BONSAPPS

AI-as-a-service for the Deep Edge

Guide for Applicants
1st Open Call

Open date for proposals: the 1st of September, 2021 at 00:00 CEST (Brussels Time).
Deadline: the 2nd of November, 2021 at 17:00 CET (Brussels Time).

Version 6.1: 19/10/2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101015848. Neither the European Commission (EC) nor any person acting on behalf of the Commission is responsible for how the following information is used. The views expressed in this document are the sole responsibility of the authors and do not necessarily reflect the views of the EC

This document summarizes the main rules of the BonsAPPS 1st Open Call that will be **open under the ink: https://bonsapps-1oc-ai-talents.fundingbox.com/ from 1st September 2021 at 00:00 CEST (Brussels Time) with a deadline on 2nd November 2021 at 17:00 CET (Brussels Time).**

Table of Contents

Tables list

Figures list

Abbreviations

AI: Artificial Intelligence
EC: European Commission
KPIs: Key Performance Indicators
OC: Open Call
SME: Small and Medium Enterprise
BMP: Bonseyes Marketplace
HPC: High Performance Computing

1. Basic Info about BonsAPPs

BonsAPPS is an EU-funded H2020 project that will help SMEs in their digitalization process by allowing them to access, implement and make use of Artificial Intelligence easily and affordably through the modular services that will be available through Bonseyes AI Marketplace (BMP).

Over the duration of the project, BonsAPPs will launch 2 Open Calls (OC) for **AI Talents** and low-tech SMEs that will lead to the development of 20 re-usable AI Solutions implemented to BMP.

Through this 1st Open Call, BonsAPPs will support:

- **Who?** 30 AI Talents (Researchers, PhDs/Post-Docs, Engineers/Developers, Data scientists)
- **To do what?** Develop, integrate and deploy an AI@Edge Solution using tools and services of the BMP service layer to solve one of the 10 Industry Challenges from automotive, manufacturing, healthcare and robotics industries.
- **With what resources?** modular services, such as experimentation, model compression, optimization, benchmarking, deployment on hardware, and security available through the **Bonseyes Marketplace Platform.**

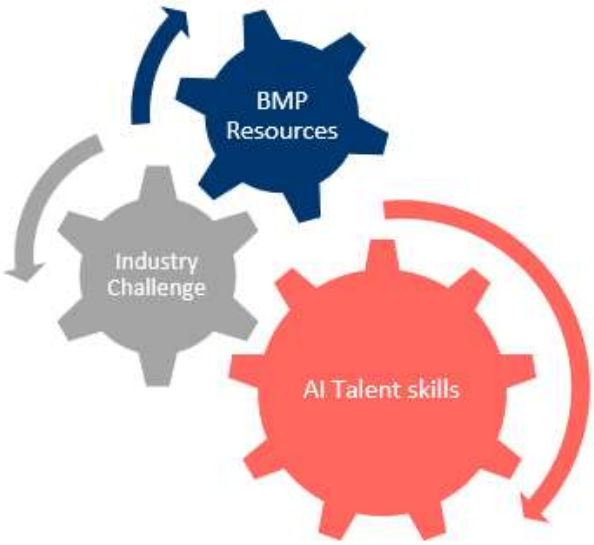


Figure 1 BonsApps 1st Open Call scope

Who are AI Talents?
The typical profile of the AI talents could be individuals (Researchers, PhDs/Post-Docs, Engineers/Developers, Data scientists) or entities, such as SMEs, MidCaps or Research and Technology Organizations with internal skills. **AI Talents must demonstrate the capacity to execute the AI model training (Data Science), AI development and integration tasks with resources and services available through Bonseyes Marketplace**

What is the Bonseyes Marketplace?

It is a Marketplace with a service layer for the Deep Edge. Originating from the EU H2020 project (2018-2020), Bonseyes is a secure, distributed marketplace that offers a range of **vendor-agnostic**, **modular services like**: **Experimentation, Model compression and optimization, Benchmarking, Deployment on hardware, Security & licensing.**

Bonseyes AI Marketplace will increase AI usage by enterprises and SMEs which lack internal innovation capabilities by providing tools to build **end-to-end, containerized, ready-to-integrate and re-usable solutions.**

Beta version of Bonseyes Marketplace's User Support Framework with AI Research and AI Challenges features will be released before the BonsAPPs Support Programme starts. More details about the structure and the content are provided in Bonseyes Marketplace release notes document.

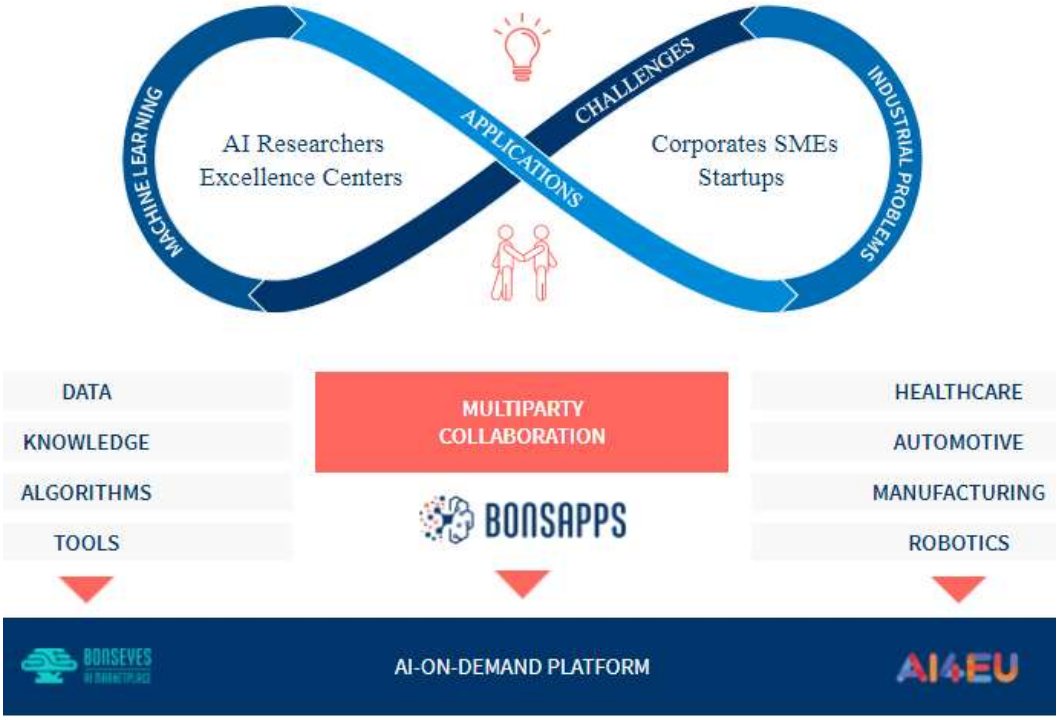


Figure 2 BonsAPPs innovation cycle

What are the Industry Challenges?

10 High impact challenges in strategic sectors where AI absorption is highly relevant to increase competitiveness were defined by the Industry sector stakeholders (Leading Corporates, Clusters and Digital Innovation Hubs) from the BonsAPPs ecosystem.

A detailed description of each Industry AI Challenge is included as Annex II to this document and includes information on its technical specifications, pre-trained models, evaluation and sample date that selected AI talents will use to solve the challenge.

2. What do we offer?

Become a certified AI Talent user of Bonseyes Marketplace Platform
Selected AI Talents will become 'certified AI Talent users' of the Bonseyes Marketplace Platform: a high-quality and versatile AI-as-a-Service Platform that reduce time and cost of AI@Edge development and can be used to develop AI@Edge solutions for a wide range of developer platforms in the market (ARM Cortex-A CPUs, embedded NVIDIA GPGPUs, Intel CPUs, RISC-V MCUs, ST-I MCUs, etc.).

The BonsAPPs AI-aaS service layer within the AI-on-demand platform will join the industry challenges with reusable research and will offer monetization opportunities to AI talents in the future.

Get funded for helping to make AI-on-demand efforts successful
Each selected AI Talent will receive a maximum 70 000 EUR for the development of an AI@Edge Solution during a two-stage, 5 -months project including up to 10 000 EUR voucher to access HPC Clouds required for model training/optimization/benchmarking.

Bonseyes Marketplace Platform tutorials and support
Selected AI Talents will use Bonseyes Marketplace Platform services and tools to develop AI@Edge Apps and Solutions based on Computer Vision, Time Series Analysis, Audio Classification and/or other AI enabling technologies through the User Support Framework.

BonsAPPs team will also provide early access and training in the use of the Bonseyes Marketplace Platform.

Licencing rights:
AI Solutions developed during the project will be open sourced (excluding the training data). The license terms of the resulting AI models will be subject to the status of the data being used to train the AI model.

- AI models trained on non-commercial data:

  AI Talents that will use the non-commercial data will be granted rights to use the results for non-commercial purposes only. During the Support Programme, BonsAPPs Team will set up a source code repository for each AI Talent including the User Support Framework and initial source code for the AI Asset. This source code will be open sourced under an appropriate contributor license agreement.

- AI model trained on commercial data:

  In case of AI solutions built on another party's proprietary data, AI Talents should be at least granted rights to re-use and commercialise them to develop new AI@Edge products for additional end users. Costs related to obtaining the necessary commercial license rights to the training data are eligible costs associated with the funding received through the project.

Business coaching:
10 AI Talents that will enter to 2nd Stage of the BonsAPPs programme will receive support from business mentors to build a business strategy out of the outcomes of the project.

3. Eligibility Criteria

All information provided in the application form that will be submitted before the deadline via the online application form. will be checked during the whole evaluation process against the eligibility criteria listed in this Section. Proposals that do not comply with those criteria will be excluded and marked as ineligible.

