

Exploiting Predictability & Interdependencies of Physical Variables in Real-Time Embedded System Design



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Real-Time Computation for Physical Processes

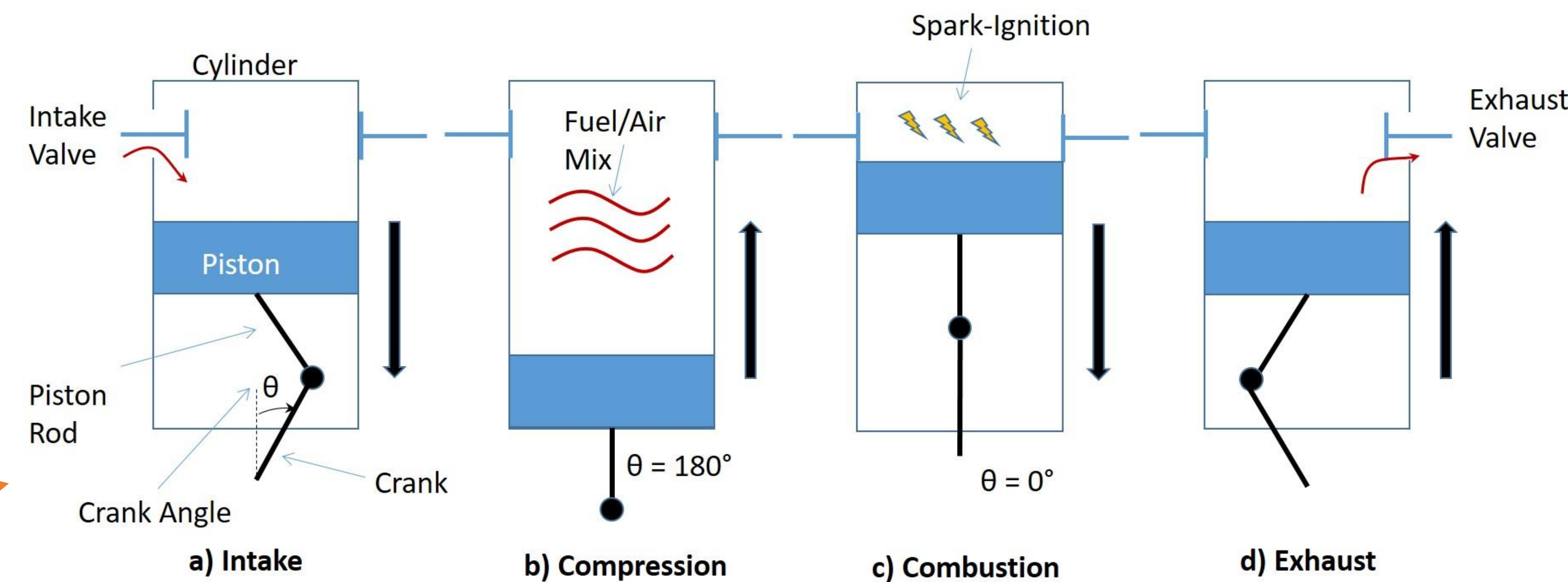
- Cyber-physical systems (e.g., engine control) often use **Adaptive Variable Rate (AVR)** tasks where task execution, arrival rate, and deadlines depend upon physical state.
- Task invoked at specific *crank angle locations*:

```
AVR-TASK-1D( int rpm ){
    f1();
    if (rpm < 3000){ f2 ( ) ;}
    elseif (rpm > 6000){ f3 ( ) ;}
    f4 ( ) ;
}
```

- Task Execution Time:** dependent upon physical variable (e.g., RPM).
- Task Deadline:** one crankshaft revolution.

Prior Research

Only a single physical dimension is addressed in determining whether a system containing AVR tasks can meet *all* deadlines.



Central Research Problem

How can real-time AVR tasks dependent upon multiple physical dimensions be effectively integrated and scheduled upon a shared computational platform?

