A

MIAMI UNIVERSITY | COLLEGE OF ENGINEERING AND COMPUTING

Virtual Twinning - Analyze and Predict Circuit Failure

Presented by: Ethan Barnes, Alecea Grosjean, Jimmy Roach

A

Purposes of Condition Monitoring

Motivation

- Mitigate Financial Loss
- Reduce Downtimes
- Human Safety

Notable Industries

- Transportation
- Industrial Automation
- Power Transmission
- Renewable energy

TELE.
PICTURES

J

What is Virtual Twinning?

A virtual twin is an application that replicates the performance of a physical system through simulation.

PICTURES

- SYSTEM DIAGRAM

BETTER
WHAT IS A BUCK CONV ?

J

Step 1 - Circuit Simulation

Software

- Alt Approaches
  - Xyce
  - PySpice
- Successful Approaches
  - LtSpice
  - Matlab
  - Python

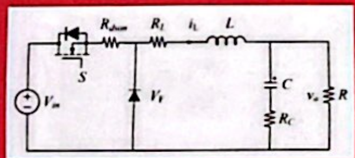
Mathematical Techniques

- Alt Approaches
  - Euler's Method
- Successful Approaches
  - Runge Kutta
  - State Space Equations

PICTURE OF CAP

A

State Space Equations



$$\begin{bmatrix} \frac{di_L}{dt} \\ \frac{dv_C}{dt} \\ v_o \end{bmatrix} = \begin{bmatrix} -\left(\frac{A}{L}\right) & -\frac{1}{L}\left(\frac{R}{R_c+R}\right) \\ \frac{1}{C}\left(\frac{R}{R_c+R}\right) & \frac{1}{C}\left(\frac{1}{R_c+R}\right) \\ \left(\frac{R_cR}{R_c+R}\right) & \left(\frac{R}{R_c+R}\right) \end{bmatrix} \times \begin{bmatrix} i_L \\ v_C \end{bmatrix} + S\begin{bmatrix} \frac{V_{in}}{L} \\ 0 \\ 0 \end{bmatrix} + (1-S)\begin{bmatrix} \frac{-V_F}{L} \\ 0 \\ 0 \end{bmatrix}$$

for A = (S · Rdson + RL + (RC R)/(RC + R))

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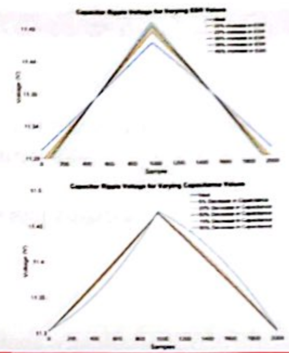
E

Capacitor Failure

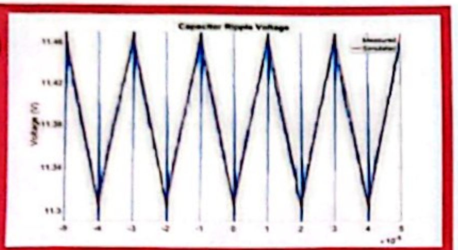
- Equivalent series resistance
  - Increases when capacitor degrades
- Capacitance
  - Decreases when capacitor degrades



E

Simulation Results

- Capacitor Ripple Voltage
- MATLAB
- 5 switching periods



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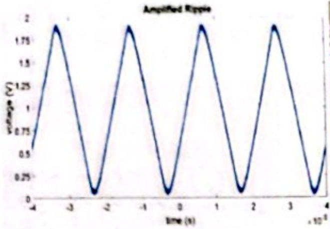
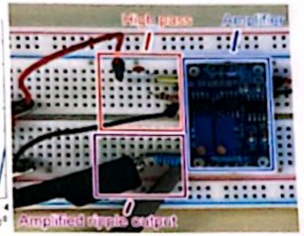
• REDUCE SWITCHING PERIODS

E

Step 2 - Data Collection





Semester Reflection

- Setbacks:
  - Overengineering
  - Inefficient communication with advisors
- Solution:
  - Approach problems systematically
  - Communicate with advisors in a more timely manner

J

Transition to J-Term and Spring

- *J-Term Goals:*
  - *Research ADC and Embedded System Solutions*
- *Spring Semester Goals:*
  - *Test ADC and Embedded System Solutions*
  - *Develop algorithm to predict/detect capacitor failure*

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WRITING!

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ADVISORS...

TITLE?

Purposes of Condition Monitoring

Motivation
- Mitigate Financial Loss
- Reduce Downtimes
- Human Safety

Notable Industries
- Transportation
- Industrial Automation
- Power Transmission
- Renewable energy

PICTURES

PICTURES

What is Virtual Twinning?