3.1 Who can apply?

Proposals can be submitted by:

- Natural Person (entrepreneur or PhD Researchers), individually or organized in a team of a maximum of 5 persons[1] OR
- One Registered Legal Entity that is an SME[2] or Mid Cap[3] or Research and Technology Organization[4]

That is registered/have citizenship or legal residence in:

- The Member States of the European Union and its Overseas Countries and Territories or
- Associated Countries to H2020 or
- United Kingdom of Great Britain and Northern Ireland

3.2 What types of activities can be funded?

The final goal of the BonsAPPs support programme is to apply the tools and services of the BMP service layer to solve the Industry Challenge and populate the content of the BMP with the developed AI Solutions.

Applicants (AI Talents) must demonstrate the capacity to execute the development and implementation of low-cost, highly scalable AI Apps and AI Solutions based on Computer Vision, Time Series Analysis, Audio Classification and/or other AI enabling technologies to solve specific AI Industry Challenges within the following sectors:

- Manufacturing
- Automotive
- Healthcare
- Robotics

Each Industry AI Challenge includes its technical specifications, pre-trained models, evaluation and sample date that selected AI talents will use to solve the challenge (for more details see Annex II).

[1] In case of a team, one of the parties will be nominated as a team leader and will be the one signing the Sub Grant agreement and receiving the grant.

[2] An SME will be considered as such if it complies with the European Commission's Recommendation 2003/361/EC. As a summary, the criteria defining an SME are:
• Headcount in Annual Work Unit (AWU) less than 250;
• Annual turnover less or equal to €50 million OR annual balance sheet total less or equal to €43 million.
Note that the figures of partners and linked enterprises should also be considered as stated in the SME user guide. For detailed information check EU recommendation: https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

[3] MidCap will be considered as such if the staff headcount calculated according to Articles 3 to 6 of the Annex to Commission Recommendation 2003/361/EC has up to 3 000 employees.

[4] Entity, such as university or research institute, irrespective of its legal status (organised under public or private law) or way of financing, whose primary goal is to conduct fundamental research, industrial research or experimental development and to disseminate their results by way of teaching, publication or technology transfer; all profits are reinvested in these activities, the dissemination of their results or teaching

3.3 What are the Industry Challenges?

The AI Industry Challenges to be addressed in 1st Open Call are listed below:

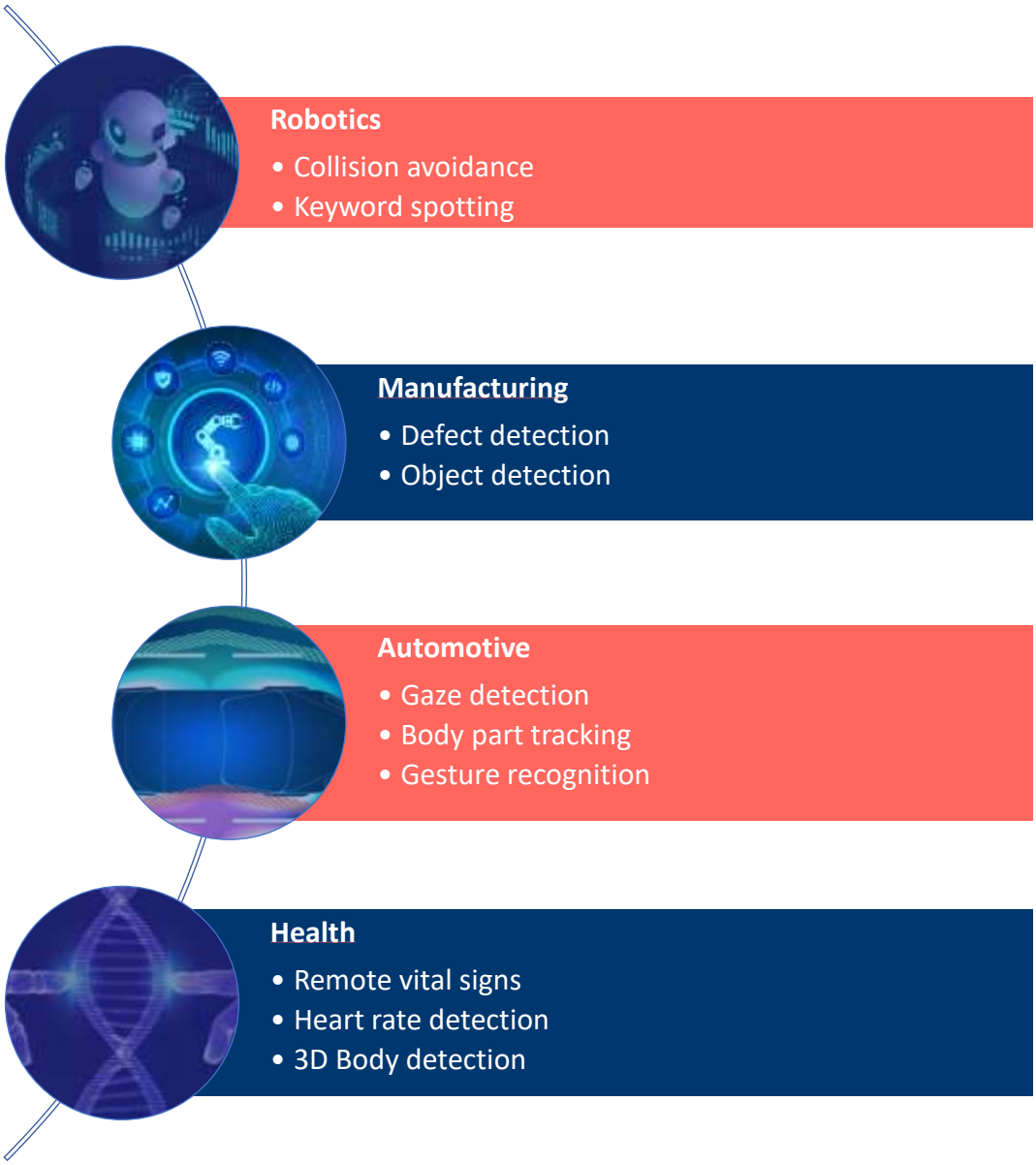


Figure 3 BonsAPPs 1st Open Call Industry Challenges

A detailed description of each Industry AI Challenge can be found in Annex II. BonsAPPs aims to select at least 3 proposals per Industry AI Challenge but the final decision of the number of proposals selected per challenge will be made based on the quality and potential of the submitted applications.

3.4 How to apply?

When applying to BonsAPPs 1st Open Call, please also note that:

- Your project should **have a clear European Dimension** meaning that the Industry AI Challenge is to fully exploit the potential of the European economy and society. Building notably on Europe's Scientific and Technology strengths in the field. The supported activities should reinforce industrial competitiveness across all sectors and help address societal challenges. The ambition is to bring AI technologies and resources to integrators and innovators in all sectors and actively engage with a wide user community, to foster adoption of AI, via Use Case projects.

- **Be on time:** We will evaluate **only** proposals submitted through the online form https://bonsapps-1oc-ai-talents.fundingbox.com/ before the **deadline: the 2nd of November, 2021 at 17:00 CET (Brussels Time).** Upon receipt of your proposal, the system will send you a confirmation of your submission.

- **Be exhaustive:** Have you answered all the sections of the application form? It won't be possible to add any information after the deadline. However, you will be able to modify the form as much as you like even after the proposal is submitted, as long as it is done before the deadline.

- Applicants can submit multiple applications (**maximum one per Industry AI challenge**) If more than one proposal per Industry AI Challenge is identified, only the last proposal which has been submitted in order of time, will be evaluated.[5]

  BUT **neither team members nor any legal entities can be funded twice** by BonsAPPs. If you submit multiple applications for different challenges and more than one proposal will reach the required score after the external evaluation phase, only ONE with a higher score will be selected for funding.

- Your proposal must be written in **English** in all mandatory parts to be eligible. Only parts written in English will be evaluated.

- Every question deserves your attention: All mandatory sections of your proposal - generally marked with an asterisk - must be filled in. Make sure that the data provided is true and complete. This is crucial for us to properly assess your proposal. Conversely, any additional material that is not specifically requested in the online application form will not be considered for the evaluation so no point overdoing it.

- We will take into consideration the existence of the potential **conflict of interest** among you and BonsAPPs Consortium partners. BonsAPPs Consortium partners, their affiliated entities, employees and permanent collaborators cannot take part in the BonsAPPS Programme. All cases of potential conflict of interest will be assessed on a case-by-case basis.

- **Healthy finances and a clean sheet are a must:** we don't accept entities that are under liquidation or are an enterprise under difficulty according to the Commission Regulation No 651/2014, art. 2.18, or that are excluded from the possibility of obtaining EU funding under the provisions of both national and EU law, or by a decision of both national or EU authority;

[5] Please note that only the application's last edit will be considered.

- **It is *your* proposal:** your project should be based on your original work or your right to use the resources included in the proposal must be clear. Going forward, any foreseen developments must be free from third party rights, or those third-party rights must be clearly stated.

4 How will we evaluate your proposal?

Our evaluation process is transparent, fair and equal to all participants. Your project will be evaluated in 4 steps before the signature of the Sub Grant agreement, as presented below:

Figure 4 BonsAPPs 1st OC selection process

4.1 Step 1: First Automatic Eligibility Check

The first evaluation step is about verifying some basic requirements based on statements from your proposal. Your proposal will be admissible for the next phase if it:

- Is complete, readable and in English in all mandatory sections.
- Includes the properly filled declaration of honour included in the application form.
- The proposal fulfils the eligibility criteria specified in section 3
- You did not exceed the maximum limit of one proposal per Industry challenge[6]

The proposals that do not comply with these criteria will be excluded and informed about the results of this first eligibility check soon after the deadline.

