PROJECT NAME: A Simulation System For Smarthome Control Using BCI

PROJECT ACRONYM: NEURAHOME

COMPANY NAME: Aibek & Rashid Technologies

DATE: 01.01.2024

SWE 523 - Project1 Proposal Form (translated & modified from
GRANTING_ORGANIZATION/SWE523 TEYDEB Template)

Initial Technological Readiness Level- (start): 2

Target Technological Readiness Level (end): 5

A.FOUNDATION AND PROJECT INFORMATION

A.0. Comparison with Related Project(*)

(*)If the new project proposal presented is the re-submission of a project that was previously submitted to GRANTING_ORGANIZATION/SWE523 and was rejected / withdrawn or abolished, or if it is the continuation of a project that was previously carried out with the support of GRANTING_ORGANIZATION/SWE523, the information requested in this section must be prepared and submitted.

Description: Your new project proposal presented in this section;
i) Re-submission of a project that was previously submitted to GRANTING_ORGANIZATION/SWE523/SWE523 and was rejected/withdrawn or abolished; By comparing it with the project in question, the differences of the new project compared to the previous one in terms of features of the targeted outputs, innovative aspects, methods to be applied, project plan, budget and collaborations,
ii) If it is a continuation of a project previously carried out with the support of GRANTING_ORGANIZATION/SWE523/SWE523; By comparing it with the project in question, the differences and advantages of the new project compared to the previous one in terms of the features of the targeted outputs, innovative aspects and the methods to be applied,
Prepare a document containing relevant information and upload it in pdf format (The file size you will add can be maximum 5 MB).
📕Comparison with Related Project

A.1 - PROJECT PRELIMINARY INFORMATION

A.1.1.

Project number	2022719069		
Project name	A Simulation System For Smarthome Control Using BCI		
Project Start Date	01.01.2024	Project End Date	01.01.2026
Support Start Date	01.01.2026	Support End Date	01.01.2028
Project Duration	24 months	Support Period	24 months
Technology Group			
Legal/special permission:	☐ Project studies require legal/special permission (Ethics Committee, etc.). ☑ Project studies do not require legal/special permission (Ethics Committee, etc.).		
Project information sharing	I hereby approve the information provided in the Project Name and Project Purpose section to be published in promotional activities, analysis and reporting studies, such as success stories, etc. ☑ After the project support process is completed, I approve the name and purpose of the project to be published on the GRANTING_ORGANIZATION/SWE523/SWE523 website. (Note to PRODİS: If the first option is selected in this section, the second option will be selected automatically.)		
Sector in which R&D Studies will be carried out	Artificial Intelligence and Machine Learning Neuroscience and Biomedical Engineering Human-Computer Interaction (HCI) Internet of Things (IoT) and Smart Home Technology Data Security and Privacy Signal Processing		
Sector Where Project Outputs Will Be Used	Smart Home Technology Healthcare Assistive Technology Human-Computer Interaction Research and Development Consumer Electronics Education and Training		
iii)			
Scientific and Technological Fields Included in the Project Proposal			

3

Economic Activity Class of Project Output (NACE Code)	J62.0.9
GTIP Code of Project Output	990000000003
Project Beginning Technology Readiness Level	3
Technology Readiness Level Targeted to be Reached at the End of the Project	8

A.1.2.

Project manager			
Name and surname	Aibek Aldabergenov	iv) TC Identification number	-
Title/Duty	Software Engineer		
Correspondence Address	İstanbul, beşiktaş 11		
Telephone	+905431234567	v) Fax	-
Email	aibek.aldabergenov@std.bogazici.edu.tr	Secondary Email	-

A.2 - ORGANIZATION INFORMATION

A.2.1 – Applicant Organization Information

A.2.1.1.

Establishment Official	
Organization Type/Scale/Balance Sheet data	Private company
Tax Administration	771287468
Tax Registration Number	24124127441
Establishment Registration Date	01.01.2024
trade register number	1013
Location of the Project: (Technocity/R&D Center/OIZ/Other)	Bogazici University

A.2.1.2. Project Person Information

Establishment Official			
Name and surname	Aibek Aldabergenov	TC Identification number	-
Title/Duty	Software Engineer		
Telephone	+905431234567	Fax	-
Email	aibek.aldabergenov@std.bogazici.edu.tr		

A.2.1.3.

Organization Personnel Distribution						
Unit of	Doctorate	Degree	Licence	Technical/Vocational High School	Other	Total
Production	1	1	1	2		5
R&D	1	1	2	2		6
Other						-
					Total	11

A.2.1.4.

Financial Information of the Organization for the Previous Year or Last Interim Accounting Period (TL)	Year/Period	2024
	Annual Number of Employees (YIB)	10
	Net Sales Revenue	$10000
	R&D Expenses	$5000
	Total Foreign Sales	$4000
	Paid-in capital	-
	Total Financial Balance Sheet (Total of Assets or Liabilities)	$40000
	Total Grant Support Amount Provided from the Public in the Last Three Years (TL)	0
	Equity	0
	Last Three Years Net Sales Average	$20000

Partner Organization Information	
Organization Name:	-
Tax Office and Registration Number:	-
Address:	-
Tel/Fax/E-mail/Web Address:	-
Establishment Official:	-
TC Identification number: Title/Duty: Tel/Fax/E-mail:	-
Organization Type/Scale:	-

A.2.1.5 Other R&D Projects of the Company:

Other R&D Projects of the Organization Completed and Ongoing in the Last Five Years (*)					
Project Number and Name	Institution from which support is received	Support Amount	Start-End Dates	Economic Values	Explanation
				Export Amount: 0 Number of Patents: 0 License Revenues: 0 TEYDEB Support?: 0 Total Sales Amount: 0	**No R&D Projects done before**

(*) In PRODİS, the organization's previous GRANTING_ORGANIZATION/SWE523 Project information comes automatically from the database. Editing can be done regarding the project information in question, and project information carried out with the support of different institutions can be added. (It will be listed automatically.)

