# Rapid Operator Awareness via Mobile Robotics (ROAMR), *Customizable Human Safety using Mobile and Wearable Co-Robots* (NRI 1830498)
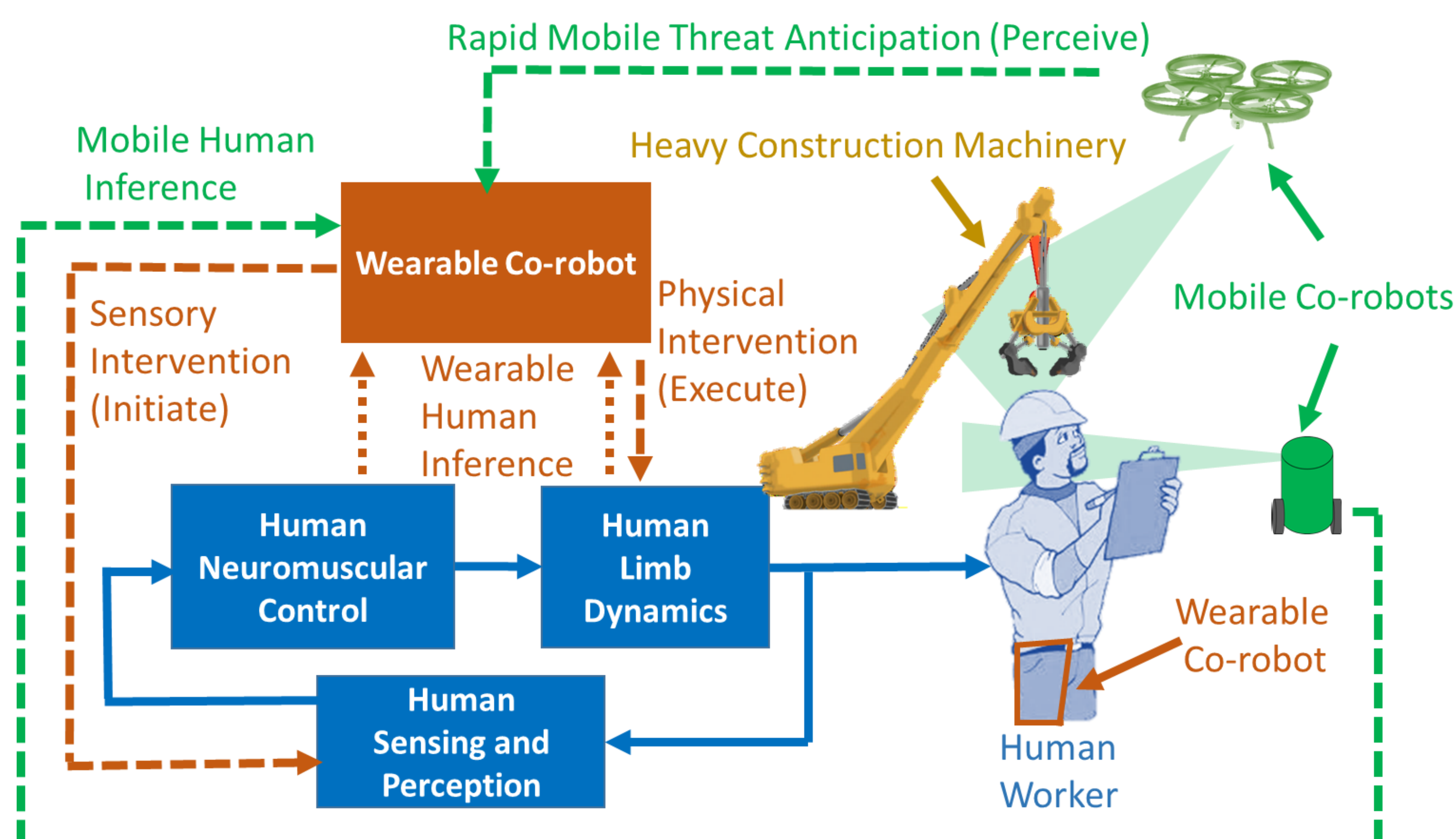
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## Overall Project Vision



- Unstructured environments such as construction sites, disaster areas, and conflict zones rely on human intuition, dexterity, and versatility.
- These environments require teams of humans and machines to work together safely but lack the controlled safety of manufacturing plants or other indoor settings.
- Mobile and wearable co-robots can provide *customizable* human-centric safety by enhancing the situational awareness and physical response of the human operator.