In case that number of submitted applications will be greater than 150, the BonsAPPs consortium may introduce pre-scoring procedure. Eligible proposals will then be automatically scored according to the scored sections of application form (excellence, impact, implementation). Details about the scores are included in FAQ document. Proposals with the highest score will pass then to the External Evaluation Phase.

[6] If more than one proposal per Industry AI Challenge is identified, only the last proposal which has been submitted in order of time, will be evaluated. *Please note that only the application's last edit will be considered*

4.2 Step 2: External Evaluation

In this phase, each project will be evaluated by 2 external, independent evaluators with wide expertise in Edge AI. Your project will be evaluated within the following awarding criteria:

EXCELLENCE will evaluate:

- **Ambition**. Clarity of pertinence of the objectives. Applicants should demonstrate a clear understanding of the end users' needs as defined in the AI Industry Challenges and their added value.
- **Innovation.** Applicants should show a clear understanding of the specific technical challenges that AI developers-integrators need to solve to respond to the need.
- **Soundness of the approac**h and credibility of the proposed methodology.

IMPACT will analyse:

- **Market opportunity:** The applicants have to demonstrate their understanding of how valid AI Apps and AI Solutions respond to a given Industry AI Challenge. The applicants should also demonstrate the level of scalability across other industries and the initial commercial strategy plan.
- **Commercial Strategy & Scalability:** The applicants have to demonstrate how the project aligns with current and/or future commercial strategy, taking advantage of new tools and services to improve the delivery of AI across Europe, particularly to SMEs/Low tech sectors.
- **Social and Economic Impact:** Environment and low carbon economy contribution, Equal Opportunities, Social impact

IMPLEMENTATION will consider:

- **Team:** The applicants have to demonstrate their technological capabilities and innovation excellence, demonstrating a strong background and skill base.
- **Resources**. Demonstrate the quality and effectiveness of the resources assigned in order to get the objectives/deliverables proposed. *In particular, proposals must demonstrate the capacity by the applicant/the team of applicants to execute both AI development and AI integration and deployment tasks*.

Each evaluator will rank the application assigning a score from 0 to 5 for each criterion and produce an Individual Evaluation Report. The final score will be calculated as an average of the individual assessments provided by the Evaluators.

If scores on a project show significant divergence between the two evaluators, a third evaluator will be involved to provide an additional independent assessment of this proposal.

Thresholds needed to pass to the next stage are:

- For each criterion, the minimum threshold is 3 out of 5 points.
- For a total sum of scores, the minimum threshold is 10 out of 15 points.

In case of ties, the following criteria will be used to rank the projects, in order: Implementation score, Impact score, Excellence score, Date of submission: latest submitted proposals go first[7].
All proposals obtaining a score above the threshold will pass to the next phase. Please note that we need time to process all the proposals in this phase, so you probably won't hear back from us for a while.

[7] Please note that only the application's last edit will be considered

4.3 Step 3: Consensus Meeting

The 'Selection Committee', formed by BonsAPPs consortium partners and three external experts, will decide by a majority (⅔ votes) the list of applicants that pass to the next phase. The discussion will be based on the ranking obtained as a result of the external evaluation.

Whilst normally the highest-ranked proposals will be selected for funding, the Selection Committee might have fair reasons for objecting to a specific applicant (alignment with BonsAPPs goals and scope, number of proposals per Industry AI challenge, the ability to achieve the highest impact possible, commercial competition, as well as the existence of significant ethical concerns or a potential conflict of interest). In this case, the choice may pass to the next-ranked proposal.

BonsAPPs aims to select at least 3 proposals per Industry AI Challenge but the final decision of the number of proposals selected per challenge will be made based on the quality and potential of the submitted applications.

The exact number of proposals approved will be decided based on the overall **quality** of the proposals.

4.4 Step 4: Sub Grant Agreement Preparation and Signature

Before signing the Sub Grant Agreement, each beneficiary will be requested to provide documents that will be verified by the BonsAPPs team to prove eligible formal status[8].

Proposals that will pass the documents review will be invited to sign the Sub Grant Agreement with the BonsAPPs Consortium before the Support Programme starts.

[8] See detailed list of documents that will be requested in Frequently Asked Questions Document. If you fail to deliver the requested documents on time without clear and reasonable justification, we will exclude you from the further formal assessment and you will be replaced with the proposal from the Reserve list

5 Support Programme and Payment Arrangements

Once the eligibility has been confirmed and the Sub Grant Agreements were signed, selected AI Talents will become official beneficiaries of the BonsAPPs programme.

Support Programme:
Up to 30 selected AI Talents will start the programme in January 2022 by defining their "Individual Use Case Plan" with the support of the Bonseyes Community Association (BCA), the Support Programme Manager. This document will become an Annex to Sub Grant Agreement and aims to establish the budget planned for execution of the Use Case as well as KPIs and Deliverables that will be taken into account when evaluating the AI Talent performance during a 5-month programme divided into 2 stages:

Stage 1. AI Assets/Apps development. *(+2 months):*
AI Talents will use the BMP services needed, interconnected with HPC clouds for model training and optimization. Stage 1 will end with a Hackathon event where developed AI Apps will be presented and evaluated by the 'Selection Committee, which will select up to 10 to proceed to Stage 2.

Stage 2. AI Solutions development, integration and deployment. (*+3 months):*
AI Talents will continue using the BMP services for benchmarking, to deploy AI Solutions in developer platforms defined by AI Industry Challenges.

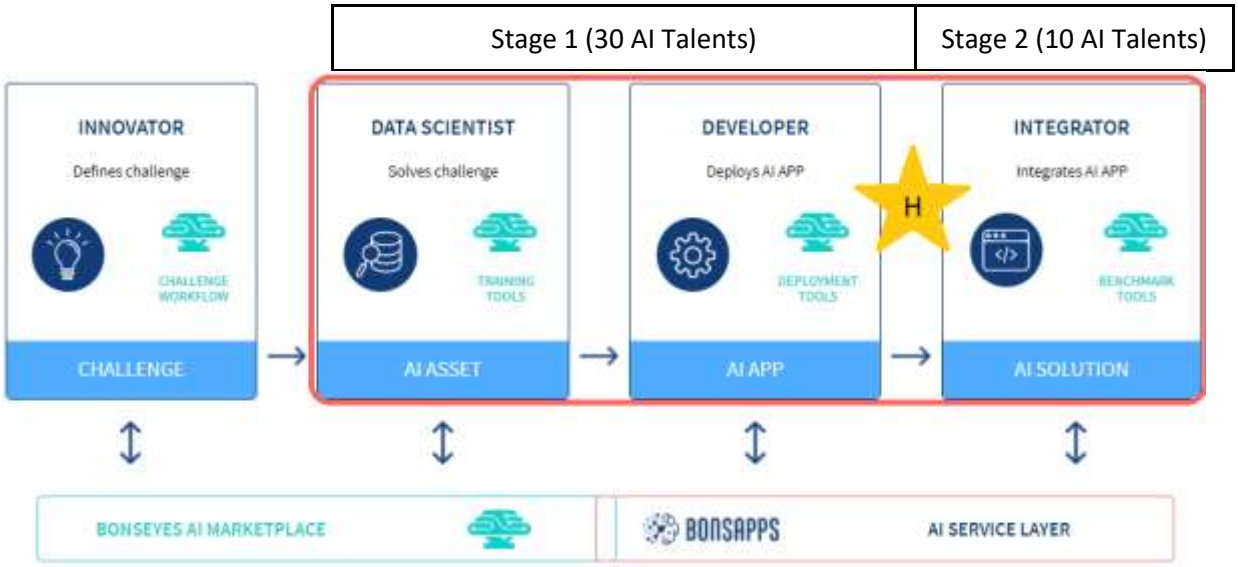


Figure 5 BonsAPPs 1st Support Programme

Details about the support provided in each Stage are shown in Table 1 below:

	Stage 1	Stage 2
Goal	AI Assets and AI Applications	AI Solutions & Integration
AI Talents	30 (3 per challenge)	10 (1 per challenge)
Funding (Lump Sum)	24k EUR	36k EUR
HPC Cloud Vouchers	4k EUR	6k EUR
Duration	2 months	3 months
Support	Early access and training by applying the services provided by the Bonseyes Marketplace	Early access and training by applying the services provided by the Bonseyes Marketplace + Business Mentoring

Table 1 BonsAPPs support provided per Stage

Payments:

The **lump-sum payment of the grant** is a simplified method of settling expenses in projects financed from Horizon 2020 funds. It means that the grantee is not required to present strictly defined accounting documents to prove the cost incurred (e.g., invoices), but is obliged to demonstrate the implementation of the project in line with the milestones set for it. Simply speaking, it means that we will carefully assess your progress and quality of your work during Milestones Reviews, not your accountancy. The milestones (deliverables, KPIs and ethical recommendations) will be fixed in the 'Individual Use Case Plan' elaborated at the beginning of the programme.

The lump-sum does not release you from the obligation to collect documentation to confirm the costs under fiscal regulation.

Voucher scheme: each beneficiary will be obliged to dedicate 2 000 EUR per month (10 000 EUR in total for both stages) from the total grant amount to cover the costs of HPC Cloud services. Those services will be contracted based on the agreement made directly between each beneficiary and one of the HPC suppliers selected from the pool of providers validated by BonsAPPs.

For a more detailed payment schedule and Milestones Evaluation process please check the Frequently Asked Questions section.

6 Contact us

How can we help you?