A.2.1.6. Questions for your company's projects previously supported by GRANTING_ORGANIZATION/SWE523 (if any):

1.What is the market share of the supported project outputs and the turnover achieved? (Indirect income for projects other than product development Detailed explanation of the benefits such as increased productivity, cost reduction, and quality increase that enable it to be achieved.
2.Does your company provide after-sales support for the outputs of supported projects? Is the product being sold continued to be developed?
3.Are the supported project outputs a component of a main exported product? (For example, the rim of an exported car)

1.What is the market share of the supported project outputs and the turnover achieved? (Indirect income for projects other than product development
Detailed explanation of the benefits such as increased productivity, cost reduction, and quality increase that enable it to be achieved.

4. Have applications been made for international R&D support programs (EU Framework Programs, etc.)? Have you taken part in an international project? If yes, please briefly state what your role is in the project.

A.3. PROJECT DESCRIPTION - BRIEF DESCRIPTION

Explanation: In this section, it is expected to provide information that can be shared with people other than those evaluating the project - without commercial sensitivity. The written and visual material you will prepare in this section will be submitted to the Executive Board where the decision for your project proposal will be made. It will be presented unchanged at the meeting. It is recommended that this section be prepared after all other parts of the project proposal form are filled in. In this section, the focus should be directly on the purpose of the project, concrete goals, R&D content, innovative aspects and technology level. Texts should be written that clearly summarize the project team structure, the project-specific methods to be applied, the unique contributions of your organization, and the technical / economic benefits of the project output to be obtained. Considering that the prepared summary will be presented to people who have expertise in the basic technological fields to which the project is related, general (book) concepts related to the subject should not be repeated, and the focus should be on the technical details to be worked on. General subject and history narratives that are not specific to the project and its content and will not contribute to the evaluation, and explanations such as general project management methodologies, work package ranking, etc. that may be valid for every project should be avoided.

1 - Brief Introduction of the Establishment and Reason for Initiating the Project
Give brief information about your organization's main field of activity, its main products and services, your core competencies that give your organization a competitive advantage (areas you are best at), and your organization's future vision, and explain how the proposed project is related to all of these (the strategic importance of the project for your organization). (Up to 1,500 characters)

We are a software company specializing in machine learning, artificial intelligence, and software development. Our main focus is on creating innovative solutions that help people with disabilities and make daily life easier.
Our vision is to lead the way in technological advancement, driving positive change and enhancing people's lives through intelligent software solutions. The development of a simulation system for smart home control using a brain-computer interface perfectly aligns with our expertise and future vision. This project showcases our proficiency in machine learning and AI techniques while helping people with disabilities, as well as the addressing growing demand for personalized smart home automation solutions.

2 – Aim of the Project
- Reading brain signals and translating them into smart home commands
- Helping people with disabilities control their homes using brain signals, including
    - Turning lights on and off
    - Control TV, audio devices
    - Control home temperature
    - Refrigerator/microwave/blender, etc.
    - Shower/bath
    - Reach emergency services and contact for help
    - Internet access

Keywords:	BCI, Brain Computing Interface, Smart home control, Disability, Assistive Technology

3 – Innovative Aspects
BCI integration will allow users to interact with their environment using brain signals. This approach eliminates the need for physical interfaces, offering a more intuitive and seamless control experience.

The integration of BCI technology into smart home control improves accessibility for individuals with disabilities or mobility impairments. By offering alternative control mechanisms based on brain signals, our system promotes inclusivity and independence.

Both BCI and AI/ML are rapidly developing areas, and their use together will allow for more applications to be developed.

4 –Techniques and Technologies to be Used/Developed and Original Contributions

The BCI devices and the readings of these devices are planned to be acquired from the companies specializing in this field. Our company is aiming to develop the ML/AI techniques to create a large model that can as accurately as possible classify the incoming signals from the interface to smart home events.

5 – Economic Benefits & Business Value to the Nation

The Fortune Business Journal says that the size of the worldwide smart home market is anticipated to expand from $93.98 billion in 2023 to a substantial $338.28 billion by the year 2030. For further details, you can access the information at the following link:
https://www.fortunebusinessinsights.com/industry-reports/smart-home-market-101900

Project Visual

At least one visual material (photo, technical drawing, layout drawing or draft drawing, table, graph, circuit diagram, system architecture, conceptual model diagram, flow diagram, etc.) that you think will best reflect your project to the evaluators should be uploaded to this section. (You can upload documents in image (JPG, JPEG, GIF, PNG), PDF or Microsoft Word Document format. 1 attachment can be a maximum of 5 MB, and the total size of your attachments can be a maximum of 10 MB.)

Presentation Material (YOU WILL PRESENT YOUR PROJECTS FOR SWE523 COURSE, 10 slides max.)

Project owner companies/project managers who wish can prepare one of the following presentation options and add it to the Project Proposal Form (Do not upload videos only for organization promotion in this section. Your video clip can be a maximum of 10 MB. The videos to be uploaded to the system must be in "flv" format. You can upload your videos in different formats. You can convert it to "flv" format with programs such as Format Factory etc. The presentation file size to be uploaded can be maximum 5 MB):

Project Presentation (must be in MSPowerPoint format, not exceed 10 slide pages)
Project Promotion Video (must be in flv format, should not exceed 5 minutes)

THIS WILL BE SUBMITTED WITH YOUR PROPOSAL AS PPT FILE

B. **INDUSTRIAL R&D CONTENT, TECHNOLOGY LEVEL AND INNOVATIVE ASPECTS OF THE PROJECT**

B.1 -RELATIONSHIP OF THE PROJECT WITH THE CALL TOPIC AND OBJECTIVES

1 -Explain the relationship of the project to the subject of the call.
100% in accordance with the subject of the call

2 - Explain the general purpose of the project. Identify the problem that is intended to be solved by the project.
People with mobility and cognitive issues may have difficulty doing daily tasks such as turning on the light, moving around the home, taking a bath, cooking food, etc.

3- Describe the proposed solution to achieve the project objectives.
The Neurahome simulation system will help train our large AI model using BCI signals. Training the AI model with diverse and representative data sets is key to ensuring accurate and reliable conversion of BCI signals into meaningful actions for smart home control. The simulation system will also help produce a customized AI model for a particular user, which then can be deployed to a physical smarthome system.

