Project charter
Embedded Systems – Smart Radiator Controller

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Abstract:

This project charter outlines the strategic framework for the development of the Embedded Systems – Smart Radiator Controller project. The document covers key aspects of the project, including its purpose, technical approach, system requirements, scope of work, deliverables, quality management procedures, prerequisites, and success criteria. The project aims to design and implement a smart thermostat that efficiently controls traditional radiator systems through real-time temperature monitoring and automated adjustments. By adhering to a structured plan and defined objectives, this project ensures the development of a reliable, user-friendly, and energy-efficient solution. The charter serves as a foundation for collaboration, guiding stakeholders in making informed decisions and achieving project success while maintaining high standards of quality.

Version history

Version	Date	Comment
0.1	18.03.2025	Working version
1.0	30.03.2025	First complete version

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1. Introduction / Management Summary

This introduction provides an overview of the main aspects and concepts of the Embedded Systems – Smart Radiator Controller project. It encapsulates vital information essential for understanding the project's purpose, scope, and significance. Below are the key components:

Objectives: The main objective of this project is to develop a smart radiator controller that automatically adjusts a traditional radiator's temperature based on user settings. The system will utilize sensors for accurate temperature measurement, a motor for valve control, and an interface for user input. The intended outcome is to create an efficient, user-friendly, and energy-saving solution for controlling room temperature.

Scope: The project focuses on designing and implementing a smart thermostat system that works with traditional radiators. It will include the development of hardware (sensors, motor, microcontroller) and software (temperature measurement, calibration algorithms, user interface). The scope excludes the development of new radiators or any other heating systems. It also does not cover the integration with external smart home systems or cloud-based control.

Deliverables: The key deliverables for this project include a fully functional smart radiator controller prototype, including the sensor and motor integration, user interface for temperature setting, auto-calibration system, and a display for real-time data. A report documenting the design, implementation, and testing of the system will also be produced.

Timeline: The project is planned to be completed over the course of several months, with key milestones including the completion of the initial design phase, prototype development, testing, and final system integration. The timeline will be adjusted as necessary based on progress and unforeseen challenges.

Budget: The estimated budget for this project ranges from 50 to 120 EUR, depending on the components selected. This budget will cover the purchase of sensors, motors, microcontrollers, displays, and other necessary materials, as well as costs related to 3D printing for custom mounts and potential power supply solutions.

Risks: Potential risks include difficulties in achieving accurate motor calibration, ensuring compatibility with various radiator valve types, and addressing any unforeseen technical challenges in integrating hardware and software. Strategies to mitigate these risks include conducting thorough testing, employing iterative development, and adjusting the project scope as needed.

Stakeholders: The key stakeholders in this project include the project team (responsible for design, development, and testing), the project advisor (providing guidance and oversight), and potential users (who will benefit from the smart radiator controller). Effective communication between stakeholders will be essential for the success of the project.

This introduction serves as a high-level reference point for stakeholders and decision-makers, providing them with a quick understanding of the project's objectives, scope, timeline, budget, risks, and stakeholders.

2. Business case

The Smart Radiator Controller project is being developed to address the growing need for efficient and automated temperature regulation in residential and commercial environments. Currently, many traditional radiator systems lack automation, requiring manual adjustments that are inefficient and inconvenient for users. This project aims to create a smart thermostat system that automates the control of radiator valves based on real-time temperature measurements and user inputs, offering both comfort and energy savings.

The customer, who is looking for an innovative solution to improve temperature regulation in buildings, expects a user-friendly, cost-effective, and energy-efficient system. The primary goal is to simplify the process of controlling room temperature by automating the radiator valve adjustments, which will help users maintain optimal indoor climates with minimal effort. The system will allow users to set target temperatures, schedule temperature changes, and monitor real-time data, making it a highly functional and adaptable solution for various use cases.

In addition to the basic functionality, the system will also include features such as auto-calibration to ensure accurate valve adjustments, a real-time safety mechanism to protect the motor, and integration with simple user interfaces for easy control. The application will be designed to be adaptable to different radiator types, ensuring its broad applicability.

The development of this smart radiator controller will require careful attention to hardware design, software development, and system integration. However, the long-term benefits will far outweigh the initial investment, as the system will enhance user comfort, reduce energy consumption, and offer greater control over heating systems. By automating temperature regulation, this project will make it easier for users to maintain their desired indoor environment, which is an important selling point for the system.

In the future, there is potential for expanding the system to integrate with other smart home technologies, further improving its functionality. The project will also explore options for incorporating additional sensors, mobile app integration, and other features to enhance the user experience.