If you have questions regarding our Open Call, you can:

- post your question in the Helpdesk space
- send us a message at **bonsapps.help@fundingbox.com**

BonsAPPs Team will organize a certain number of Hackathons and Online webinars about this Open Call that will be announced through the BonsAPPs GET HELP website and communication channels.

Complaints

If, after receiving the results of one of the evaluation phases (when foreseen), you consider that a mistake has been made, you can send us your complaint. To do so please send us your complaint in English by email to **bonsapps.help@fundingbox.com** including the following information:

- your contact details (including email address),
- the subject of the complaint,
- information and evidence regarding the alleged breach.

You have **3 calendar days** to submit your complaint starting from the day after the communication was sent. We will review your complaint within no more than seven calendar days from its reception. If we need more time to assess your complaint, we will inform you by email about the extension.

We will not review anonymous complaints as well as complaints with incomplete information.
Please take into account that the evaluation is run by external experts in the field of Edge AI, and we do not interfere with their assessment, therefore we will not evaluate complaints related to the results of the evaluation other than related to the mistakes in the evaluation of the eligibility criteria.

7 Final provisions

Any matters not covered by this Guide will be governed by Polish law and rules related to the H2020 and EU grants.

Please take into account that we make our best effort to keep all provided data confidential; however, for the avoidance of doubt, you are solely responsible to indicate your confidential information as such.

For the selected grantees, the Sub Grant agreement will include the set of obligations towards the European Commission (for example: promoting the project and giving visibility to the EU funding, maintaining confidentiality, understanding potential controls by the EC/ECA and OLAF).

The BonsAPPs Consortium might cancel the call at any time, change its provisions or extend it. In such a case, we will inform all applicants that have started the application form about such a change. The signature of the Sub Grant agreement is an initial condition to establish any obligations among applicants and any Consortium partners (concerning the obligation of confidentiality of the application).

Did not find what you were looking for?
You may want to check out our Frequently Asked Questions Section.

8 Extra hints before you submit your proposal

A proposal takes time and effort and we know it. Here are a few crucial points you should read before submitting your proposal.

- Is your profile in line with what the BonsAPPs project is looking for? You are not sure? You can consult Sections 1 and 3.
- Did you present your proposal in a way that will convince evaluators? Not sure if you did? Go back to Section 4.2.
- Is your proposal fulfilling all eligibility requirements described in the Guide? Check again Section 3.
- Are you sure you can cope with our process of the Sub Grant agreement signature and payment arrangements for selected proposals? You may want to go over Section 5.
- Do you need extra help? Contact us.

Annex I: Information Clause

Processing of personal data in 1st Open Call in BonsAPPs project

CONTROLLER`S IDENTITY AND CONTACT DETAILS

The data controller is FundingBox Accelerator sp. z o.o. (Al. Jerozolimskie 136, 02-305 Warsaw, Poland). In all matters regarding personal data, you can contact us via: **privacy@fundingbox.com.**

PURPOSES, LEGAL BASIS AND PROCESSING PERIOD		
The purpose and legitimate interest of processing	Legal basis for processing	Period
1) To run an Open Call and collect data necessary to evaluate applications submitted in the Open Call	Legitimate interest of FundingBox (based on Article 6, paragraph 1 (f) of GDPR) which is fulfilling the obligations and our other interests related to these purposes	6 years from the end of the year in which the Project ended
2) To realize the Project goals described in the Grant Agreement (e.g., communication, reporting, collaborating with other project partners)		
3) To consider potential complaints		
4) To gather feedback from applicants when the Open Call is over to improve processes		

DATA RECEIVERS

Data controller will transfer personal data only to trusted recipients such as entities belonging to the FundingBox's capital group, IT service providers, accountants, law firms, postal and courier companies (who process personal data on the controller's behalf).

Due to the fact that we use the services of Google LLC, your data may be transferred to the USA. We have concluded an agreement with Google LLC - the so-called Standard Contractual Clauses. This means that in accordance with the decision of the European Commission No. 2021/914 EU of June 4, 2021, your personal data may be processed by this company in the USA. More information about the decision at: **https://eur-lex.europa.eu/legal-content/PL/TXT/?uri=CELEX%3A32021D0914&qid=1623665716691**

To realize the Project data can be transferred also to Project Partners (complete list of the project partners is available at the email address: privacy@fundingbox.com) and European Commission.

RIGHTS OF DATA SUBJECT

Due to the fact that we process your personal data, you have the right to:

1) request access to your personal data,
2) demand the rectification of your personal data,
3) request to remove or limit the processing of your personal data,
4) complain with the supervisory authority (The President of the Personal Data Protection Office, Warsaw, Poland, **https://uodo.gov.pl/en).**

You also have a right to object to processing of your personal data for all purposes indicated above (according to the Article 21 of GDPR).

INFORMATION ABOUT VOLUNTARY OR OBLIGATORY DATA PROVISION

Providing data is voluntary, although it is necessary to participate in the Open Call. Without providing your data, it is not possible to contact you and evaluate the application

BONSAPPS

AI-as-a Service for the Deep Edge

Guide for Applicants, 1st Open Call

Annex II: BonsAPPs Industry Challenges

List of Content

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Robotics

Collision Avoidance

R.1

Robotics Challenge | Collision Avoidance

General Description

Collision avoidance is a natural problem in mobile robotics that navigate through environments with static and dynamic elements.

The robot can either navigate through a planned circuit or follow a track through visual cues. During the navigation, the robot needs to detect the possibility of a collision to modify the speed or even the steering angle of the robot.

Industry (AI Solutions)	☐ Automtive ☐ Healthcare ☐ Manufacturing ☑ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Robotics Challenge | Collision Avoidance

Detailed Description

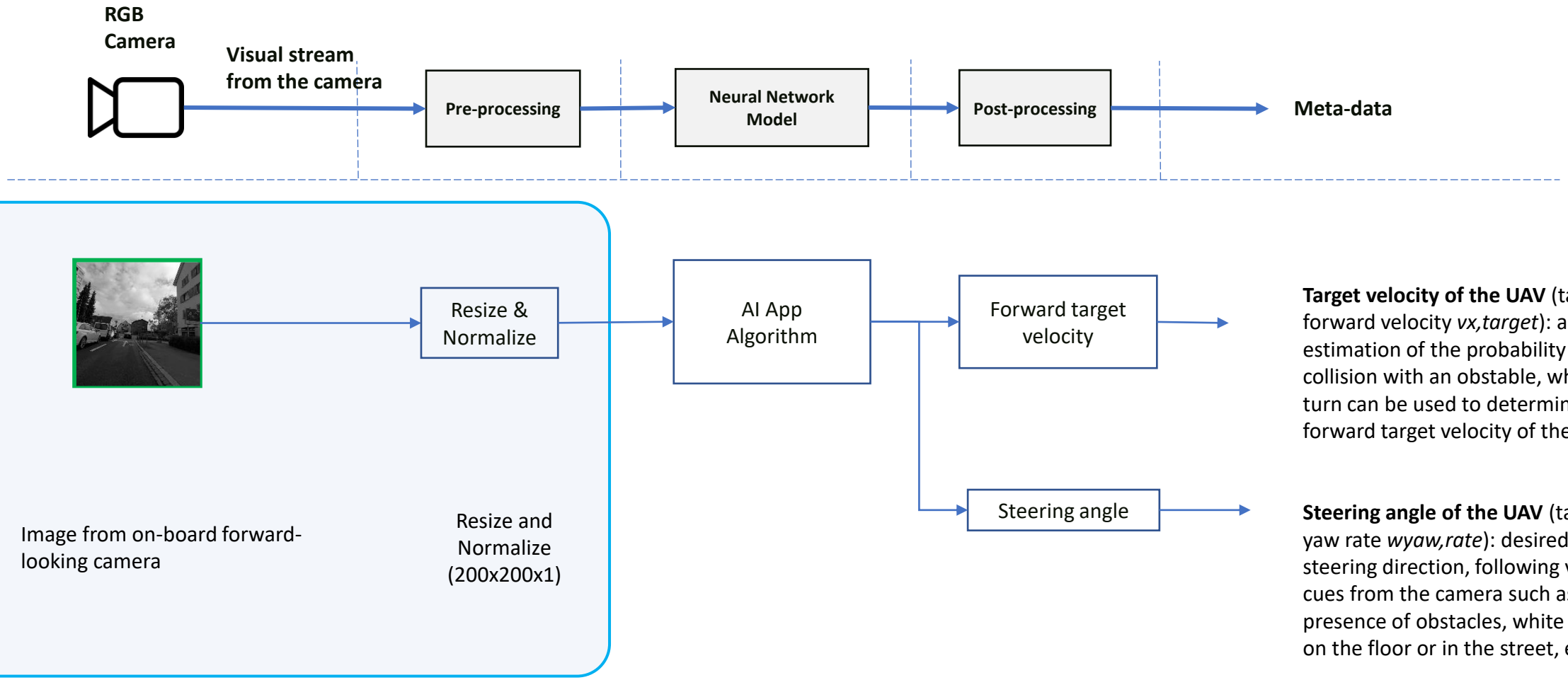
BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Collision avoidance is a natural problem in mobile robotics that navigate through environments with static and dynamic elements. The robot can either navigate through a planned circuit or follow a track through visual cues. During the navigation, the robot needs to detect the possibility of a collision to modify the speed or even the steering angle of the robot.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can this robot navigate following a track, e.g., white tracks or corridor in building, and in the event of an obstacle, avoid it and continue its trajectory?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on collision avoidance on the Zurich bicycle dataset. • Establishing a baseline accuracy on the driving steering angle on the Udacity, a dataset designed to train self-driving cars. • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• The *Zurich Bicycle* dataset has been derived from the open-source Zürich Bicycle dataset by the RPG from the University of Zürich (UZH). Part of it is redistributed here with modified resolution, and in gray-scale to match the configuration of our ultra-low-power camera. • The Udacity dataset dataset includes driving in Mountain View California and neighboring cities during daylight conditions. It contains over 65,000 labels across 9,423 frames collected from a Point Grey research cameras running at full resolution of 1920x1200 at 2hz.

