DoorBully: A Mechatronic Locking System Enhanced by IoT Connectivity and Machine Learning for Rapid School Safety Lockdown Response

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Over the past two decades, educational institutions have witnessed an exponential increase in school shootings and gun-related threats, marking a prominent need for enhanced security solutions that are compliant with all Fire and Safety regulatory codes. The DoorBully system, a retrofittable security mechanism designed for educational environments, introduces a singular action or central command point door locking system. Its architecture integrates an electronic control system with a Peer to Peer (P2P) network, utilizing secure SSH connections and an isolated UPS for reliability during fluctuating power availability. The system features acoustic triangulation through machine learning algorithms, powered by Random Forest Regressor, for Sound Source Localization (SSL), enabling precise identification of gunshot origins within the facility. This capability is critical for quickly informing authorities about potential threats, thus optimizing emergency responses. Utilizing MQTT protocol for mesh network coverage, DoorBully ensures robust device communication, balancing data load efficiently across the network for real-time, web-hosted monitoring and control available to first responder via pre-provide APIs. This provides immediate updates on door statuses and environmental conditions, enhancing situational awareness during crises.The DoorBully system underwent rigorous testing across many educational institutions, subjected to various scenarios and levels of operational autonomy to assess responsiveness. Through iterative development, incorporating extensive data collection and feedback, we refined the system to ensure its advancement in both technological sophistication and reliability, resulting in a security solution adept at addressing modern safety challenges.