Evaluating a heart rate regulation system for human–electric hybrid vehicles

Heart rate regulation systems for human–electric hybrid vehicles (such as electric bicycles) might help to promote physical activity and prevent overexertion. To date, there has not been a thorough evaluation that shows the benefits and limitations of such a system compared to a conventional assistance. In this article, the authors evaluated a control system that adjusts the motor torque of a four-wheeled human–electric hybrid vehicle prototype (QuadRad) to maintain the heart rate of the cyclist within user-specified limits. A randomized block design was used to validate the system. A total of 42 persons performed a 70-min test cycle with the QuadRad on a stationary test rig. Participants were equally divided into 14 blocks based on an estimate of their fitness level. Within each block, participants were randomly assigned to one of three experimental groups. The three groups compared the following: (1) regulation of subjectively perceived exertion using standard assistance, (2) regulation of heart rate using standard assistance and (3) regulation of heart rate using control system. A non-parametric Kruskal–Wallis test showed...
significant differences between the three groups for mean absolute deviation of the heart rate from the reference heart rate (MADref) (?2(2)=19.91, p<.001). Post hoc comparison showed that MADref was significantly lower for groups 2 (p=.001, r=.71) and 3 (p=.001, r=.75) compared to group 1 and similar between groups 2 and 3 (p=1.0, r=.04). Time out of the heart rate zone (tzone) was significantly different between all groups (?2(2)=19.19, p<.001). Post hoc analysis showed that tzone was lower for groups 2 (p=.001, r=.73) and 3 (p=.001, r=.70) compared to group 1 and similar between groups 2 and 3 (p=1.0, r=.04). The results indicated that cyclists can use the system to maintain their heart rate within self-chosen limits without having to monitor their heart rate or manually change the assistance mode. Heart rate regulation systems for human-electric hybrid vehicles (such as electric bicycles) might help to promote physical activity and prevent overexertion. To date, there has not been a thorough evaluation that shows the benefits and limitations of such a system compared to a conventional assistance. In this article, the authors evaluated a control system that adjusts the motor torque of a four-wheeled human-electric hybrid vehicle prototype (QuadRad) to maintain the heart rate of the cyclist within user-specified limits. A randomized block design was used to validate the system. A total of 42 persons performed a 70-min test cycle with the QuadRad on a stationary test rig. Participants were equally divided into 14 blocks based on an estimate of their fitness level. Within each block, participants were randomly assigned to one of three experimental groups. The three groups compared the following: (1) regulation of subjectively perceived exertion using standard assistance, (2) regulation of heart rate using standard assistance and (3) regulation of heart rate using control system. A non-parametric Kruskal-Wallis test showed significant differences between the three groups for mean absolute deviation of the heart rate from the reference heart rate (MADref) (?2(2)=19.91, p<.001). Post hoc comparison showed that MADref was significantly lower for groups 2 (p=.001, r=.71) and 3 (p=.001, r=.75) compared to group 1 and similar between groups 2 and 3 (p=1.0, r=.04). Time out of the heart rate zone (tzone) was significantly different between all groups (?2(2)=19.19, p<.001). Post hoc analysis showed that tzone was lower for groups 2 (p=.001, r=.73) and 3 (p=.001, r=.70) compared to group 1 and similar between groups 2 and 3 (p=1.0, r=.04). The results indicated that cyclists can use the system to maintain their heart rate within self-chosen limits without having to monitor their heart rate or manually change the assistance mode.

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