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://ieeexplore.ieee.org/document/8804776 https://ieeexplore.ieee.org/document/8715489 **Reference Code** https://github.com/pulp-platform/pulp-dronet **Dataset - *Udacity*** https://www.udacity.com/self-driving-car **Dataset – *Zurich Bicycle*** https://github.com/pulp-platform/Zurich_Bicycle_Dataset
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Robotics Challenge | Collision Avoidance

Technical Specifications | Overview



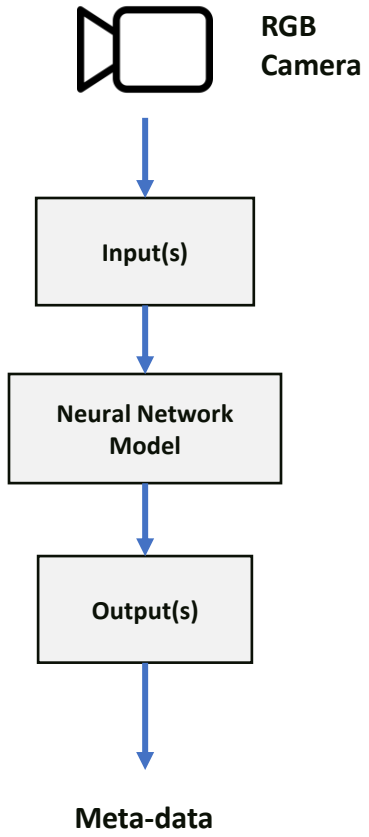
Target velocity of the UAV (target forward velocity *vx,target*): an estimation of the probability of collision with an obstable, which in turn can be used to determine the forward target velocity of the UAV

Steering angle of the UAV (target yaw rate *wyaw,rate*): desired steering direction, following visual cues from the camera such as the presence of obstacles, white lines on the floor or in the street, etc.

Robotics Challenge | Collision Avoidance

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Zürich bicycle dataset used for the collision task • Udacity dataset used for the steering task. Dataset designed to train self-driving cars
	Data Format		• The *Zurich Bicycle* dataset: pgm images with resolution 324x244, each tagged with a 0/1 collision label • Udacity dataset: png images with resolution 1920x1200 with csv files for steering angle
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Probability of collision -> Target velocity • Steering angle
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any*	Input	Gray-scale image	Image from on-board forward-looking camera
	Output	Target velocity	An estimation of the probability of collision with an obstable, which in turn can be used to determine the forward target velocity of the UAV
		Steering angle	Desired steering direction, following visual cues from the camera such as the presence of obstacles, white lines on the floor or in the street, etc.



Robotics Challenge | Collision Avoidance

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is collision probability (translated into target velocity) and steering angle in degrees. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Collision Avoidance Accuracy Average and standard deviation of steering angle.
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	**Model Accuracy**		**Deployment**	
	Metric	• RMSE & EVA (steering angle) • Average classification accuracy & F-1 score (collision prediction)	Latency	>18 FPS
	Accuracy	<=4.0 degrees	Peak Memory	8 MB
	Ethics Bias	<=1.0 degrees	CPU % Usage	<10%
	Availability	99%	Storage	16 MB
Target Platform	• Raspberry 4B: raspberry4b-ubuntu: gcc cross compiler • NVIDIA Jetson Nano: jetson_nano-jetpack4.4: Jetpack 4.4 + Ubuntu Bionic gcc cross compiler • RISC-V based multicore: GWT GAP 8			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 20.04 for Ubuntu Focal LTS
Target Hardware	Raspberry Pi 4 NVIDIA Jetson Nano GWT GAP 8

BONSAPPS

AI-as-a Service for the Deep Edge

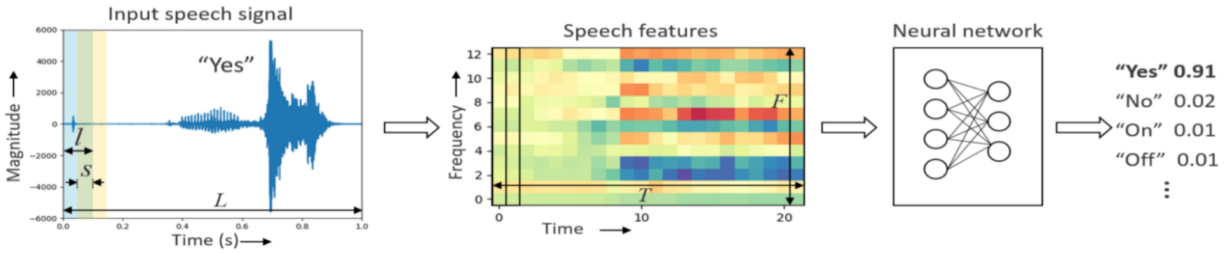
Industry Challenges | Robotics

Keyword Spotting

R.2

Robotics Challenge | Keyword Spotting

General Description



Keyword spotting (KWS), a particular case of Automatic Speech Recognition, which is the process of recognizing predefined words from a speech signal. KWS may also serve as a "wake-up" signal to initiate a larger service.

The goal of this challenge is to recognize key words, e.g., stop, start, yes, no, from a speech signal that can be used to interact with a robot for simple direct question answering.

Industry (AI Solutions)	☐ Automtive ☐ Healthcare ☐ Manufacturing ☑ Robotics		
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production		
Task (AI Assets)	☐Computer Vision ☑ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other		
Application	Computer Vision	Time Series	Natural Language Processing
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring	☐ Speech recognition ☐ Speech synthesis ☑ Keyword spotting
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised	

Robotics Challenge | Keyword Spotting

Detailed Description

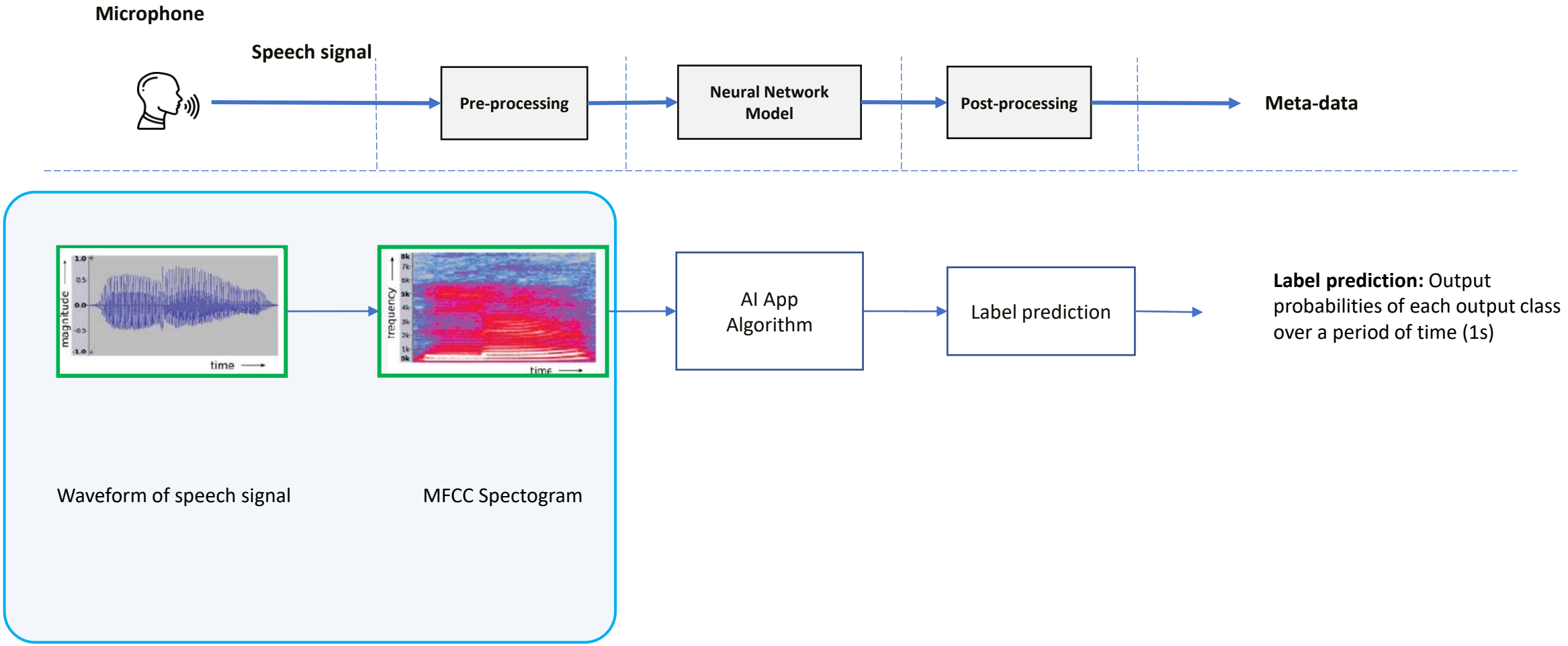
BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Keyword spotting (KWS), a particular case of Automatic Speech Recognition, which is the process of recognizing predefined words from a speech signal. KWS may also serve as a "wake-up" signal to initiate a larger service. In this challenge, we will use a KWS application either to wake up the Robot, e.g., “Hallo Robot”, answer direct questions, e.g., yes, no, ok, or give short commands, e.g., stop, start.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can we communicate with the robot providing single short commands?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline accuracy on the Google Speech Command dataset. Establishing a baseline accuracy on the TrueCobotics datatasets. Validation of robustness using different microphones. Providing an efficient ONNX model, through model compression and quantization. Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	The *Google Speech Command* dataset has 65,000 one-second long utterances of 30 short words, by thousands of different people. The *True Cobotics* dataset contains thousands of one-second long samples for waking up a robot and simple utterances of words.