4 -Explain the goals planned to be achieved with the proposed solution.
The Neurahome system will contribute to developing a large AI model for BCI signals recognition and conversion to smarthome actions. The model then can be deployed to more than 300 million smart homes improving the quality of life of millions of people.

5 -Identify the ultimate beneficiaries of the proposed project and justify the reasons for selecting this target group.
Neurahome will help users with mobility or cognitive limitations to autonomously control their environment through mental commands, fostering independence.
Secondly, it will be helpful to all users with the daily tasks to a new level and increase people's productivity.
Neurahome can be beneficial for healthcare professionals to enhance rehabilitation programs and monitor patient progress.
Technology enthusiasts and innovators, researchers in the field of Neurocomputing can use Neurahome to develop useful applications for various life scenarios.
Neurahome will eliminate the need for physical interfaces like remotes and switches, simplifying the living space and reducing complexity.

6 -Explain in detail the methods to be applied and the reasons for choosing these methods.

7 –Examine the priority areas link in the call text and indicate whether your project has been developed for the "Priority R&D and Innovation Topics" in these areas. (It is recommended to take into account the explanations under the Priority Products and Technologies headings and the Technology Readiness Level (THS).)
YES

B.2 TECHNOLOGY LEVEL OF THE PROJECT

Current State of the Technology ("State-of-the-Art")
Explain the current national/international level regarding the project subject. (Up to 3,000 characters)

The fields of Machine Learning and Deep Learning, Feature Extraction and non-invasive BCI techniques are still in active development. The improvements in each of these fields will continue to contribute to the quality of the project overall. Recording of clear and strong signals from non-invasive BCI headsets (EEG-based interfaces are worn on the head and do not require surgery) is still not attainable, and using full invasive methods (requires surgery to implant electrodes under the scalp) carry health complication risks for patients. Partially invasive BCI methods (devices are implanted inside the skull but rest outside the brain rather than within the grey matter) are the most optimal for use in terms of signal quality and the level of risks associated with the process.

Techniques and Technologies Covered by Project Activities and Original Contributions

List the techniques and technologies that will be developed or used in the project, especially during the design/development processes, in the table below. Please also indicate your organization's unique contributions to the technical/technological content of the project and the areas of expertise that will receive support from outside your organization:

Name/description of technique/technology	To Be Used / To Be Developed	Why is it needed in the project?	Which phase of the project does it concern (work package)	Project personnel who will carry out the work	Persons or organizations to receive consultancy/service from outside the organization
BCI data	to be used	in order to train the model	Preparation and Setup	Neuroscience specialist, AI/ML developers	BCI Research institutes and organizations
AI model	to be developed	this is one of the main parts of the project	Model Development	Neuroscience specialist, AI/ML developers	
Smart home simulation system	to be developed	the trained AI model will be able to control the simulated smart home system	Integration and Optimization	Backend and frontend developers	

Technical/Technological Uncertainty and Challenges

Taking into account your organization's current knowledge and capabilities gained from past projects, describe the technical/technological uncertainties and difficulties you will encounter for the first time and that you will have to overcome during the development of the proposed project, with which you have no experience. (Up to 3000 characters)

Right now, we might have problems with obtaining high quality data of the brain signal readings for training the AI model. We will consult with the neuroscience research companies with a request to assist in collecting the data that we need.

B.3 PROMOTION OF THE PROJECT WITH CONCRETE / MEASURABLE OBJECTIVES AND SOLUTION APPROACHES (R&D SYSTEMATICS)

Project Goals

Please indicate in the table below the most important (maximum 5) concrete and measurable success criteria (capacity, physical size, working conditions, speed, various performance values, etc.) that define the targeted outputs of the project.

measure of success	target value
User feedback and satisfaction	*90%*
Accuracy of smarthome actions	*95%*
Safety of the BCI integration surgery	*completely safe with no long-term health risks*

Project Preparation Studies

Please indicate in the tables and fields below the information obtained before the project application regarding the literature and patent research on the project subject, technical feasibility studies and the standards / specifications to be followed.

Literature research results, if any, that will contribute to the project:

Publication name	Date	Writers)	Summary information that will form input to the project:
Brain-Computer-Interface (BCI) Based Smart Home Control Using EEG Mental Commands	19 September 2023	Ahmed Zakzouk, Karsten Menzel & Mohamed Hamdy	The paper discusses using a non-invasive BCI method to train an AI model to control a scaled down prototype of a smart home.
Brain–Computer-Interface-Based Smart-Home Interface by Leveraging Motor Imagery Signals	18 July 2023	Simona Cariell, Dario Sanalitro, Alessandro Micali, Arturo Buscarin and Maide Bucolo	The paper discusses using a non-invasive BCI method to record the motor imagery signals, and performing data preprocessing, feature extraction and classification

Patent / utility model research results, if any, related to the project subject:

patent number	Patent office where it is registered (TPE, EPO, USPTO, JPO...etc)	Year (application year if at the application stage)	Patent/applicants	Summary information that will form input to the project

Summary findings of technical pre-feasibility studies - if conducted: (Maximum 1500 characters)

1.
2.
3.

Standards / specifications to be followed regarding the project output: (Maximum 1500 characters)

1.
2.
3.

Methods to be Used in the R&D Process

Specify the analytical / experimental solution methods that will be applied to achieve the project objectives defined above. (NOTE: In this section, it should be explained which technical / scientific approaches and their stages will be followed

specifically for the project presented, and the names of work packages or standard / routine working methods that may be in every project should not be repeated.) (Maximum 3000 characters)

BCI System Integration - in order to collect the needed data for the AI model, we will need to integrate the BCI hardware with signal processing and AI components.

Signal Processing techniques - we will employ signal preprocessing, feature extraction and classification algorithms to extract meaningful information from the recorded signals.

AI and Machine Learning Algorithms - after recording the signals and labeling the data, we will train various AI models and evaluate their performance using new data.

