Micro-Mobility Safety

[Advanced Cyclist-Assistance Schemes]

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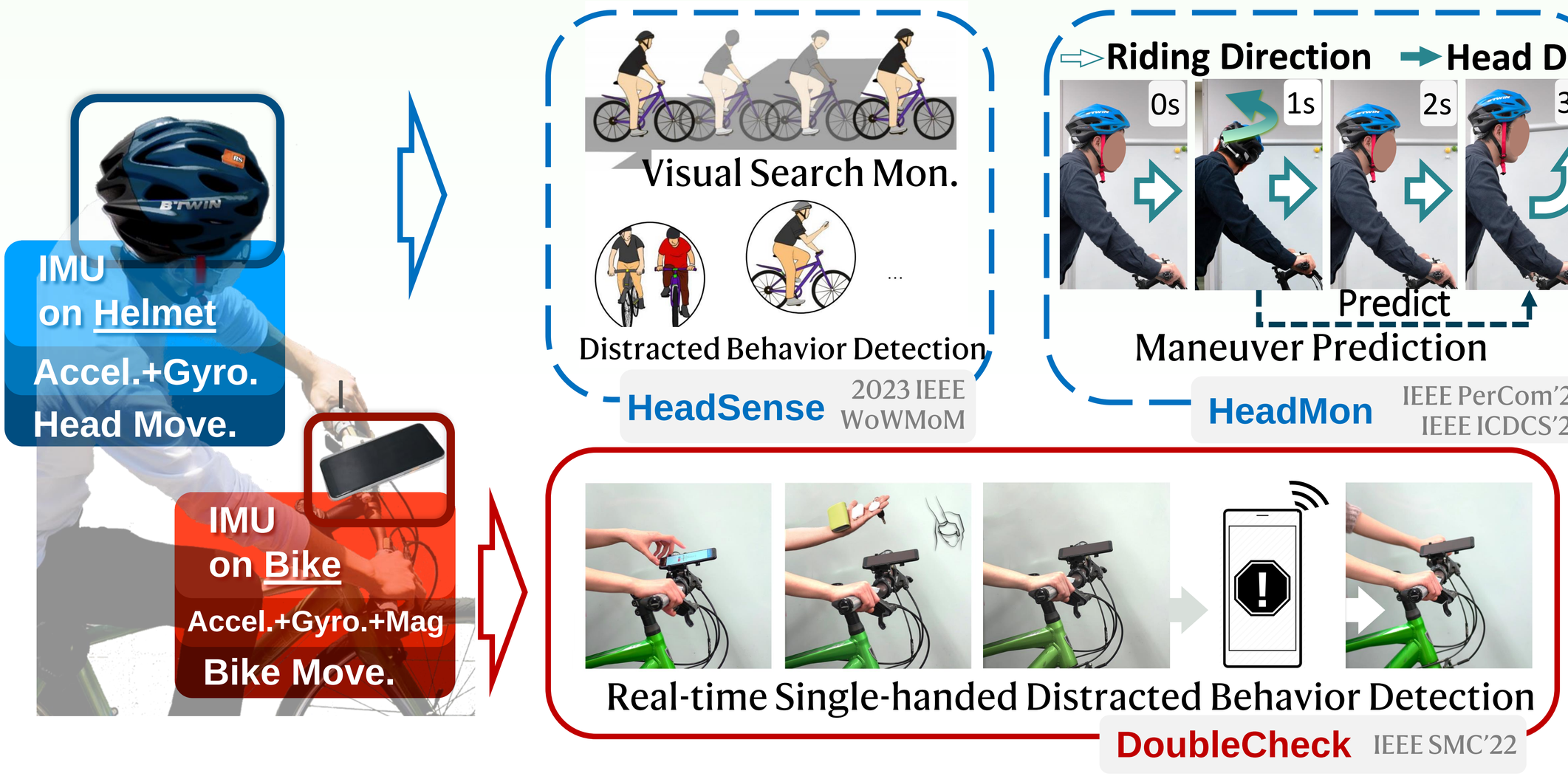
Cycling must be safe, and perceived as such, if micro-mobility trips by all populations are to increase, and the benefits in traffic decongestion and carbon emission cut are to be realized. WHO estimates that 40,000 cyclists died in road accident in 2016. There is an urgent need to address this problem by low-cost and robust safeguard systems.