~~A virtual twin is an application that replicates the performance of a physical system through simulation.~~

PICTURES

JIMMY SAID

PROBLEM SPECIFIC?

OTHERS?

WHAT IS ESR

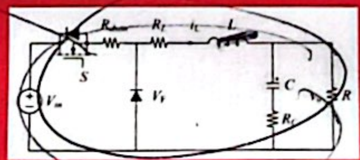
Step 1 - Circuit Simulation

Software
- Alt Approaches
  - Xyce
  - PySpice
- Successful Approaches
  - LtSpice
  - Matlab
  - Python

WHY?

Mathematical Techniques
- Alt Approaches
  - Euler's Method
- Successful Approaches
  - Runge Kutta
  - State Space Equations

State Space Equations



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$$for\ A = (S \cdot Rdson + RL + (RC\,R)/(RC + R))$$

CITATION

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Capacitor Failure

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- Capacitance
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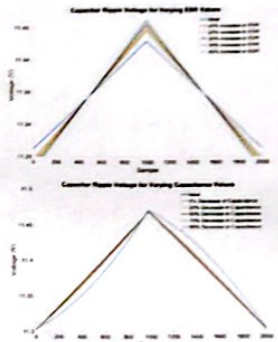
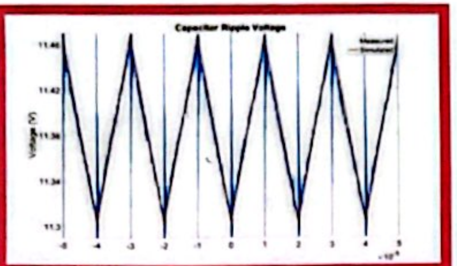


Simulation Results

- Capacitor Ripple Voltage
- MATLAB
- 5 switching periods



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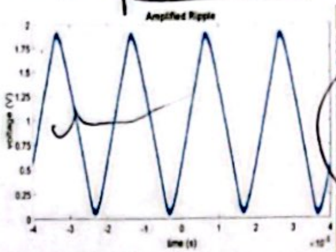
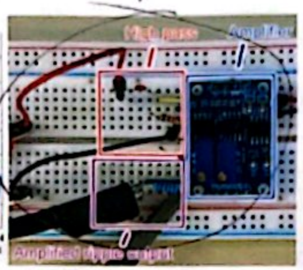
EXPERIMENTAL SETUP

Step 2 - Data Collection





ADC?

Semester Reflection

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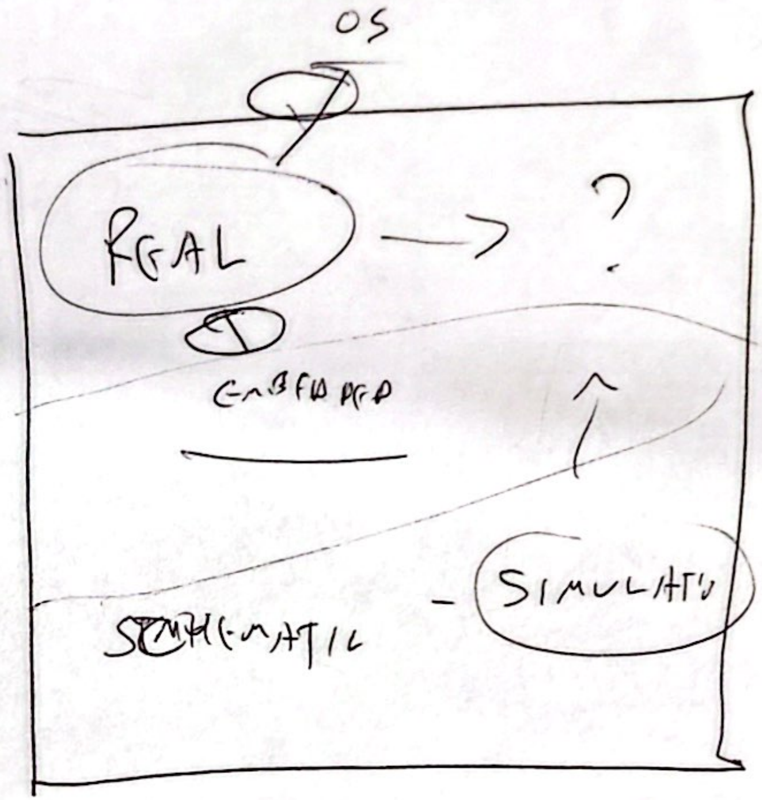

Transition to J-Term and Spring

GANTT CHARTS

- J-Term Goals:
  - Research ADC and Embedded System Solutions
- Spring Semester Goals:
  - Test ADC and Embedded System Solutions
  - Develop algorithm to predict/detect capacitor failure

THANKS

TIME: 7:30