Virtual Smarthome Simulation testing - connect the BCI System and the AI model to the smart home simulation system to assess real time performance of the system.

B.4. INNOVATIVE ASPECTS OF THE PROJECT

Innovations

After briefly summarizing the innovative aspects of the output targeted in the project, its anticipated differences, advantages and superiorities compared to its counterparts in the market and sector (within the company, at home or abroad), please state it by comparing it with concrete/numerical and measurable values as much as possible in the two tables below.

The project aligns with the ongoing trend of merging AI, IoT (Internet of Things), and assistive technologies to create intelligent and user-centric environments. It also opens avenues for further research and development in BCI-driven smart home applications. Overall, the project has the potential to transform how we interact with smart home systems, making them more intuitive, adaptive, and inclusive through the integration of BCI technology and AI assistants.

a) Comparison of the proposed project output with your organization's existing products/processes and the outputs of previously completed R&D projects (Table Y.1):

o There is no similar product/process in our organization that can be compared with the proposed project output. Comparison of our organization with similar products/processes is made in the table below.

Technicial Specifications	Project Output	Other Product/Process Available in the Organization (1)	(If any) Other Product/Process Available in the Organization (2)	....
Feature-1				
Feature-2				
Feature-3				

o

b) Comparison of the proposed project output with existing or potential similar ones in the domestic/foreign market (Table Y.2):

o In the project, a new product/process that has no comparable counterpart in the market will be developed.

o Comparison of the project output with its current or potential counterparts in the domestic/international market is made in the table below.

Technicial Specifications	Project Output	Similar Product/Process (1)	(If any) Similar Product/Process (2)	....
Feature-1				
Feature-2				
Feature-3				

INFORMATION RELATED TO THE PARTNER PROJECT (*)
(*)(This section will be activated for applications within the scope of projects carried out with national partnerships.)

Explain the division of labor between the partners in the project. State your duties and responsibilities in the project by associating them with the work packages. Provide information about the complementarity of the project partners' skills to be used in the project.

If technology transfer is planned from the partners of the project, please provide information about the efforts to ensure the permanence of technology transfer in the project.

Explain how the intellectual and industrial property rights that will arise as a result of the project will be shared among the partners.

C. PROJECT PLAN AND ESTABLISHMENT INFRASTRUCTURE

C.1. BUSINESS PLAN

Detailed Work-Time Bar Chart
📕 - Tree Work Breakdown Structur of the Neurahome

List of Work Packages			

Sequence No.	Code	Work Package Name	Start-End Dates
1	0001	Preparation and Setup	01-01-2024 - 01.04.2024
2	0002	Model Development	01-04-2024 - 01.06.2025
3	0003	Integration and Optimization	01-06-2024 - 01.01.2026

Work Package Identification Form (A separate form will be prepared for each work package)	
Work Package Number:	**0001**
Work Package Name:	**Preparation and Setup**
Starting date:	**01-01-2024**
End Date:	**01.04.2024**
Related Organizations (In joint projects, please tick the ones included in this work package from the project partners)	

List work package activities (Maximum 3,000 characters):

1. **Calibrate and configure BCI hardware**
   a. Properly set and install the scalp brain sensors
   b. Adjust settings to optimize signal quality.
   c. Calibrate the devices for each user

2. **Gather brain signal datasets from different people**
   a. Recruit diverse participants for varied brain signal patterns.
   b. Ensure ethical consent and follow guidelines.
   c. Record brain signals during relevant activities.

3. **Data Preprocessing and Feature Extraction**
   a. Clean signals: filter, reject artifacts, correct baseline.
   b. Extract features: spectral power, ERPs, spatial patterns.
   c. Normalize features for ML compatibility.

Describe the methods to be used in the work package and your unique contributions to them, and list the parameters to be examined (Maximum 3,000 characters):

In this work package, we will calibrate and configure BCI hardware. We will also ensure that scalp brain sensors are installed properly and that signal quality is optimized. User-specific calibrations will also be conducted. To gather brain signal datasets, we will recruit a diverse pool of participants. Activities will be recorded during relevant tasks. During data processing, we will clean the signals using filtering, artifact rejection, and baseline correction. We will also capture spectral power, ERPs, and spatial patterns. We will ensure that the data is compatible with ML models through normalization. We will examine the accuracy of sensor placement, the signal-to-noise ratio, and the efficacy of feature extraction.

List the experiments, tests and analyzes in the work package with their reasons in the table below (specify where the experiments and tests will be carried out, give detailed justification for the ones to be carried out abroad. If no experiments / tests / analyzes will be performed in this work package, specify):

Experiment / Test / Analysis Name	Reason for Making	Where it will be carried out (in the company, domestic or international organizations)	(If it will be held abroad) Materials

Gathering brain signal datasets	Obtaining data for model training	Research laboratory	

Specify the measurable/concrete technical intermediate outputs (milestones) that enable the monitoring of this work package activities and indicate their completion:

Definition of Intermediate Output	Expected Realization Date:	Work Package for Which Output Will Be Used
Brain signals data for specific commands	01/04/2024	0002

List of Interim Outputs (Milestones) (*)			
Search Output	Work package to be achieved	Expected realization date	Work package from which the output will be used
Intermediate Output-1			
Intermediate Output-2			

(*)This section is automatically created by PRODİS using the Intermediate Output information given in the work packages.

Work Package Number:	0002
Work Package Name:	Model Development
Starting date:	01-04-2024
End Date:	01.06.2025
Related Organizations(In joint projects, please tick the ones included in this work package from the project partners)	

List work package activities (Maximum 3,000 characters):

1. **Data Classification**
   a. Choose ML model to classify features into commands.
   b. Train model using labeled brain signal data with cross-validation.
   c. Fine-tune parameters for optimal accuracy and robustness.
2. **Command Generation**
   a. Map model output to smart home commands (e.g., lights).
   b. Handle uncertainty with logic like thresholding.
3. **Monitor the Performance of The Model**
   a. Monitor model performance during development/testing.
   b. Evaluate accuracy, precision, and recall using validation data.
   c. Identify errors, and iterate for improvements.
4. **Adjust the model parameters**
   a. Adjust parameters based on metrics, and user feedback.
   b. Experiment with ML algorithms for better accuracy.

