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A PDM-based strategy for power packet dispatching on shared power line

Shiu Mochiyama†

†Graduate School of Engineering, Kyoto University
Kyoto Daigaku Katsura, Nishikyo, Kyoto 615-8510, Japan
Email: s-mochiyama@dove.kuee.kyoto-u.ac.jp

Abstract—In this study, we discuss a pulse density modulation (PDM) based strategy for power packet supply control under the restriction of power line capacity.

Summary

Power processing based on power packetization has been proposed and studied intensively for seamless coordination of information and communications technologies with electric power distribution [1]. Here we discuss a pulse density modulation (PDM) based strategy to constitute the packetized power supply sequence that achieves an optimized drive of a load under the limitation of the power line capacity.

In the power packet dispatching system, the power supply is encoded as a sequence of unit power pulses of time interval T_p and voltage V [2]. Power packets between various supply pairs, from a source to a load, are multiplexed in the time domain to share a power line. Thus, the line capacity corresponds to the sum of the time occupancy of all the pairs in a certain time interval. In this study, we discuss the design strategy of the packet supply controller to ensure that the time occupancy of a supply pair does not exceed a predetermined threshold.

To this end, we set two controllers of different time rates for the packet supply control. In a time period $T_\mathrm{q} = nT_\mathrm{p}$ ($n \in \mathbf{N}_{>0}$), the first controller, an optimal dynamic quantizer [3], generates a discrete-valued reference of the control input $v \in \{mV/n | m \in \mathbf{N}_{>0}\}$. Then, the second controller constitutes the PDM input by letting be on-state the m (out of n) power packets of time interval T_p and off-state the others. To ensure the line capacity limitation, the quantizer is designed so that it generates the optimal discrete-valued reference under the limitation of its output $m \leq N$, where N ($< n$) represents the maximum number of time slot allowed to be occupied. The design is achieved by considering the constraints of the quantizer's output gains concerning both its input and quantization error [3].

Now let us discuss the proposed system with a numerical example. The plant is assumed to be a 1 DOF robot arm driven by a dc brushed motor. The parameters related to the time occupancy are set as $n = 10$, $N = 7$, and $T_\mathrm{p} = 0.5$ ms. Figure 1 shows the angle trajectory with its target. The angle followed the target successfully with errors less than 0.1 degrees. Figure 2 shows the output of the quantizer and the input packet sequence. The solid and dotted gray lines represent the time intervals of the quantizer and the packet, respectively. The figure shows that the quantizer's output was converted to the number of packets m out of $n = 10$.

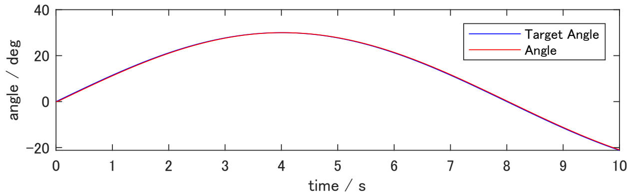

Figure 1: Angle trajectory.

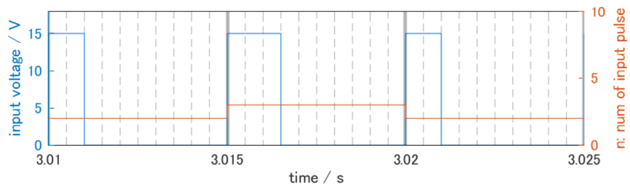

Figure 2: Input sequence.

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References

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ORCID iDs Shiu Mochiyama: 0000-0001-7126-9187

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