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved .*	**Reference Paper** https://arxiv.org/abs/1711.07128 https://arxiv.org/abs/1901.05049 https://ieeexplore.ieee.org/abstract/document/9188213 **Reference Code** https://gitlab.com/bonseyes/training/projects/keywordspotting_bfh **Dataset – *Google Speech Commands*** https://ai.googleblog.com/2017/08/launching-speech-commands-dataset.html **Dataset – *TrueCobotics*** Under request
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Robotics Challenge | Keyword Spotting

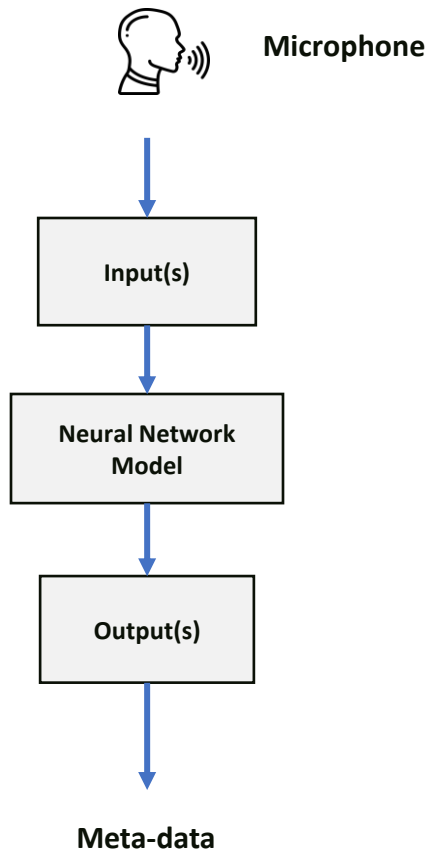
Technical Specifications | Overview



Robotics Challenge | Keyword Spotting

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		Speech input signal from a microphone
	Data Format		Wave files of 1 second long
	Data Type		☐Image ☐ Meta-Data ☐ Time Series ☑ Audio
Output *Please indicate the output data format and type.*	Description		Label prediction
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any*	Input	MFCC spectogram	Input speech signal is framed into overlapping frames. From each frame (F) MFCC speech features are extracted.
	Output	Label prediction	Output probabilities of each output class over a period of time (1s)



Robotics Challenge | Keyword Spotting

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at a speech signal level based on reference datasets. For each input speech signal frame, the result is label prediction. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy error on dataset Average and standard deviation of latency
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	**Model Accuracy**		**Deployment**	
	Metric	TOP-1 and TOP-5 accuracy	Latency	< 30 ms (RPi 4B)
	Accuracy	> 90%	Peak Memory	256 KB
	Ethics Bias	---	CPU % Usage	<10%
	Availability	99%	Storage	500 KB
Target Platform	• Raspberry 4B: raspberry4b-ubuntu: gcc cross compiler • NVIDIA Jetson Nano: jetson_nano-jetpack4.4: Jetpack 4.4 + Ubuntu Bionic gcc cross compiler • RISC-V based multicore: GWT GAP 8			
Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out			
Format	Docker Image			
Output	Evaluation Report (see table for details)			
Docker Version	Docker 20.04 for Ubuntu Focal LTS			
Target Hardware	Raspberry Pi 4B NVIDIA Jetson Nano GWT GAP 8			

BONSAPPS

AI-as-a Service for the Deep Edge

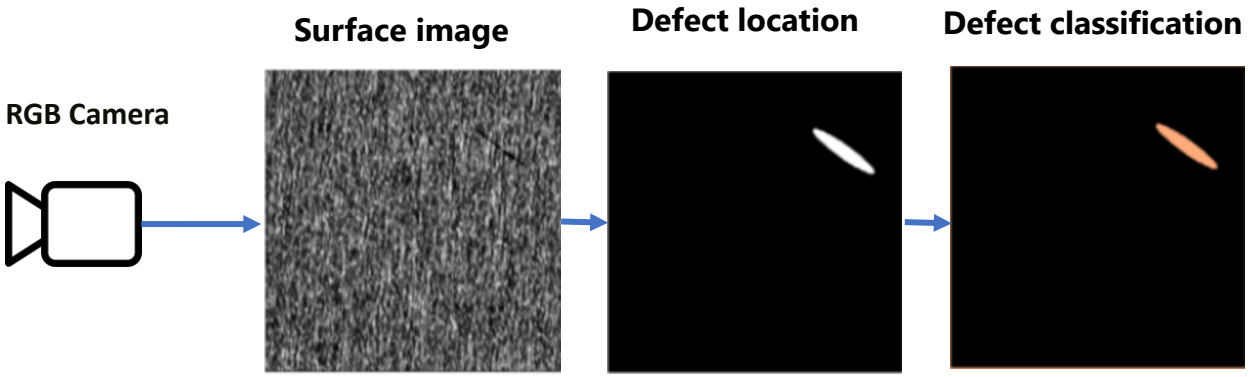
Industry Challenges | Manufacturing

Defect Detection

M.1

Manufacturing Challenge | Defect Detection

General Description



In order to ensure zero defect in manufactured components and products, quality inspection is a key capability that manufacturing companies should develop. Manual inspection is tedious, labor intensive and often error prone. Vision-based automated quality inspection is a promising technology for manufacturing companies. AI is a potential enabler to develop such solutions.

Must work globally across several types of industrial products and several categories of defects.

Industry (AI Solutions)	☐ Automotive ☐ Healthcare ☑ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☑ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Manufacturing Challenge | Defect Detection

Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	In order to ensure zero defect in manufactured components and products, quality inspection is a key capability that manufacturing companies should develop. Manual inspection is tedious, labour intensive and often error prone. Vision-based automated quality inspection is a promising technology for manufacturing companies. AI is a potential enabler to develop such solutions.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Does a surface of a manufactured part contain a defect?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on defect detection on the DAGM20117 / KolektorSDD/KolektorSDD2 data sets • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• Automatic Defect Inspection Using the NVIDIA End-to-End Deep Learning Platform, 2019 (https://developer.nvidia.com/blog/automatic-defect-inspection-using-the-nvidia-end-to-end-deep-learning-platform/) • Jakob Bozi et al., Mixed supervision for surface-defect detection: from weakly to fully supervised learning, arXiv:2104.06064v3 [cs.CV] 20 Apr 2021

Datasets, Tools, and Resources	

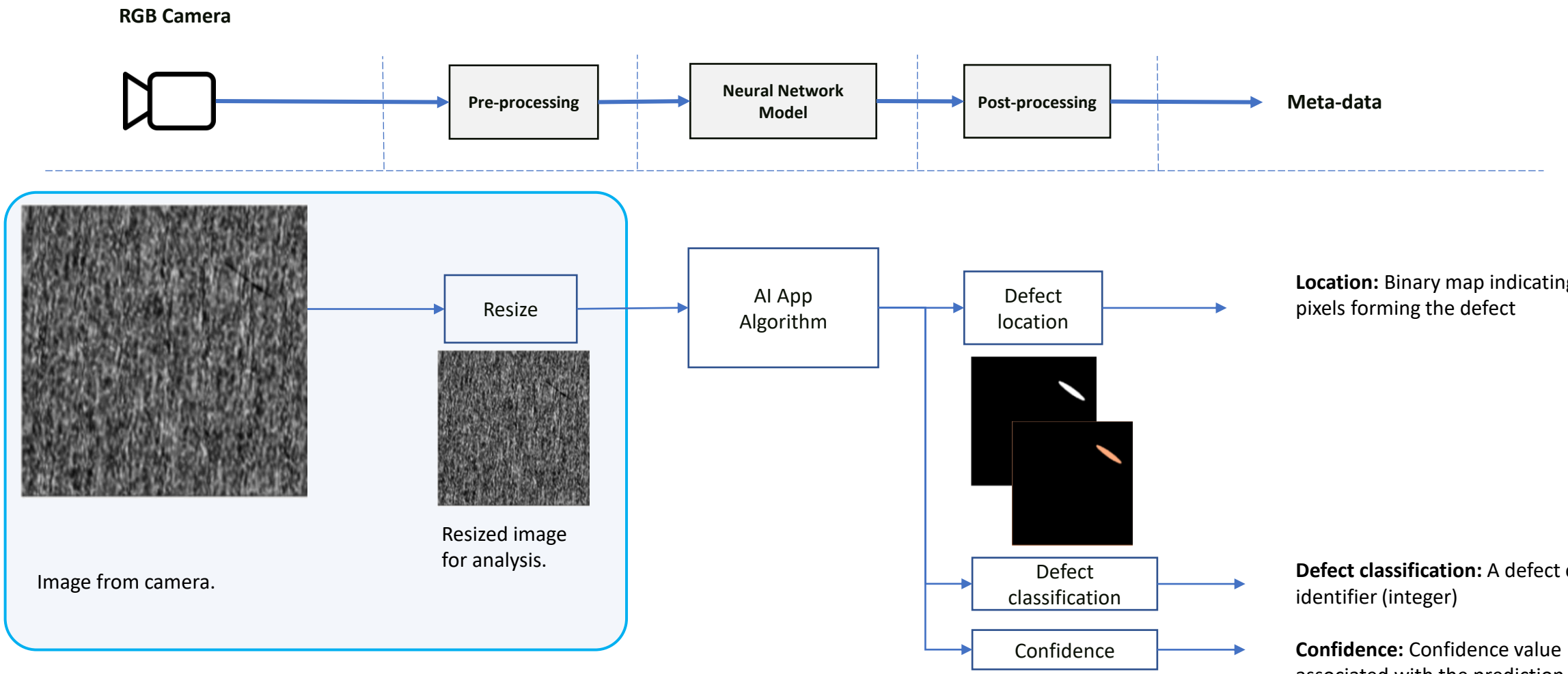
Tools and Resources
Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.
	• Reference papers:
	  ○ https://arxiv.org/pdf/2104.06064v3.pdf
	○ https://ieeexplore.ieee.org/document/8715489
	○ https://www.sciencedirect.com/science/article/abs/pii/S0007850616300725
	• Reference github:
	  ○ https://github.com/NVIDIA/DeepLearningExamples/tree/master/TensorFlow/Segmentation/UNet_Industrial
	• The DAGM 2007 dataset
	  ○ https://conferences.mpi-inf.mpg.de/dagm/2007/prizes.html
	• The KolektorSDD dataset :
	  ○ https://paperswithcode.com/dataset/kolektorsdd
	• The KolektorSDD2 dataset :
	  ○ https://paperswithcode.com/dataset/kolektorsdd2

Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Manufacturing Challenge | Defect Detection

Technical Specifications | Overview

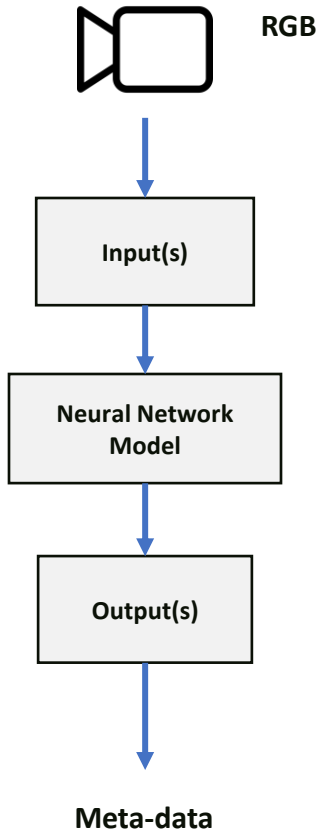
BONSAPPS
AI-as-a-Service for the Deep Edge



Manufacturing Challenge | Defect Detection

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB or IR camera.
	Data Format		• 8bit grayscale image of [width x height] • JSON meta-data
	Data Type		☑ Image ☐ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Defect location • Defect class
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any*	Input	N/A	N/A
	Output	Defect location	Binary map indicating the pixels forming the defect
		Defect class	A defect class identifier (integer)



Manufacturing Challenge | Defect Detection

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is defect detection and classification accuracy. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Defect Detection & Classification Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	**Model Accuracy**		**Deployment**	
	Metric	F1 (Precision / recall)	Frame Rate	30 FPS
	Accuracy	>= 95%	Peak Memory	200 MB
			CPU % Usage	<10%
			Storage	20 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \\ --target-url http://target-hardware.local:8080/inference \\ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

BONSAPPS

AI-as-a Service for the Deep Edge

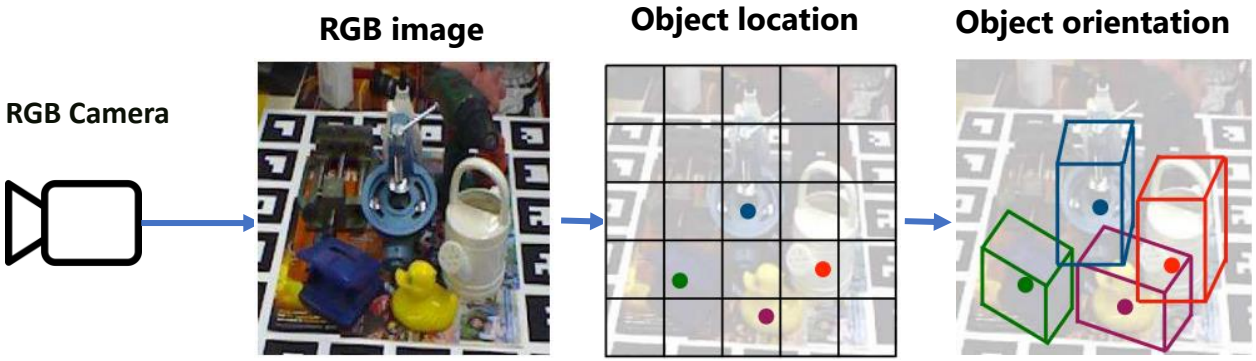
Industry Challenges | Manufacturing

6DoF Object Detection

M.2

Manufacturing Challenge | 6DoF Object Detection

General Description



The goal of this challenge is to automatically detect object location and orientations (6 Degrees of Freedom – DoF) in a production environment. The capability will be used by high performance feeding systems in Bin Picking scenarios.

Must work globally across several types of industrial products.

Industry (AI Solutions)	☐ Automotive ☐ Healthcare ☑ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Manufacturing Challenge | 6DoF Object Detection

Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Production lines with different manufacturing and assembly stations/machines are often interconnected using transfer systems like conveyors. In order to feed the production lines with well positioned/oriented components and parts, a feeding system is often needed. Bin picking is one of the major challenges to solve in order to have high performance feeding system. Vision based and AI enabled 3D object detection with six degrees of freedom (6DoF) is an essential capability.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	What is the location and the orientations of a 3D object (manufactured parts)?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on 3D object detection using Fraunhofer IPA Bin-Picking and LINEMOD datasets • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• Yongzhi Su et al. SynPo-Net—Accurate and Fast CNN-Based 6DoF Object Pose Estimation Using Synthetic Training, 2021

Datasets, Tools, and Resources	

Tools and Resources
Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.
	• Reference papers:
	  ○ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7796199/
	  ○ https://arxiv.org/pdf/2011.05669.pdf
	  ○ http://openaccess.thecvf.com/content_cvpr_2018/papers/Tekin_Real-Time_Seamless_Single_CVPR_2018_paper.pdf
	• Reference github:
	  ○ https://github.com/microsoft/singleshotpose
	• Fraunhofer IPA Bin-Picking :
	  ○ https://www.bin-picking.ai/en/dataset.html
	• LINEMOD dataset :
	  ○ https://bop.felk.cvut.cz/datasets/
	• MVTEC ITODD data set (A DATASET FOR 3D OBJECT RECOGNITION IN INDUSTRY)
	  ○ https://www.mvtec.com/company/research/datasets/mvtec-itodd

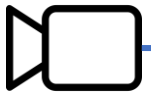
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Manufacturing Challenge | 6DoF Object Detection

Technical Specifications | Overview

BONSAPPS
AI-as-a-Service for the Deep Edge

RGB Camera



Pre-processing

Neural Network Model

Post-processing

Meta-data

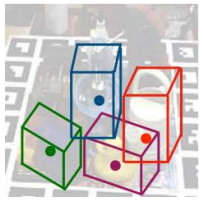
Image from camera.

Resize

Resized image for analysis.

AI App Algorithm

Object Location



Location: 2D bounding box

Object orientation

Orientation: 3D bounding box

Object classification

Classification: class probabilities

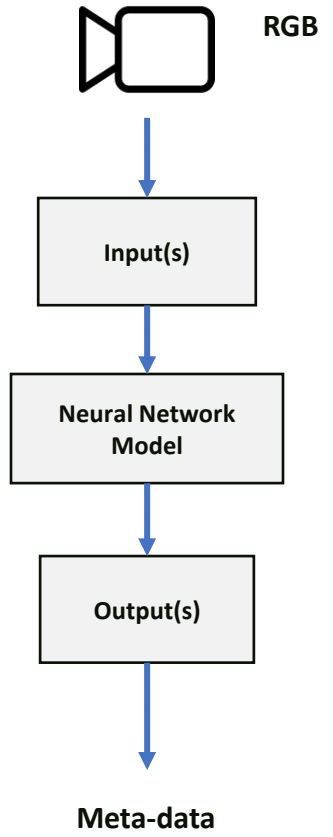
Confidence

Confidence: Confidence value associated with the prediction

Manufacturing Challenge | 6DoF Object Detection

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB camera.
	Data Format		• 32bit RGB image of [width x height] • JSON meta-data
	Data Type		☑ Image ☐ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Object location • Object orientation • Object classification • Detection & classification prediction confidence
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any*	Input	N/A	N/A
	Output	Object location	Bounding box
		Object orientation	



Manufacturing Challenge | 6DoF Object Detection

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is object location (bounding box) and object orientation. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Object location & orientations Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	PE: % of correctly estimaed position using 2D projection error (PE) ADD: % of correctly estimaed position using Average 3D Distance (ADD) of model vertices	Frame Rate	30 FPS
	Accuracy	>= 90%	Peak Memory	200 MB
			CPU % Usage	<10%
			Storage	20 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			
Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out			
Format	Docker Image			
Output	Evaluation Report (see table for details)			
Docker Version	Docker 19.03			
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1			

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Health

Remote Vital Signs

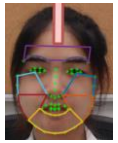
H.1

Healthcare Challenge | Remote Vital Signs

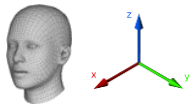
Overview

RGB Camera

3D Face Landmarks



Skin Regions of Interest



3D Headpose

3D Face Detection reveals key information on a person's state. It is an important clue for understanding Vital Signs. In a health assessment, information extracted from observation of 3D Face Landmarks, Skin Regions of Interest for rPPG and 3D Headpose can be used to provide information on head and eye movements, liveness and consciousness which can be used to assess Remote Vital Signs.

