**UNIVERSITY STUDENT CATEGORY**

**REGISTRATION FORM ROUND 1**

**BACH KHOA INNOVATION 2025**

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**PROJECT’S INFORMATION**

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| 1. **PROJECT’S NAME:** AutoMate |
| *Research field (Maximum 3 options):*   * *Electricity and Electronics;*   AutoMate utilizes embedded systems such as STM32 microcontroller, along with components like microphones, and LED modules - requiring deep knowledge in electronic circuit design, power management, and real-time signal processing.   * *Transport Engineering;*   AutoMate is designed to interface directly with various vehicle systems via UART/I2C/CAN protocols, making it a practical application of transport system integration and in-vehicle network communication. |
| 1. **SUMMARIZING YOUR IDEA/PROJECT (Maximum of 500 words)** |
| Interacting with vehicle functionalities while driving often necessitates attentional shifts away from the primary task of driving, presenting potential safety hazards. Furthermore, prevailing voice assistant solutions frequently rely on consistent internet connectivity, which can limit their performance and reliability, particularly in areas with poor network coverage. Therefore, we develop AutoMate, a voice-controlled virtual assistant system designed for in-car integration, to directly address these challenges. It aims to **enhance the user experience and improve driving safety** by providing an intuitive and dependable method for hands-free vehicle interaction.  Functioning as an intelligent chatbot, AutoMate is capable of understanding and executing a range of simple driver commands. These include controlling vehicle lights, adjusting air conditioning settings, providing warnings for low fuel levels, monitoring tire pressure, and issuing reminders for routine maintenance tasks such as oil changes or scheduled vehicle inspections.  A core advantage of the AutoMate system is its **operation via offline speech recognition technology.** This ensures consistent and reliable performance without dependence on internet connection, a critical feature for operation in remote locations or during network outages. The chatbot interfaces directly with embedded microcontrollers (Raspberry Pi, STM32,…) utilizing standard communication protocols such as UART, I2C, or CAN, thereby enabling real-time control over the vehicle's hardware components.  Beyond its technical capabilities, AutoMate is also conceived as a **visually appealing miniature robot model** situated on the vehicle's dashboard, dually serving as a distinctive decorative element. Its modern and friendly design introduces a degree of personalization and a futuristic aesthetic to the vehicle's interior.  By combining advanced functionality with considered aesthetics and practical utility, AutoMate presents itself as an intelligent and stylish solution poised for the next generation of automotive experiences. Its scalable architecture ensures readiness for future enhancements, including navigation assistance, deeper smartphone integration, and the incorporation of AI-powered behavioral learning algorithms. |
| 1. **DETAILS OF YOUR IDEA/PROJECT (Minimum of 300 words)**   *Describe in detail your idea/project.*  *The solution/idea (product/service) is clear and appropriate to the problem.*  *The idea (product/service) is innovative and unique, addressing problems and challenges with creative solutions.*  *It demonstrates clear improvements in business processes by introducing new techniques or methods to enhance efficiency or quality.* |
| **a. Introduction and Problem Statement**  The rapid evolution of automotive technology has introduced increasingly complex human-vehicle interactions, often becoming a significant contributor to driver distraction and traffic safety risks. Infotainment systems, for example, are a leading source of user complaints, with J.D. Power reports indicating that 90% of these issues stem from non-intuitive design. This complexity necessitates manual interactions, such as using touchscreens, which scientific studies have shown can induce higher cognitive load and distraction than physical buttons.[[1]](#footnote-1)  Critically, driver distraction has severe consequences. Research from the AAA Foundation for Traffic Safety highlights that drivers can be distracted for over 40 seconds by in-car tasks, while just 2 seconds of eyes off the road doubles crash risk.[[2]](#footnote-2) This contributes to the alarming accident rates in Vietnam, where nearly 10,000 fatalities were recorded in 2024 (according to Vietnamnet).