

Design and Implementation of a Multi-Modal 3-in-1 Smart Robotic Vehicle Using Smartphone Integration

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Abstract: Modern developments in robotics and wireless communication have transformed the design of unmanned ground vehicles (UGVs). This paper presents a versatile, low-cost **3-in-1 Robot Car** capable of switching between three distinct control modes: Bluetooth Terminal Control, Smartphone Gesture Control, and Google-powered Voice Control. The system uses an **Arduino Uno** board as its main microprocessing unit, paired with an **HC-05 Bluetooth module** to receive serial wireless commands. A dual-bridge **L298N motor driver** manages power distribution to four independent DC gear motors. Physical gestures and voice inputs are captured by a smartphone app and converted into standardized ASCII characters before transmission. Experimental testing demonstrates low command latency, precise directional tracking, and stable multi-modal switching, making this architecture highly applicable for hazardous material handling, search-and-rescue operations, and domestic automation

Keywords: RF, **Arduino Uno**, Wireless Telemetry Link, Hidden Markov Models