Describe the methods to be used in the work package and your unique contributions to them, and list the parameters to be examined (Maximum 3,000 characters):

The data is libraries NumPy, Pandas, or TensorFlow's data loading utilities.
The architecture of the model is defined using a deep learning framework such as TensorFlow or Keras.
The model is compiled by specifying the loss function, optimizer, and any additional metrics to be tracked during training.
The model is trained using the fit() function provided by the deep learning framework.

List the experiments, tests and analyzes in the work package with their reasons in the table below (specify where the experiments and tests will be carried out, give detailed justification for the ones to be carried out abroad. If no experiments / tests / analyzes will be performed in this work package, specify):

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Experiment / Test / Analysis Name	Reason for Making	Where it will be carried out (in the company, domestic or international organizations)	(If it will be held abroad) Materials
No experiments in current work package			

Specify the measurable/concrete technical intermediate outputs (milestones) that enable the monitoring of this work package activities and indicate their completion:

Definition of Intermediate Output	Expected Realization Date:	Work Package for Which Output Will Be Used
Search output-1	.../.../......	0003

List of Interim Outputs (Milestones) (*)			
Search Output	**Work package to be achieved**	**Expected realization date**	**Work package from which the output will be used**
Intermediate Output-1			
Intermediate Output-2			

(*)This section is automatically created by PRODİS using the Intermediate Output information given in the work packages.

Work Package Number:	**0003**
Work Package Name:	**Data Classification**
Starting date:	**01.06.2025**
End Date:	**01.01.2026**

Related Organizations(In joint projects, please tick the ones included in this work package from the project partners)	

List work package activities (Maximum 3,000 characters):

1. **Testing with Home Control System**
    a. Integrate the model with smart home for real-time interaction.
    b. Test thoroughly for seamless BCI system communication.
2. **Optimize the model**
    a. Optimize the model for efficiency, scalability, and usability.
    b. Explore techniques for complexity reduction like compression, quantization, and specialized hardware.

Describe the methods to be used in the work package and your unique contributions to them, and list the parameters to be examined (Maximum 3,000 characters):

For the testing, we will use the smart home features in the laboratory. The real output will be compared with the desired and we will be able to calculate the accuracy.
The model will be optimized based on the results and later steps will be documented.

List the experiments, tests and analyzes in the work package with their reasons in the table below (specify where the experiments and tests will be carried out, give detailed justification for the ones to be carried out abroad. If no experiments / tests / analyzes will be performed in this work package, specify):

Experiment / Test / Analysis Name	Reason for Making	Where it will be carried out (in the company, domestic or international organizations)	(If it will be held abroad) Materials
Smart home testing	Checking the accuracy	Laboratory	

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Specify the measurable/concrete technical intermediate outputs (milestones) that enable the monitoring of this work package activities and indicate their completion:		
Definition of Intermediate Output	**Expected Realization Date:**	**Work Package for Which Output Will Be Used**
The accuracy of the brain signals conversion	01.01.2026	-

List of Interim Outputs (Milestones) (*)			
Search Output	**Work package to be achieved**	**Expected realization date**	**Work package from which the output will be used**
Intermediate Output-1			
Intermediate Output-2			

(*)This section is automatically created by PRODİS using the Intermediate Output information given in the work packages.

C.2. PROJECT MANAGEMENT AND ORGANIZATION

Explanations About Project Management

Project Personnel List
In this form, information about the personnel working on the project will be added. For each project personnel,
Fill out the Personnel Resume Form, convert it to PDF format from the "Add Personnel" screen and attach it.

Personnel Name	Title	TR ID/Passport Number	Educational Status	Undergraduate Graduation Date	Date of start	Opinionator	Resume
Thomas Anderson	Project Lead	MTRX0001	Master's of Science	23.05.2010			
John Smith	BCI Specialist	MTRX0900	Phd in Neuroscience	10.06.2008			
Jenna Lee	AI/ML Engineer	MTRX0701	PhD in Artificial Intelligence	11.05.2020			
Grace Foster	Software Developer (Backend)	MTRX0234	Bachelor's in Computer Science	23.02.2021			
Sam Berger	Software Developer (Frontend)	MTRX3345	Bachelor's in Computer Science	01.06.2018			
Brad Ford	UX/UI Designer	MTRX4453	Bachelor's in Computer Science	20.05.2017			

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C.3. ORGANIZATION INFRASTRUCTURE (*)

(*)This section will be filled out separately for each organization in collaborative projects offered by more than one organization.)

R&D Opportunities of the Organization
Describe your organization's R&D opportunities and experience under the following headings:
a) Your organization's current R&D structure (R&D unit, laboratory and test environments, tools-equipment and software tools, library facilities, dedicated platform for R&D purposes, etc.),
b) Consultancy services received from outside your organization and joint work with other organizations.
c) Explain the measures you have taken to make the knowledge that will emerge as a result of the project permanent in your organization.
d) Provide information about your new product development and design ability.

Our organization's main activities are based around developing AI/ML software solutions for making the lives of people better and more comfortable. We have hired a BCI specialist with a PhD in Neuroscience to research the ways of integrating BCI into a smarthome environment. Our AI/ML Engineer will work closely with our own BCI Specialist and with a BCI Research Institute's staff in developing the model for processing brain signals and converting them to meaningful commands. Our staff software engineers will develop the simulation environment of the smarthome application.