[[3]](#footnote-3) Recognizing this danger, Vietnamese law, specifically Decree No. 168/2024/ND-CP (Article 6, Clause 5, Point h), now stipulates significant penalties. For instance, car drivers using a mobile phone handset or other electronic devices while the vehicle is in motion face substantial fines ranging from VND 4,000,000 to VND 6,000,000, in addition to potential demerit points on their driving license.[[4]](#footnote-4)  Furthermore, many existing virtual assistant systems rely on continuous internet connectivity, limiting their reliability in areas with poor network coverage - a known issue in various regions of Vietnam. This can force drivers back to manual, distracting interactions.  AutoMate directly addresses these critical challenges by offering an intelligent, reliable, and inherently safer virtual assistant solution, designed for consistent offline operation and intuitive control.  **b. The AutoMate Solution:**  AutoMate is a voice-controlled virtual assistant system, specifically engineered for automotive integration, with two primary objectives: Enhancing user comfort and convenience and Maximizing driver safety. The core principle of the AutoMate solution lies in its full offline operational capability. This ensures the system is always ready to respond to user commands promptly and accurately, irrespective of internet connectivity status.  The system is developed through a flexible, two-phased approach. Phase 1 focuses on controlling basic, non-CAN bus integrated devices, thereby proving the core concept's feasibility and effectiveness.  **c. Detailed Technical Architecture (Phase 1)**   * **Central Processing Unit (Raspberry Pi 5):** Powered by the vehicle's 12V supply via a stable 5V DC-DC converter, the Raspberry Pi 5 serves as the system's brain. It handles offline voice recognition using the Vosk library - a lightweight, efficient, and offline-capable solution that supports vocabulary customization. Initially, the system supports English, utilizing keywords to understand flexible command variations. Processed commands are then transmitted via I2C to the control units. I2C is chosen for its minimal pin requirement and future multi-device scalability. * **Microcontroller System (STM32 x 2):**   + **STM32\_1 (Main Controller):** Acts as an I2C slave, receiving commands from the Raspberry Pi 5. It processes these commands and then acts as an I2C master, relaying appropriate signals to the second STM32 via a separate I2C bus.   + **STM32\_2 (Execution Controller):** Functions as an I2C slave, receiving commands from STM32\_1. Its primary role is to generate direct electrical signals (digital logic levels) to control the target devices. * **Non-CAN Device Control:** Phase 1 targets devices like interior lighting and basic air conditioning functions, particularly on vehicle models (e.g., Mitsubishi Xpander) where these systems are accessible via simpler electrical signals rather than the CAN bus. STM32\_2 interfaces with Relays or Power Driver circuits (e.g., MOSFETs) to switch or modulate these devices, ensuring appropriate current and voltage handling.   **d. Physical Design: Innovation and Uniqueness**  One of AutoMate's most innovative aspects is its physical design, transforming it from a mere software system into a tangible in-car presence:   * **Structure:** AutoMate has a special look. It features a custom-designed base unit that sits on your car's dashboard. This themed base neatly holds all the main electronics (like the Raspberry Pi and STM32 circuits. A cube-shaped Robot Figure (4-5cm), with a display face) is placed on this roadway, acting as the tangible interactive key. * **Activation Mechanism:** The robot figure serves as a physical key. The entire system activates only when the figure is placed onto the base unit. This connection is secured by magnets, which can also cleverly integrate with a magnetic switch (like a reed switch or Hall sensor) to complete the power circuit. * **Significance:** This design offers more than just aesthetics; it provides a unique interaction, a form of security/control, and enhances vehicle personalization.   **e. Improvements and Efficiency**  AutoMate introduces clear improvements to the driving process:   * **Enhanced Safety:** Significantly reduces the need for drivers to look away or take their hands off the wheel. * **Increased Efficiency & Convenience:** Allows for quick, intuitive control of vehicle functions using only voice commands. * **Innovation & Uniqueness:** The blend of offline voice recognition, the physical key concept, and direct hardware control creates a distinct and compelling solution.   **f. Development Roadmap**  Phase 2 of the project will focus on deeper and more sophisticated integration with the vehicle's CAN (Controller Area Network) bus. This phase will leverage the planned dual-microcontroller architecture:   * The primary STM32 microcontroller (STM32\_1), already interfacing with the Raspberry Pi, will be enhanced with a CAN transceiver. This will allow it to directly read critical vehicle data (fuel levels, door status) from the CAN bus and send commands to CAN-enabled vehicle systems. * A secondary STM32 microcontroller (STM32\_2), also equipped with its own CAN transceiver and connected to the vehicle's CAN bus, will be implemented. STM32\_1 will communicate targeted commands or data to STM32\_2 via custom CAN messages. STM32\_2 will then execute these commands, managing distributed control tasks for specific peripherals or additional non-CAN devices, allowing for a more modular and scalable system.   This advanced integration strategy will enable AutoMate to access and control a much broader and more diverse range of vehicle systems and sensors (such as central locking, windshield wipers, advanced climate control functions, or even reading specific diagnostic trouble codes). This paves the way for a truly comprehensive, intelligent, and context-aware in-car virtual assistant experience, offering more sophisticated automation and richer information to the driver. |
| 1. **BUSINESS MODEL**   *The value proposition is presented and explained.*  *The revenue model is well-defined, highly potential, and testable.*  *(The project can be presented using a table format based on the criteria of the Lean Canvas model.)* |
| AutoMate introduces an innovative yet practical business model, focusing on bridging the technological gap for non-smart vehicles through a cost-effective, modular, and personalized dashboard assistant. The product does not simply provide functionality; it enhances driver safety, satisfaction, and style - particularly for users of older cars or budget vehicles.  **Value Proposition:**   * **Superior Safety:** Minimize distractions, ensures hard-on-wheel, eyes-on-road operation. * **Offline Reliability:** Offline voice assistant that works anywhere - no internet required. In short functions seamlessly without Internet anytine, anywhere. * **Personalization & Mordern Appeal:** Customizable robot design (colors, voice, packs) that adds visual flair to the vehicle interior. * **Simple & Intuitive Interaction:** Physical robot key offers a tabgible and engaging user interface. * **Affordable for Retrofit Market:** Attainablity and modularity, allowing upgrades or repairs without replacing the whole system. Futhermore, brings smart tech to older cars at a reasonable price.   **Revenue Streams:**   * **Direct product sales**: AutoMate units sold via online platforms and physical accessory stores. * **Premium customization**: Personalized colors, voice packs, or accessory upgrades. * **Service bundles**: Installations offered through partner garages or car service providers. * **Future scalability**: Mutilple robot variants with miscellaneuos appearances, optional software/firmware upgrades, expansion to mobile app or cloud syncing.   **Core Revenue:**   * Direct sales of the full AutoMate kit: includes Raspberry Pi, STM32, control circuits, and robot interface. * Suggested retail price: 2,999,000 VDN per unit.   **Key Distribution Channels:**   * E-commerce platforms (Shopee, Tiki, Lazada). * Auto accessory shops and car maintenance services. * Pop-up booths at motor shows or universities. * Social media marketing targeting young tech users and ride-hailing communities.   **Cost Structure:**   * Hardware (PCB, sensors, microcontrollers, casings). * R&D (software development, voice dataset training). * Manufacturing and packaging. * Marketing, partnership development, customer service.   **Competitive Advantage:**   * No existing mass-market assistant offers offline voice control with physical personality. * Targeting the underserved low- to mid-range vehicle segment. * Strong potential for emotional connection and brand loyalty due to robot “companion” appeal.   **Revenue Projection:**   * 3-year target: Capture 2% of Serviceable Obtainable Market (SOM) = 12,000 units. * Potential revenue 12, 000 x 2,999,000 ≈ 36 billion VND ( ~ 1.41 milion USD).   **Business Model Canvas (BMC):** |
| 1. **MARKET FEASIBILITY**   *Defining the target market for the product/service using relevant data and research* |