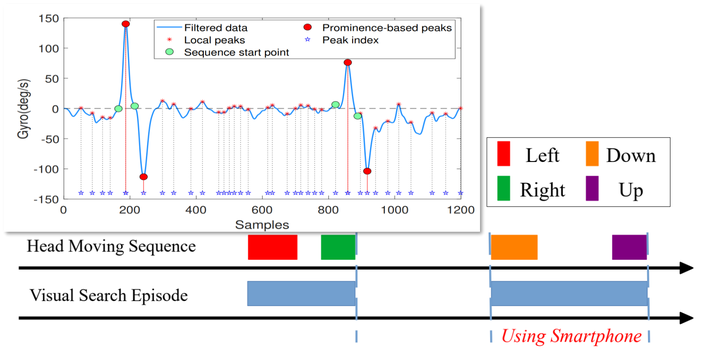


HEADSENSE

We present HeadSense, a helmet-based system that leverages the inertial motion unit (IMU) to recognize 4 distracted behaviors: checking handlebar-mounted devices, using smartphones, attracting to the roadside element, and abreast riding.

The feasibility lies as followed:

- The head dynamic is a strong **indicator** of the rider's **eyesight** / attention. And the **helmet**, as an essential bicycle accessory, follows the same movement pattern as rider's head.
- the rider's head shows unique motion patterns during distracted riding behaviors. These patterns consist of a series of abnormal head movements.

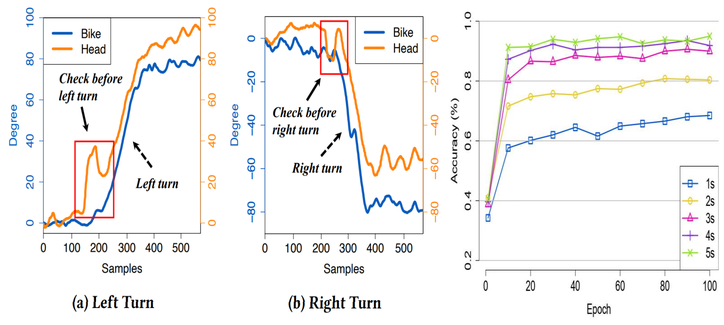


Evaluation results show HeadSense can segment visual search into episodes with an accuracy of up to 86.14%. Additionally, from sequences of episodes, it can effectively detect distracted riding behaviors at an average precision of 85.04%.

HEADMON

Detection of ongoing maneuver may be less effective in accident prevention. In this work, we take a step further to explore the feasibility of using riders' head dynamics to predict their riding maneuvers with two key observations:

- Rider needs to observe the traffic situation in advance based on their riding maneuver intentions.
- For different maneuver intentions, the rider's head dynamics (such as turning left and right) are also different.



We constructed an Attention-based network to solve the prediction problem. The precision of riding maneuver prediction is **at least 0.80** under **4 seconds time gap**. We also finds that the accuracy would be improved with longer detection window size.

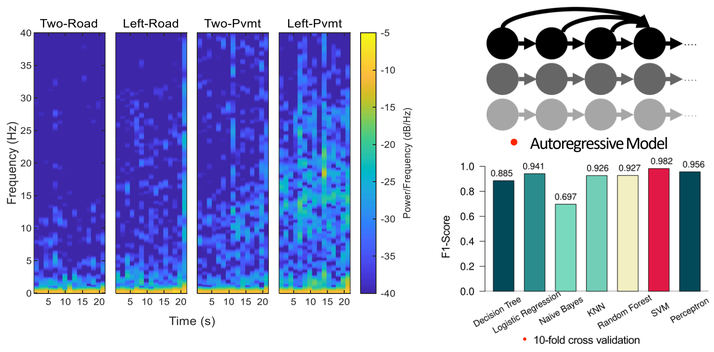
The results indicate a novel start on improving micro-mobility safety.

DOUBLECHECK

DoubleCheck is a method that utilizes a handlebar-mounted smartphone to detect single-handed cycling and followed distracting secondary tasks. The work was established on the premise that single-handed cycling undermines the stability of handlebar during cycling. Preliminary data shows that For both acceleration and angular speed:

- The signal has denser power over the frequency band during single-handed cycling.
- The signals contain periodic components

Accordingly, we adopt Autoregressive Model, featuring robust performance in extracting features of periodic time-series signal.



Experiment with 22 participants on asphalt and pavement demonstrated that DoubleCheck achieves an F1-score of **0.96 for hand detection** and **0.69 for distraction recognition**