D. CONVERTERABILITY OF THE PROJECT INTO ECONOMIC BENEFIT AND NATIONAL GAIN

D.1 ECONOMIC FORECASTS

Potential for Commercial Success
By evaluating the potential of the project output to be commercialized / transformed into economic benefit;
a) Provide information about the targeted areas of use, the size of the domestic and international markets, the strategy to access these markets, potential customers and the current market shares of competitors. (Up to 3,000 characters)

The primary targeted areas are:
- Smart Home Appliances
- Healthcare
- Assistive technologies

There are around 1.3 billion people with disabilities (WHO).
The global smart home number reached 361 million homes in 2023.

b) If there is a need for additional investment to commercialize the output / make it economically profitable, explain the significant cost items and how these costs will be covered / financed. Summarize who and how will manage the commercialization process and their experiences on the subject. (Up to 3,000 characters)

There is NO Need for Additional Investment to commercialize the project

Economic Return Estimate
(NOTE: If the project output is a "product" that will be marketed by targeting a specific sector or customer base, then part (a) is included. If it is a product or process that will be developed in line with a single customer demand (customer specific), part (b) is part (b) only. If it is a new or improved process or product to be used by your organization, please complete part (c).)

a) Please indicate your numerical predictions regarding the economic return that the project output will provide to your organization in the table below. Please explain below your calculations/approaches that form the basis of your predictions. (Up to 3,000 characters)

It is aimed to present the project output to foreign markets.

Time to enter the domestic market from the beginning of the project (Months): 24

Time to enter the foreign market from the beginning of the project (Months)(*): 24

After the project is completed, your organization;	end of 1st year	end of year 3	Year 5 and beyond
Expected total domestic sales revenue (TL)	1,000,000	10,000,000	30,000,000
Expected total foreign sales (export) revenue (TL) (*)	10,000,000	100,000,000	300,000,000
Expected increase in domestic sales revenue (%)	%100	%1000	%3000
Expected increase in foreign sales revenue (%)(*)	%100	%1000	%3000
Expected increase in domestic market share (%)	%100	%300	%3000
Expected increase in foreign market share (%)(*)	%100	%300	%3000

(*)It will be filled in if the project output is intended to be presented to foreign markets.

b) Provide information about the customer of the project output (domestic, foreign), the sector in which it will be used, the potential to provide import substitution to our country, the expected profit from the sale of the project output, and the potential to receive new orders on subjects similar/related to the project output after the project. (Up to 3,000 characters)

b-1) Total sales revenue expected to be obtained with the project output (TL):

b-2)

O i) The project output will be offered to the domestic market only.

20

O ii) It is aimed to present the project output to foreign markets.

Time to enter the domestic market from the beginning of the project (Months):24

Time to enter the foreign market from the beginning of the project (Months)(*):24

After the project is completed, your organization;	end of 1st year	end of year 3	Year 5 and beyond
Expected total domestic sales revenue (TL)	1,000,000	10,000,000	30,000,000
Expected total foreign sales (export) revenue (TL) (*)	10,000,000	100,000,000	300,000,000
Expected increase in domestic sales revenue (%)	%100	%1000	%3000
Expected increase in foreign sales revenue (%)(*)	%100	%1000	%3000
Expected increase in domestic market share (%)	%100	%300	%3000
Expected increase in foreign market share (%)(*)	%100	%300	%3000

(*)It will be filled in if the project output is intended to be presented to foreign markets.

c) State the expected contributions of the project output to organizational efficiency, cost reduction, quality increase and competitiveness, using numerical data. (Up to 3,000 characters)

Transition Point to Profit
Explain how and how long it will take to recover the resources spent on the project. Specify the time to profit from the beginning of the project - together with your calculations. (Up to 3,000 characters)

D.2 NATIONAL ACHIEVEMENTS

Please indicate the national gains that the project can provide, taking into account the following headings that you deem relevant:
  a) Contribution to national knowledge and technological development,
  b) The potential to initiate new applications or R&D projects in the same or different technology areas, within or outside the organization,
  c) Anticipation of obtaining patents and licensing/know-how sales (outputs of the project that may be subject to patent, utility model and industrial design registration),
  d) Creating new business areas and employment impact,
  e) Sectoral contribution (contribution of the project to the creation and development of sub-industry, the relevant sector and other sectors),
  f) The impact of the project and its outputs on socio-cultural life, the potential to provide improvements in issues such as education, health, and reducing the development gap between regions,
  g) Positive effects of project activities and output on the environment and living things
  h) Outputs of project studies that can be subject to scientific publication.
(Up to 5,000 characters)

E. RISK AND FINANCIAL STRUCTURE

Risks That May Encounter and Precautions to be Taken During the Execution of the Project
Indicate the technical, financial, administrative and legal risks that may be encountered during the execution of the project and what kind of measures you plan to take to minimize them ("your Plan B(s)").

Risk	Precautions Taken to Prevent the Risk from Realizing	What is the probability of the risk occurring despite the measures taken, and what is the impact it might have if it occurs?		What to do if a risk occurs despite the precautions taken ("Plan B")
		Possibility (High / Medium / Low)	Effect (High / Medium / Low)	
Health risks from invasive surgery	Thorough testing should be performed	Medium	High	Switch to non-invasive BCI and work on improving the signal quality of BCI headset
Data security	High data security standards should be put in place	Low	High	Revise the security measures
BCI Signal Quality	Researchers from BCI Institute had good results with reading BCI signals	Low	High	Work on improving the signal quality from BCI device

Risks that may be encountered and precautions to be taken during the commercialization phase of the project output
State the possible obstacles your organization may encounter during the commercialization phase (technical, financial, legal, intellectual property rights, etc.) and your plans to overcome these obstacles. In addition, if the project activities and project output have negative effects on the environment and living things, indicate the precautions you plan to take against them.