## Predict Human Avoidance Response (Infer)

- A human-centric approach relies on assisting human motions.
- Our team has already demonstrated how machine learning can be used to infer desired human speed.
- We seek to infer transient avoidance behaviors in order to provide suitable physical assistance.
- Primary desired output: direction of motion.
- Secondary desired output: type of motion (jump, lunge, sidestep).
- Machine learning will be used to gauge human intention based on human kinematics, kinetics, muscle recruitment, and knowledge of the environment.
- Intention recognition algorithms will be implemented on wearable sensors for human-centric performance outside of controlled settings.
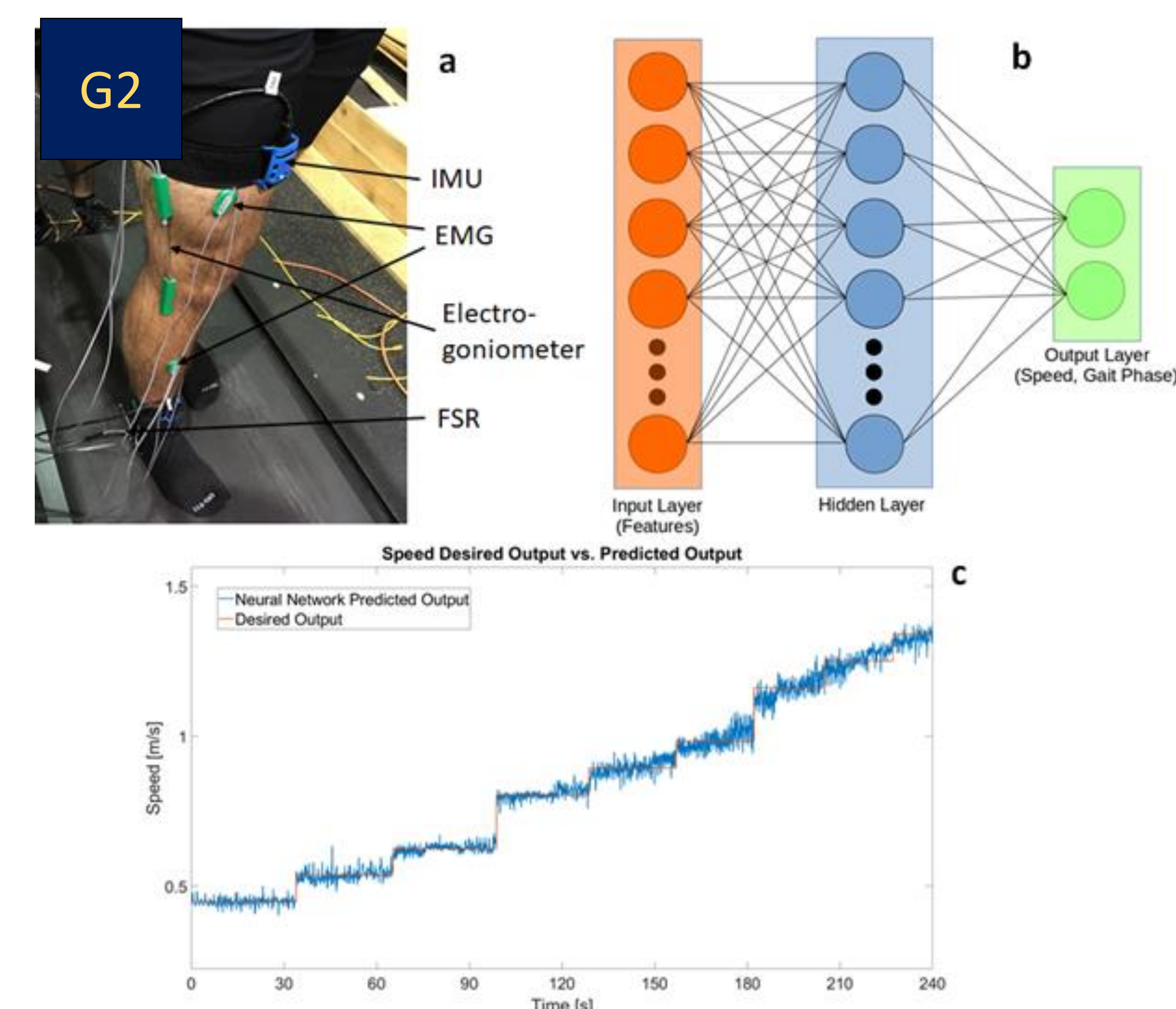