Motivation

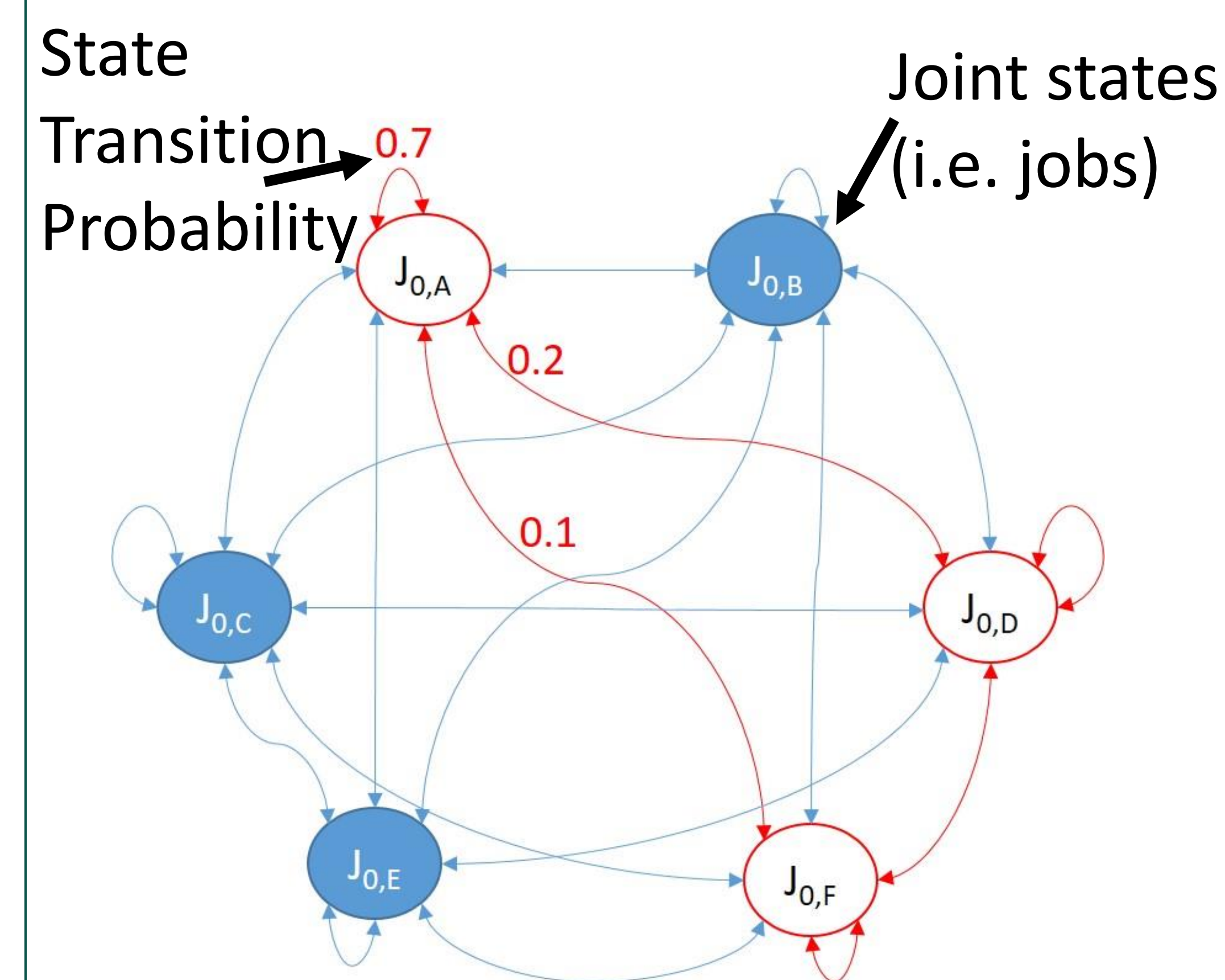
- Cyber-physical systems often have multiple physical dimensions. In engine control:
 - Rotational speed (RPM)
 - Engine Temperature

```
AVR-TASK-2D( int rpm, int temp ){
    f1();
    if (rpm < 3000){ f2 ( ) ;}
    elseif ((rpm > 6000) and
            (temp > 300)){ f3 ( ) ;}
    f4 ( ) ;
}
```

Current real-time *schedulability analysis* is unable to address.