Risk	Precautions Taken to Prevent the Risk from Realizing	What is the probability of the risk occurring despite the measures taken, and what is the impact it might have if it occurs?		What to do if a risk occurs despite the precautions taken ("Plan B")
		Possibility (High / Medium / Low)	Effect (High / Medium / Low)	

Financial Management
In the projects supported by the support program you are applying for, the project expenses are submitted to TUBITAK/SWE523 after they are made by the organization, and at the end of the evaluation, a certain percentage of the expenses related to the project is paid to the organization by TUBITAK/SWE523. Provide information about the adequacy of your equity and other financial resources and the measures you plan to take to carry out the project. (Up to 3,000 characters)

F. PROJECT BUDGET

F.1 - PERSONNEL EXPENSES ESTIMATED COST FORM (M011)

Project name	Neurahome						
Work Package Number/Name	Preparation and Setup						
Name and surname	**Role in the Work Package**	**Title in the Company**	**Man/Month Ratio**	**Month**	**Total Man-Month**	**Monthly Cost**	**Total**
Thomas Anderson	Project Lead	Project Lead	1	3	3	$10000	$30000
John Smith	BCI Specialist	BCI Specialist	1	3	3	$10000	$30000
Jenna Lee	AI/ML Engineer	AI/ML Engineer	1	3	3	$10000	$30000
WORK PACKAGE MAN-MONTH TOTAL =					9	TOTAL	$90000

Project name	Neurahome						
Work Package Number/Name	Model Development						
Name and surname	**Role in the Work Package**	**Title in the Company**	**Man/Month Ratio**	**Month**	**Total Man-Month**	**Monthly Cost**	**Total**
Thomas Anderson	Project Lead	Project Lead	1	15	15	$10000	$150000
John Smith	BCI Specialist	BCI Specialist	1	15	15	$10000	$150000
Jenna Lee	AI/ML Engineer	AI/ML Engineer	1	15	15	$10000	$150000
Brad Ford	UX/UI Designer	UX/UI Designer	1	2	2	$8000	$16000
			WORK PACKAGE MAN-MONTH TOTAL =		47	TOTAL	$466000

Project name	Neurahome						
Work Package Number/Name	Integration and Optimization						
Name and surname	Role in the Work Package	Title in the Company	Man/Month Ratio	Month	Total Man-Month	Monthly Cost	Total
Thomas Anderson	Project Lead	Project Lead	1	6	6	$10000	$60000
Grace Foster	Software Engineer	Software Engineer	1	6	6	$8000	$48000
Sam Berger	Software Engineer	Software Engineer	1	6	6	$8000	$48000
Brad Ford	UX/UI Designer	UX/UI Designer	1	6	6	$8000	$48000
WORK PACKAGE MAN-MONTH TOTAL =					24	TOTAL	$204000

F.2 - TRAVEL EXPENSES ESTIMATED COST FORM (M012)

Project name	Neurahome				
Name and Surname of the Person Who Will Make the Travel	**Title in the Company**	**Travel Description**	**Relationship of Travel to Project Activities**	**City Country**	**Amount (TL)**
Grace Foster	Software Engineer	Flight to Paris	Meeting with the ML expert	Paris, France	5,000
Sam Berger	Software Engineer	Flight to Ankara	Meeting with laboratory	Ankara, Turkey	2,000
Brad Ford	UX/UI Designer	Ride to Izmir	To get the equipment	Izmir, Turkey	1,000
				TOTAL	**TL**

F.3 - ESTIMATED COST FORM FOR TOOLS/EQUIPMENT/SOFTWARE/PUBLISHING PURCHASES (M013)

Project name	NEURAHOME									
Sequence number	Tool/Equipment/ Software/Publication Name	Piece	Capacity	Technical specification	Purpose of Use in Project Activities	Place/Purpose of Use After the Project		Unit Price (USD)	Unit price (TL)	Total Amount (TL)
						R&D	Production			
7	EEG Headset	3		Electrodes, wireless connectivity	Reading brain signals			$500	15000	45000
8	Signal Processing Software	1		Data preprocessing, feature extraction	Analyzing brain signals			$1,000	30000	30000
9	Smart Home Devices	1		Various smart home functionalities	Controlling home environment			Varies	Varies	Varies
10	Machine Learning Libraries	1		ML algorithms, neural network architectures	Developing classification model			$0 (open-source)	0 TL	0 TL
									TOTAL	75000TL

F.4 - ESTIMATED COST FORM FOR WORKS PERFORMED BY R&D AND TESTING ORGANIZATIONS (M014)

Project name				
Organization from which R&D is carried out	**Description of the Work Done**	**Relationship with Project Activities**	**Reason for Outsourcing**	**Amount (TL)**
BCI Research Institute	**Help with data collection, validation and BCI integration to the simulation system**	**Crucial in the Project setup phase because of our reliance on lots of data samples**	**Impossible to get the brain signals data from any other sources**	**1 500 000**
			TOTAL	**1 500 000 TL**

F.5 - SERVICE PROCUREMENT ESTIMATED COST FORM (M015)

Project name	Neurahome			
Organization from which the service is received	**Description of the Service**	**The Relationship between Service Procurement and Project Activities**	**Justification for Service Procurement**	**Amount (TL)**
NeuroTech Solutions	EEG Data Collection and Analysis	Essential for gathering brain signals for the project	Outsourcing expertise in EEG technology	20,000 TL
AI Consulting Firm	Machine Learning Model Development	Core aspect of project development	Leveraging specialized ML expertise	30,000 TL
Smart Home Device Manufacturer	Access to Smart Home Devices	Required for testing and integration	Ensuring compatibility and functionality	15,000 TL
Cloud Computing Service Provider	Cloud Hosting for Simulation System	Necessary for deployment and scalability	Ensuring reliable performance and accessibility	10,000 TL
			TOTAL	TL

F.6 - MATERIAL PURCHASES ESTIMATED COST FORM (M016)

Project name		Neurahome					
Sequence No.	Product name	Purpose of Use in Project Activities	Quantity and Unit	Justification of Amount	Unit Price (USD)	Unit Price (TL)	Total Amount (TL)
1	EEG Headset	Reading brain signals	3 sets	Essential for data collection	$500	15000	45000
2	Signal Processing Software	Analyzing brain signals	1 license	Key tool for data preprocessing	$1,000	30000	30000
3	Smart Home Devices	Controlling home environment	Variable	Necessary for testing and integration	Varies	Varies	Varies
4	Machine Learning Libraries	Developing classification model	1 set	Core component for ML model development	$0 (open-source)	0 TL	0 TL
						TOTAL	20000TL