## Communicate Threats and Safe Paths to the Human Operator (Initiate)
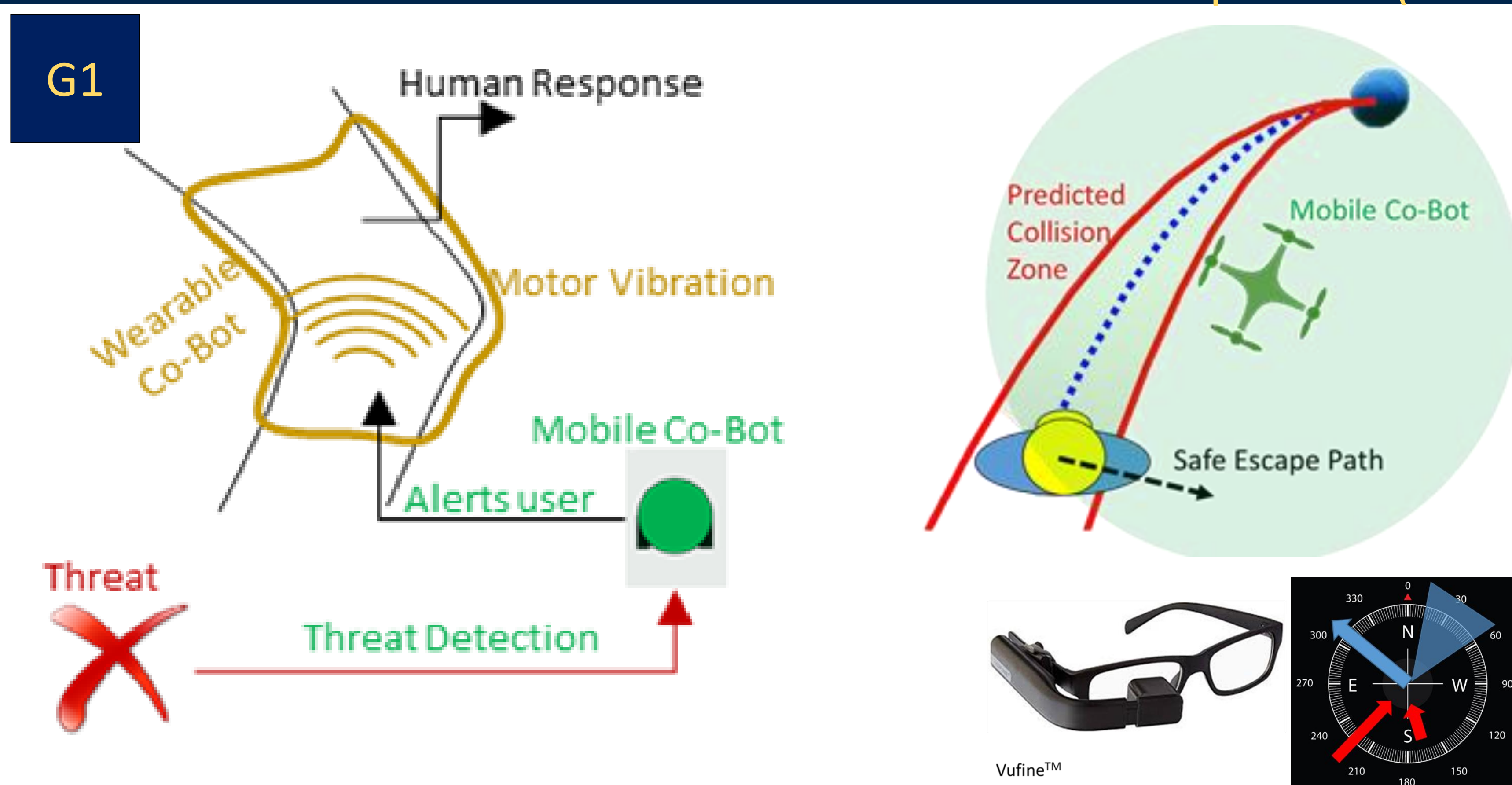


- Human-worn devices including the wearable co-robot have the potential to enhance communication to the human operator.
- Potential threats as well as a safe "escape path" will be communicated to the human operator.
- A range of multi-sensory communication methods will be explored. Physical communication that helps induce a avoidance response will be of particular interest.
- We will explore how natural human intuition interacts with an automated motion plan.
- A human team-mate or "back seater" can also be used to explore optimal human-human teaming strategies.
- Human-human teaming will also be part of our "smart dodgeball" outreach activity that seeks to introduce young students to human performance augmentation via scientific principles.

## Physically Assist Human Response (Execute)

- We seek to physically accelerate the human response using a human-worn co-robot.
- Physically assisting rapid human behaviors remains relatively unexplored.
- Obstacle avoidance experiments will be performed with flying objects and/or padded ground robots. Physical obstacles enable humans to utilize their range of senses and physical intuition.
- Metrics of performance include time to reach safe zone, ability to avoid moving obstacles.
- Results can help inform a different class of assistive robots intended for enhancing transient behaviors rather than steady-state ones.
- A range of physical assistance strategies will be explored using a novel hip exoskeleton device.
- EMG based control can enhance customizability.