| **a. Clear Market Needs**  AutoMate directly addresses three urgent and interrelated needs of modern drivers:   * **Maximum driving safety**: Hands-free interaction reduces distractions and ensures full focus. This need is critical, as studies from the AAA Foundation for Traffic Safety indicate that looking away from the road for just 2 seconds doubles crash risk, and interactions with complex systems can divert attention for over 40 seconds. Furthermore, Vietnam recorded nearly 10,000 traffic fatalities in 2024 (according to Vietnamnet). * **Reliable functionality in all environments**: The solution must operate completely offline. This is not only ideal for areas with inherently weak or no mobile coverage but also addresses the broader vulnerability of internet-dependent systems. For instance, significant disruptions to Vietnam's undersea internet cables, such as the incident in mid-2024 where three out of five lines were down, severely impacted nationwide connectivity and highlighted the risks of relying on online services for critical in-vehicle functions.[[5]](#footnote-5) * **Simple and stress-free interaction**: Avoids the complexity of infotainment systems with intuitive voice commands and a tangible robot interface. This addresses a major user pain point, as J.D. Power reports highlight infotainment complexity as a top complaint, with 90% of issues stemming from non-intuitive design.   **b. Market Size Estimation**   |  |  |  | | --- | --- | --- | | **Concept** | **Estimate** | **Explanation** | | **TAM** - Total Addressable Market | ~5 million cars | Cars under 9 seats circulating (~3.45 million[[6]](#footnote-6)) and expected to be sold in Vietnam (~500.000-600.000/year) within 3-5 years.[[7]](#footnote-7) | | **SAM** - Serviceable Addressable Market | ~2 million cars | Vehicles without built-in virtual assistants or owners seeking upgrades | | **SOM** - Serviceable Obtainable Market | 12,000 units | 2% of SAM as a realistic entry goal for the first 3 years |   **c. Target Customers**  AutoMate targets the following key customer segments:   * Young to middle-aged tech-savvy individuals in urban and suburban areas. * Ride-hailing or service vehicle drivers needing safe, hands-free operations. * Intercity travelers seeking reliable offline functions. * Owners of standard or older vehicles looking to modernize affordably.   **d. Competition & Unique Advantages**  **Current Competitors:**   * Integrated assistants (CarPlay, Android Auto): Require constant Internet. * Premium OEM solutions (Cerence, Sensory): Expensive, inaccessible to general users. * In-car robots (e.g., Nomi/Nio): Emotion-focused, not hardware-integrated.   **AutoMate’s Unique Advantages:**   * 100% offline operation for core car control. * Physical “robot key” interface - unique brand identity. * Focus on real safety and usability, not flashy features. * Deep hardware integration (STM32) - surpasses Bluetooth or app-only methods. * Affordable (~3M VND) - accessible for the retrofit market.   **e. Supportive Trends**   * Rising awareness of traffic safety and intelligent driving aids. * Growing trend of in-car personalization among younger drivers. * Expansion of Edge AI and DIY tech communities backing offline innovation. * Strong retrofit demand: upgrading older cars with affordable smart tech. |
| **Note: (\*) Criteria are encouraged, but not mandatory.** |
| 1. **INTERNAL ANALYSIS OF THE PROJECT (\*)**   *The project can be presented using the SWOT model* |
| **STRENGTHS:**   * Offline voice recognition: stable even in poor network zones. * Friendly, customizable physical form (robot look) with emotional appeal. * CAN/I2C/UART-based: compatible with both new and old vehicles. * Modular hardware for easy repair and part replacement. * Compact and aesthetic design improves interior experience.   **WEAKNESSES:**   * Production cost per unit remains relatively high for small batches. * Limited vocabulary set in early-stage voice command system. * Dependency on CAN protocols may require wiring expertise during installation. * Requires continuous UX refinement to avoid user fatigue.   **OPPORTUNITIES:**   * Ride-hailing and car rental sectors rapidly growing. * Policies supporting startup innovation and local tech manufacturing. * Emerging awareness about traffic safety and smart mobility. * Partnerships with universities, vocational schools for training tools.   **THREATS:**   * Market preference for smartphone-based assistants (Google, Siri). * Supply chain issues for chips and microcontrollers. * User skepticism toward aftermarket electronics due to fear of damaging vehicles. * Copycat products entering the market post-prototype success. |
| 1. **DEVELOPMENT STRATEGY (\*)** |