In summary, the development of the Smart Radiator Controller will provide significant benefits to both end users and stakeholders, making the management of heating systems more efficient, cost-effective, and environmentally friendly.

3. Approach

In the Approach chapter of the Embedded Systems – Smart Radiator Controller project, a methodology will be applied to guide us through management, planning, and implementation. The approach is designed to make efficient use of time and resources, ensuring the delivery of a high-quality project that meets both user and stakeholder expectations.

Methodology

For this project, we will adopt an **Agile** approach, specifically following the **Scrum methodology**. This allows us to work closely as a team, remain flexible to changes, and deliver consistent results throughout the project lifecycle.

Key Practices:

- **Regular teamwork:** We will maintain frequent communication and collaboration between team members, ensuring continuous feedback and alignment with project objectives. This will allow us to refine requirements and adjust the system as necessary.
- **Adaptability to change:** As in any project, changes are inevitable. The team will remain prepared to adapt, making adjustments as required to avoid setbacks and maintain the quality of the system.
- **Continuous delivery:** We will provide regular updates on our progress, delivering work-in-progress versions of the system to stakeholders to keep them informed and involved throughout the development process.
- **Iterative development:** Based on user feedback, the system will be continuously refined and improved, ensuring that it aligns with user needs and expectations.

Quality Management

Throughout the project lifecycle, a strong focus on quality will be maintained. This will be achieved through:

- **Regular testing** to identify and resolve issues early.
- **Code reviews** to ensure the development follows best practices and standards.
- **Quality assurance checks** to confirm the system's functionality, usability, and reliability meet the necessary criteria.

In Scope Deliverables

The key deliverables for this project include:

- Development of a fully functional smart radiator controller system, including sensors, motor control, and user interface.
- Integration of temperature measurement and motor control features for real-time temperature regulation.
- Auto-calibration functionality to optimize valve adjustments.
- User-friendly interface for temperature setting and scheduling.
- Safety mechanisms to protect the motor from damage due to mechanical limits.
- Documentation detailing the system design, implementation, and testing procedures.

Activities

The activities for the project include:

- Requirements gathering and analysis to ensure all necessary system features are included.
- Design and development of hardware and software components.
- Testing to ensure the system meets performance and safety standards.
- Final deployment and system integration into the desired environment.
- Training for users on how to effectively operate and maintain the smart radiator controller.

Objectives

The main objectives of the project are:

- Provide a smart and energy-efficient solution for controlling radiator temperatures.
- Enhance user comfort by allowing easy temperature adjustments and scheduling.
- Increase energy savings by automating radiator control based on real-time data.
- Develop a user-friendly and reliable system that integrates seamlessly with existing radiator setups.

Boundaries

The project will focus on:

- Creating a system for controlling traditional radiators, not developing new types of radiators.
- Ensuring compatibility with various radiator valve types through adjustable motor attachments.
- Integrating a simple user interface for easy temperature setting and scheduling.
- Complying with electrical and mechanical safety standards.

Out of Scope

The following items are out of scope for this project:

- Integration with external smart home systems or cloud-based control.
- The development of new radiator models or systems.
- Features unrelated to radiator control, such as smart lighting or other smart home integrations.
- Extensive support for remote control or mobile app integration in this version of the system.

4. Deliverables

The project will produce the following deliverables throughout its different phases:

1. Development of a user-friendly system for controlling the temperature of a radiator.
2. Integration of temperature sensors to measure the room and radiator temperatures for accurate control.
3. Implementation of motor control for adjusting the radiator valve based on temperature readings.
4. User interface for setting the target temperature and scheduling adjustments.
5. Real-time display of temperature data on an OLED or LCD screen.
6. Auto-calibration mechanism for adjusting the motor to ensure accurate temperature regulation.
7. Safety mechanism that stops the motor if it reaches its movement limit.
8. Power supply integration to ensure the system can be powered through an adapter or battery.
9. 3D-printed or adjustable mounting system to attach the motor to different radiator valve types.

5. Quality management

Quality management is essential for the success of our Smart Radiator Controller project. It ensures that the system and its components meet the quality standards set at the beginning of the project. Given the technical nature of the project, maintaining a high standard of quality is vital not only for meeting customer expectations but also for ensuring the system's functionality, reliability, and performance in the long term.

The project team will adopt a proactive approach to quality management, integrating quality assurance practices from the initial phases of development through to delivery. By focusing on continuous improvement, the team will identify potential issues early, mitigate risks, and guarantee that the deliverables meet the agreed-upon specifications.

