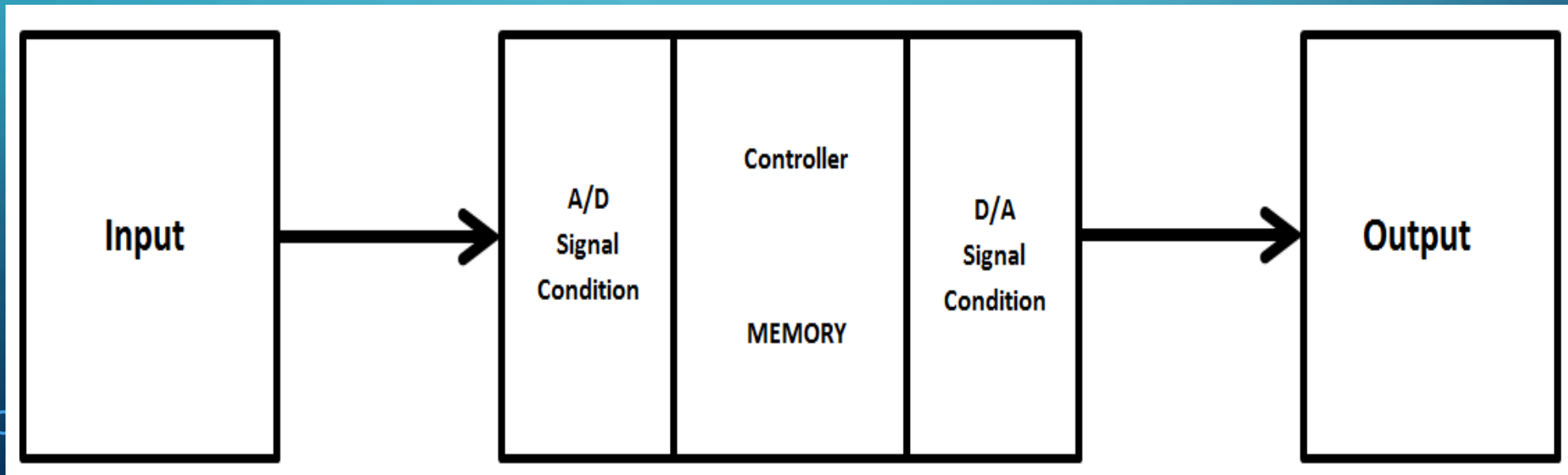
- Expand the use of digital and embedded control to replace the outdated analog systems.
- Develop designs that are reliable as well as cost-effective.



PROCESS CONTROL



- Digital Controllers used as “brains” behind most of the control systems.
- Off-the-shelf units cost hundreds to thousands of dollars.



PROPOSED SYSTEM



- Replace digital controllers and analog circuitry with much cheaper microcontrollers or development boards.
- Implement K-Nearest Neighbor algorithm for control process.
- It will allow controller to study techniques used by operators and will “learn” right and wrong actions.
- Can be used for Feed System and Heater Temperature Control.

CRYSTAL STRING SAW



PROPOSED STRING SAW CONTROL

- Implement development board encased in weather proof casing.
- Connect inputs and outputs to current motors and sensors.
- Pick-and-place manipulator would be convenient for moving crystal as it's sliced without the need for human intervention.



ENVIRONMENTAL CONTROL

- Crystals absorb moisture so the room which they are processed in must have efficient ventilation.
- Currently the system employs a simple thermometer with ON/OFF control.
- Utilizing a microcontroller, such as an Arduino, PID control can be implemented which would better cool the room during temperature increases.



AUTOMATION AND JOBS

- 47% of workers in America have jobs at high risk of potential automation [1].
- There is a potential that a number of operators would lose their positions with the automation of these processes.

[1] The Economist, "Artificial Intelligence: The impact on jobs," [Online]. Available: <http://www.economist.com/news/special-report/21700758-will-smarter-machines-cause-mass-unemployment-automation-and-anxiety>. [Accessed: May 3, 2017].

CONCLUSION

- As proposed by this project, computer science can play a major role in alleviating many of the issues with the systems within the Crystal Growth Department.
- By implementing microcontrollers and well-written software, many of the processes would be more efficient and cost less than store bought systems.
 - More reliable growth process with custom programmed microcontrollers implementing machine learning techniques.
 - More efficient String Saw with custom embedded microcontroller system.
 - More effective cooling system for Dry Room with microcontroller-based system utilizing PID control rather than on/off control.

The background is a blue gradient. In the corners, there are white line-art illustrations of circuit boards or neural networks, with lines and small circles representing nodes.

QUESTIONS?

Thank you