| **Short Term (1-3 months): Building a fully functional prototype**   * Finalize the prototype with full integration of offline voice control to perform key operations on a test vehicle (Mitsubishi), including:   + Turning on/off interior lights, air conditioner.   + Reading and reacting to signals on CANH and CANL vehicle lines.   + Alerting empty fuel and reminding for routine maintenance tasks such as oil changes. * Ensure synchronization between microcontrollers (STM32) and CAN bus signals of the vehicle. * Run intensive lab tests to validate offline voice commands, electrical stability, and safety compliance.   **Mid Term (3-6 months): Pilot Testing and Compatibility Expansion**   * Conduct compatibility testing on various car models from different brands and years of production. * Deploy early-stage pilots with selected users (e.g., ride-hailing drivers, car service providers). * Collect feedback on usability, design, and effectiveness; refine voice command database and improve firmware responsiveness. * Begin outreach to automotive accessory retailers for future distribution opportunities.   **Long Term (6-12+ months): Feature Expansion and Market Readiness**   * Introduce optional advanced features such as:   + AI-based behavior learning (adapting to user habits).   + Basic Bluetooth smartphone pairing.   + Mutiple designs for many concepts. * Prepare for limited-scale production with optimized manufacturing cost. * Develop brand identity and explore crowdfunding, partnership, or incubation opportunities if feasible. |
| 1. **HUMAN RESOURCES (\*)**   *Who is involved in the project, and what are the roles and responsibilities of each team member?* |
| The AutoMate project is the result of a dedicated five-member team, each specializing in a key technical or strategic aspect of development:   * One member is in charge of embedded programming, handling the integration between the microcontroller (STM32) and vehicle signals via CAN, UART, and I2C protocols. * The second team member takes the lead on **product prototyping and industrial design**, specifically the external design of the AutoMate robot (shape, size, materials, and visual personality). This member also handles **core electronic circuit design,** power management, and electrical safety features. * A third member takes the lead on voice control logic, modifying offline voice datasets and configuring the recognition structure to match Vietnamese commands. * The fourth member **supports the prototyping process and the refinement of the robot's external design**. This member's primary role is expanded to focus on conducting **initial market research, product-focused competitive analysis, and assisting with the commercialization aspects** of the AutoMate project. * Finally, one member (team spokesperson) takes on the support role of product introduction and communication. This includes observing the entire project workflow, writing the product report, preparing presentation materials, and representing the team during pitches and competitions.   We are especially grateful to our mentor, Mr. Pham Tran Dang Quang, Lecturer at the Faculty of Transportation Engineering, for his invaluable guidance. His industry insights and critical feedback helped us refine both our system architecture and user-centric design thinking. |
| **HIGH POTENTIAL TO CONTRIBUTE TO SOCIETY/COMMUNITY?** |
| AutoMate contributes to road safety by reducing driver distraction through hands-free operation. For older or rural users without access to smart features, AutoMate provides an accessible, low-cost way to improve control and vehicle awareness.  It also helps promote digital equity by ensuring that technological enhancements are not exclusive to high-end vehicles. For communities with poor internet access, this offline solution empowers more inclusive use of technology.  In the educational space, AutoMate can be adapted as a teaching aid for embedded systems, voice control programming, or vehicle diagnostics, supporting STEM learning at universities and vocational schools.  Furthermore, the robot’s friendly form encourages driver mental well-being by introducing a humanized companion on the road - a small but meaningful contribution in a stressful driving culture. |
| **THE TEAM'S ASPIRATIONS AND OBJECTIVES IN SUBMITTING THE PROJECT TO THE COMPETITION** |
| AutoMate is more than a technical project - it reflects our team’s vision of accessible, inclusive, and humanized vehicle technology. By participating in Bach Khoa Innovation 2025, we seek not only recognition but also mentorship, collaboration, and real-world validation.  We hope to turn AutoMate into a tangible solution used on Vietnamese roads, especially in everyday cars that are often overlooked by the tech industry. The competition gives us a platform to connect with investors, mentors, and fellow innovators.  Long-term, we aspire to build a Vietnamese product line that proves local creativity can solve local challenges - and we hope AutoMate will be one of the first steps in that journey. |

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7. Vietnam News Agency. (2025, January 25). Vietnam's automobile industry to face multiple challenges in 2025. VietnamPlus. <https://en.vietnamplus.vn/vietnams-automobile-industry-to-face-multiple-challenges-in-2025-post308759.vnp> [↑](#footnote-ref-7)