Regular reviews, validations, and compliance checks will be implemented throughout the project lifecycle to ensure that the quality of the system is consistent. These checks will include verifying the accuracy of temperature measurements, ensuring proper motor calibration, and validating the user interface's responsiveness.

Additionally, quality control will be maintained through techniques such as code reviews, unit testing, integration testing, and user testing. These efforts will help to confirm that the system performs as expected under various conditions and that all features function seamlessly.

The goal is to create a product that not only meets but exceeds the project's specifications and ensures customer satisfaction. By embedding quality management practices into every step of the process, the project will produce a reliable, efficient, and user-friendly Smart Radiator Controller that aligns with customer expectations and the organization's reputation for excellence.

6. Prerequisite

The prerequisites section outlines the essential requirements and conditions that must be fulfilled before the Smart Radiator Controller project can begin. By ensuring the availability of necessary resources, dependencies, and conditions, this section aims to guarantee a smooth and efficient project execution.

Hardware Requirements: The hardware needed for this project includes development computers for software coding and testing, sensors to measure room temperature, a microcontroller (such as an ESP32) for system integration, and a servo motor for radiator valve control. Additionally, servers or cloud infrastructure will be required to host the application and manage backend processes.

Software Requirements: The project will require specific development environments and tools. This includes integrated development environments (IDEs) for coding, such as Visual Studio Code or PlatformIO. The system will also require embedded software for controlling the microcontroller and temperature sensors, as well as software for database management and storing configuration data. The application will be developed using programming languages such as C/C++ for the embedded systems and possibly Python for backend integration.

Infrastructure Requirements: Adequate office space and utilities are necessary for the development team to collaborate effectively. Internet connectivity is required for research, software downloads, and regular updates to project components. Furthermore, access to a testing lab may be needed to simulate real-world conditions for radiator control and environmental testing.

Skills and Expertise: The project team must have proficiency in embedded systems development, including experience with microcontrollers, sensors, and actuator control. Familiarity with agile development methodologies such as Scrum will be important for managing the project. Knowledge of temperature control systems, hardware integration, and software development is essential. Soft skills such as teamwork, communication, and problem-solving will be crucial for the team's success.

By defining these prerequisites, the project ensures that all necessary resources, skills, and conditions are in place before the project commences, laying the groundwork for successful execution.

7. Success criteria

The Success Criteria section defines the measurable components that determine the successful completion of the Smart Radiator Controller project. These criteria ensure that the project meets its objectives and delivers value to stakeholders by evaluating its performance against clearly established metrics.

Measurable Objectives: The project aims to design and implement a Smart Radiator Controller that effectively manages room temperature based on user input and feedback. Specific goals include achieving precise temperature regulation, ensuring seamless integration with a variety of radiator models, and providing a user-friendly interface. These objectives are measurable by evaluating temperature accuracy, user satisfaction, and the overall effectiveness of the system's functionality.

Performance Metrics: To evaluate the success of the project, the team will track various performance metrics. These include system reliability (e.g., downtime or failure rates), user satisfaction (gathered through feedback and testing), and time efficiency (e.g., the speed at which the system responds to temperature adjustments). Additionally, cost-effectiveness will be measured by comparing the estimated and actual project costs. Meeting deadlines and staying within budget are also key performance indicators (KPIs).

Acceptance Criteria: Clear acceptance criteria will be defined for each deliverable and project phase. For example, the hardware integration must ensure that the temperature sensor and motor work together to achieve accurate radiator control. The software should be user-friendly, and the system must operate without errors under typical usage conditions. Each deliverable will be assessed based on its functionality, usability, and performance to ensure that it meets the project's quality standards.

KPIs: Key performance indicators will include system uptime, user feedback scores, temperature regulation accuracy, and completion of development milestones within the projected timeline. Monitoring these KPIs will provide insights into the project's progress and highlight areas requiring adjustments or improvements.

Stakeholder Expectations: The primary stakeholders include the project team, the customer, and end users who will interact with the Smart Radiator Controller. Stakeholder expectations include a reliable and intuitive product, a seamless user experience, and timely project completion. By regularly communicating with stakeholders and incorporating their feedback, the project team will ensure alignment with their needs and expectations.

In conclusion, the Success Criteria for this project include measurable objectives, performance metrics, clear acceptance criteria, tracking of KPIs, and alignment with stakeholder expectations. These elements will guide the project team in delivering a successful, high-quality Smart Radiator Controller that meets all defined goals and satisfies stakeholders.