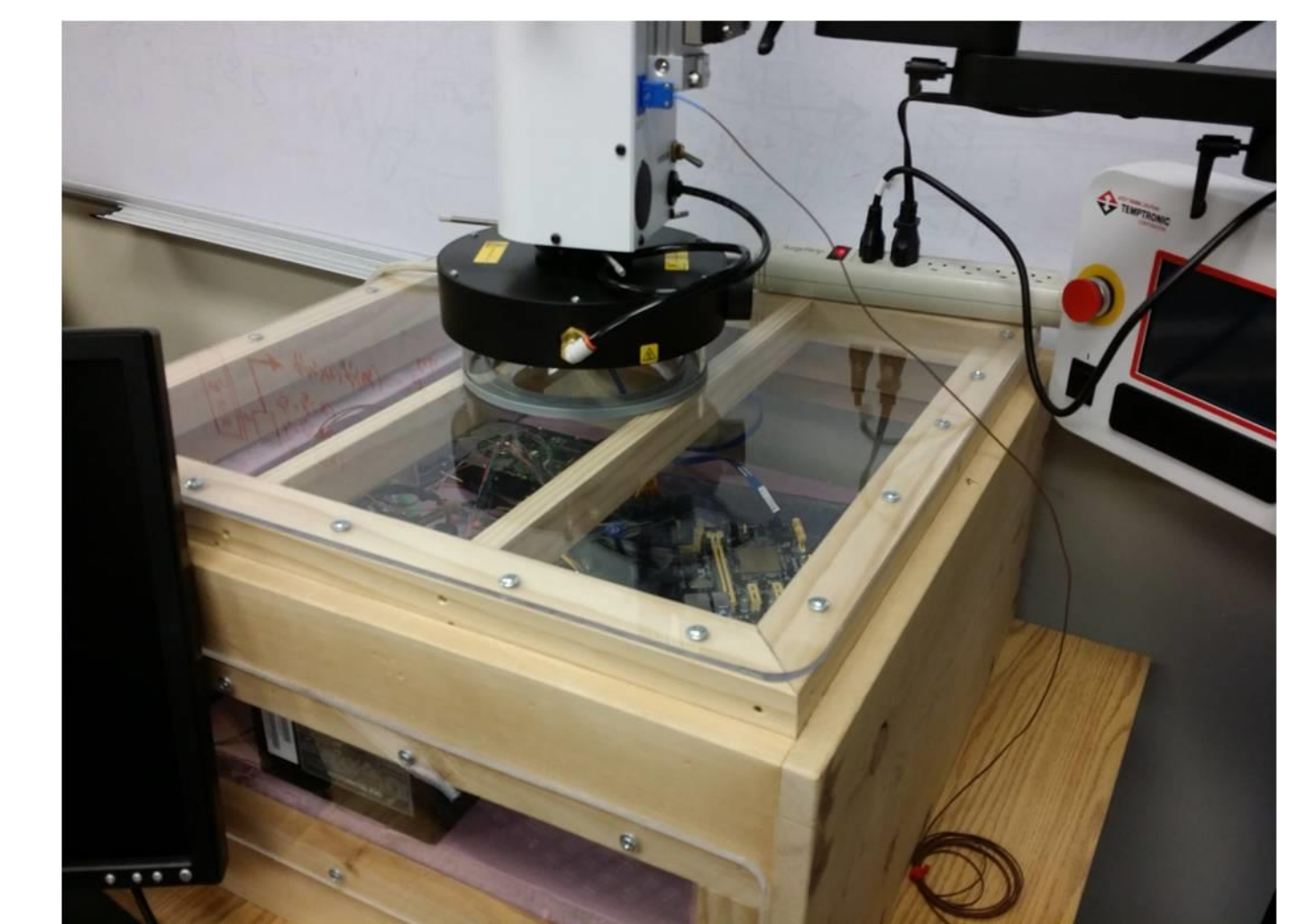
Challenge/Opportunity

- Physical parameters are often **dependent** or **correlated**.



Objectives

- Develop schedulability analysis to quantify maximum demand of AVR tasks controlled by multiple physical dimensions under:
 - Independent physical variables;
 - Dependent/correlated physical variables.
- Evaluation upon physical thermal testbed at WSU:



Future Directions

Apply techniques to other physical domains (e.g., short-circuit detection in variable voltage electric systems).

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