I/O Aware Task Scheduling for Energy Harvesting Embedded Systems with PV and Capacitor Arrays

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Abstract

The energy harvesting embedded system is highly recently, and it also uses multi-core architectures which offer high performance, flexibility, low-cost and power efficient implementations. We challenge to developing a mechanism for maximizing quality of services provided by the embedded system with the limited and unstable energy sources.

We presents a generalized technique for the task scheduling of a multi-core processor considering the transferring efficiency in multiple loads. The target system contains a functionality for dynamic reconfiguration of a photovoltaic/supercapacitor array to change the input voltage of DC-DC converters and charger. The proposed technique minimizes the power loss in the DC-DC converters and charger. Experiments demonstrate that our approach reduces the energy consumption over the conventional approach.
Abstract

The energy harvesting embedded system is highly recently, and it also uses multi-core architectures which offer high performance, flexibility, low-cost and power efficient implementations. We challenge to developing a mechanism for maximizing quality of services provided by the embedded system with the limited and unstable energy sources. We presents a generalized technique for the task scheduling of a multi-core processor considering the transferring efficiency in multiple loads. The target system contains a functionality for dynamic reconfiguration of a photovoltaic/supercapacitor array to change the input voltage of DC-DC converters and charger. The proposed technique minimizes the power loss in the DC-DC converters and charger. Experiments demonstrate that our approach reduces the energy consumption over the conventional approach.

Introduction

I/O aware task scheduling

(a) Conventional

CPU1

CPU2

CPU3

CPU4

V_{variable} \approx \frac{(V_1 + V_2)}{2}

(b) Proposed

CPU1

CPU2

CPU3

CPU4

V_{variable} \approx V_1

I/O

Time

I/O

Time

Good harvest mode

Control the configuration

Control the charging current

PV VI curve

Efficiency of DC-DC converter

MPP (5.08V, 81.8mA)

Power loss (mW)

Efficiency (%)

Power loss at 10 mA output

Efficiency at 10 mA output

Power loss at 100 mA output

Efficiency at 100 mA output

Voltage difference (V_{in} - V_{out})

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Characteristics

PV VI curve

Efficiency of DC-DC converter

Typical embedded system

Energy source

DC-DC

Supply voltage A group

DC-DC

Supply voltage B group

DC-DC

Supply voltage C group

Approach

Three motivations

- Reduce voltage difference by the array reconfiguration
- Direct power supply from the supercapacitor
- I/O aware task scheduling

Design

Array reconfiguration for PV cells and supercapacitors

Experimental Results

<table>
<thead>
<tr>
<th>Condition</th>
<th>System</th>
<th>Proc.</th>
<th>Etc.</th>
<th>Loss</th>
<th>Total (mJ)</th>
<th>Saving</th>
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<tbody>
<tr>
<td>Case 1</td>
<td>Single-core</td>
<td>13.94</td>
<td>61.56</td>
<td>24.78</td>
<td>100.28</td>
<td>-</td>
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<td></td>
<td>Multi-core</td>
<td>7.91</td>
<td>61.56</td>
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<td>6.47%</td>
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<tr>
<td></td>
<td>Proposed</td>
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<td>61.56</td>
<td>18.48</td>
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<tr>
<td>Case 2</td>
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<td>61.56</td>
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<td>61.56</td>
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<tr>
<td></td>
<td>Proposed</td>
<td>7.91</td>
<td>61.56</td>
<td>14.00</td>
<td>83.47</td>
<td>17.68%</td>
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