F.7 - PERIODICAL AND TOTAL ESTIMATED COST FORM (TL) (M030)

| Cost Item	20..		20..		20..		TOTAL (TL)	RATIO IN TOTAL COST (%)
	I	II	I	II	I	II		
Project name : Neurahome								
Employee								
Trip								
Tool/Equipment/Software/Publication								
Works Outsourced to Domestic R&D and Testing Organizations								
Works Outsourced to Foreign R&D and Testing Organizations								
Domestic Service Procurement								
Foreign Service Procurement								
Material								
TOTAL COST								one hundred
CUMULATIVE COST								one hundred
TOTAL MAN-MONTH IN THE PROJECT								

G.ANNEXES
Brain-Computer-Interface (BCI) Based Smart Home Control Using EEG Mental Commands

https://link.springer.com/chapter/10.1007/978-3-031-42622-3_51

Disability. WHO. (7 March 2023)
https://www.who.int/news-room/fact-sheets/detail/disability-and-health

G1. Tree Work Breakdown Structure of the Neurahome
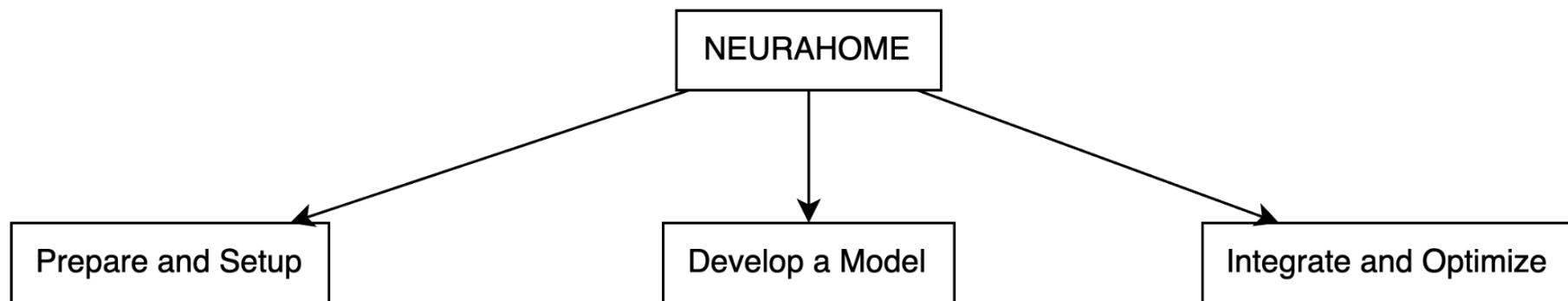
G1.1 Tree Work Breakdown Structure of the Prepare and Setup
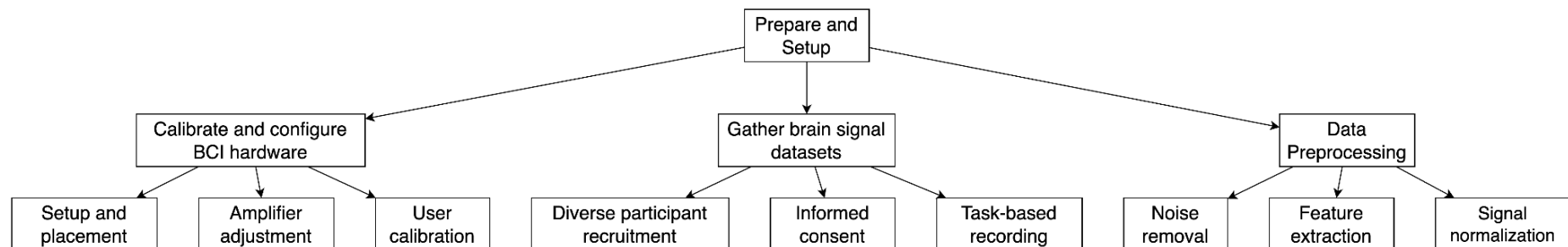
G1.2 Tree Work Breakdown Structure of the Model Development

```
                              ┌──────────┐
                              │ Develop a│
                              │  Model   │
                              └──────────┘
    ┌──────────────┐    ┌──────────────┐    ┌──────────────┐    ┌──────────────┐
    │     Data     │    │   Command    │    │ Monitor Model│    │ Adjust Model │
    │Classification│    │  Generation  │    │  Performance │    │  Parameters  │
    └──────────────┘    └──────────────┘    └──────────────┘    └──────────────┘
```

| Algorithm selection | Model training | Hyperparameter tuning | Output mapping | Uncertainty handling | Continuous evaluation | Error identification | Parameter tuning | Algorithm exploration |
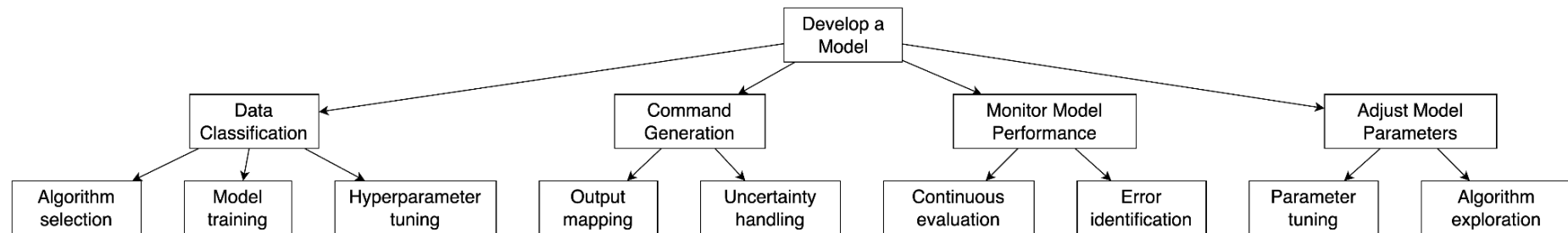
G1.3 Tree Work Breakdown Structure of the Integration and Optimization

```
                    ┌─────────────────────┐
                    │ Integrate and Optimize│
                    └─────────────────────┘
        ┌──────────────────────┐      ┌──────────────────┐
        │ Testing with Home System│    │  Optimize Model  │
        └──────────────────────┘      └──────────────────┘
```

| Integration testing | Real-time interaction | Efficiency enhancement | Usability improvement |