Must work globally across all people, of all ages, across the world. Must be robust in "at home" settings outside of a laboratory as well as in care facility conditions which may mean imperfect lighting conditions and occlusions found where a patient is, for example, resting in bed.

Industry (AI Solutions)	☐ Automotive ☑ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Healthcare Challenge | Remote Vital Signs

Detailed Description

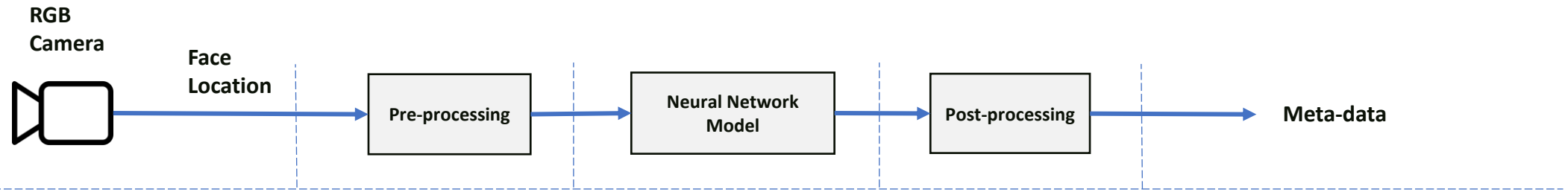
BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	As part of the process of monitoring in both clinical and home care situations there is a common need for non-invasive observation of various measures of a patients condition. This includes the remote observation of vital signs which can be done through assessment of head and eye movements through tracking of head pose and facial landmarks along with skin regions of interest for rPPG.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can head pose, landmarks and skin regions of interest be sufficiently accurately observed such that they can be used for remote observation of vital signs?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of facial landmark, head pose and skin region observations leading to development of production systems for deployment as clinical tools using standard mobile platforms. Validate usage of 3D landmarks in remote photoplethysmography (rPPG) monitors of heart rate without requiring physical contact.
References *Reference material available.*	Assessment of Deep Learning-based Heart Rate Estimation using Remote Photoplethysmography under Different Illuminations https://arxiv.org/pdf/2107.13193

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://arxiv.org/pdf/2106.03021.pdf **Reference Code** https://github.com/MCG-NJU/SADRNet **Dataset-300W-LP and Dataset-AFLW2000-3D** http://www.cbsr.ia.ac.cn/users/xiangyuzhu/projects/3ddfa/main.htm
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge | Remote Vital Signs

Overview



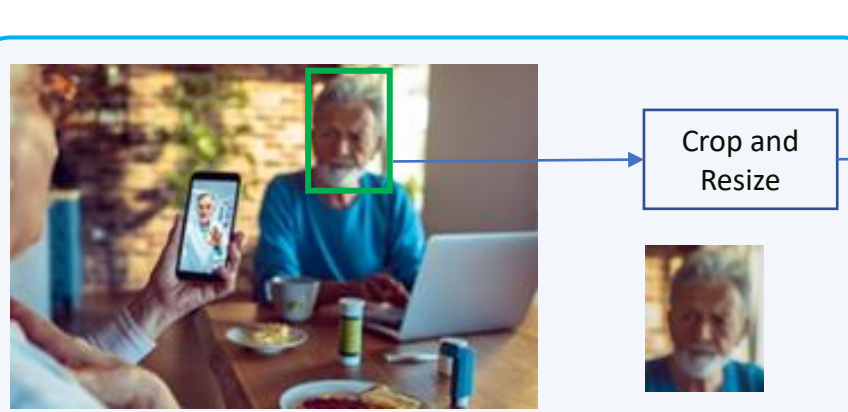


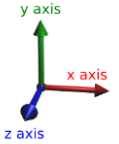
Image from camera and available face location.

Crop and Resize

Cropped region for analysis.

AI App Algorithm

Headpose Vector



3D head pose: Euler rotation angles in degrees:
yaw: "left-right" rotation around the vertical axis. Yaw is positive when the person is looking to his/her right
pitch: "up-down" rotation around the horizontal axis (left-right). Pitch is positive when the person is looking up
roll: "tilting" rotation around the horizontal axis (front-rear). Roll is positive when the person tilts his/her head to the left

Skin Regions of Interest

Skin Regions mapped using landmark coordinates for optimised rPPG .

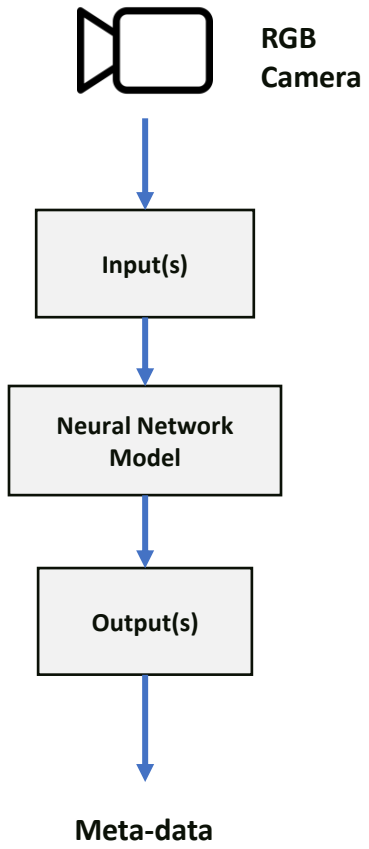
3D Face Landmarks

3D face landmarks: x,y,z position of facial landmarks.

Healthcare Challenge | Remote Vital Signs

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB camera. • 2D Face Location within image.
	Data Format		• 24bit color image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• 3D face landmarks and the yaw, pitch and roll Euler angles for head pose. • Skin Regions mapped using 3D face landmark coordinates
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Face Location	Location of face bounding box within image (x,y,width,height) in pixels. (0,0) is top left of image.
	Output	3D head pose	Euler rotation angles in degrees: yaw: "left-right" rotation around the vertical axis. Yaw is positive when the person is looking to his/her right pitch: "up-down" rotation around the horizontal axis (left-right). Pitch is positive when the person is looking up roll: "tilting" rotation around the horizontal axis (front-rear). Roll is positive when the person tilts his/her head to the left
		3D face landmarks	x, y, z position of each facial landmark
		Skin Regions	Mapped using facial landmark coordinates



Healthcare Challenge | Remote Vital Signs

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is %age error in the measurement of 3D face landmarks, head pose and face region location. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Landmark and Headpose Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame Rate	20 FPS
	Accuracy	4% Headpose	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	N/A
	Availability	TBA	Storage	TBA
Target Platform	Bonseyes Developer Platforms |iPhone 10 and above			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	iPhone 10 and above

BONSAPPS

AI-as-a Service for the Deep Edge

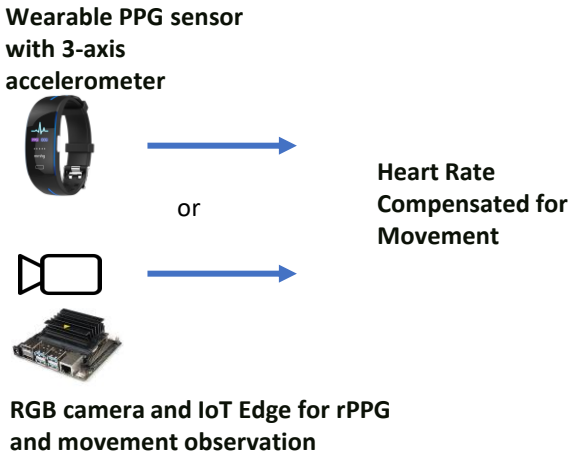
Industry Challenges | Health

Heart Rate Detection

H.2

Healthcare Challenge| Heart Rate Detection

Overview



Time Series Analysis provides details on a signal such that condition information can be estimated. It has important application within Patient Monitoring for human Heart Rate Detection, providing heart rate information compensated for movement. There is a choice of methods for generating the needed information including:

(i) a PPG (photoplethysmography) sensor combined with a 3-axis accelerometer in a wearable device or
(ii) rPPG (remote PPG) observed, along with movement observation, through an RGB camera.

A PPG sensor observes the capillaries in the wrist which fill with blood when the heart ventricles contract. The light emitted by the PPG sensor is absorbed by red blood cells in these capillaries and a photodetector will see the drop in reflected light. When the blood returns to the heart, fewer red blood cells in the wrist absorb the light and the photodetector sees an increase in reflected light. The period of this oscillating waveform provides the pulse rate.

rPPG-based methods observe subtle colour variations of human skin. Pulsatile blood propagating in the cardiovascular system changes the blood volume in skin tissue. The oxygenated blood circulation leads to fluctuations in the amount of haemoglobin molecules and proteins thereby causing variations in the optical absorption and scattering across the light spectrum. The period of oscillation of these fluctuations as shown by the colour variation provides the pulse rate.

Must be robust under real world conditions providing meaningful information for patients in all activity levels from rest to extreme levels of movement.

Industry (AI Solutions)	☐ Automotive ☑ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☑ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☑ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Healthcare Challenge| Heart Rate Detection

Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Within patient monitoring there is a need for robust solutions providing meaningful information on key parameters such as heart rate for patients under all activity levels from rest to extreme levels of movement. Data related to heart rate and movement can be collected from either: (i) a PPG (photoplethysmography) sensor along with a 3-axis accelerometer embedded along with and MCU in a wearable device. or: (ii) rPPG (Remote PPG) and movement data collected via an RGB camera and IoT Edge embedded system. The collected Time Series data needs to be analyzed in order to provide a detection result which is compensated for physical movement.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can a time series analysis of the data provide by either (i) a physical sensor based system with embedded MCU or (ii) a camera based system with IoT Edge processing sufficiently robust and accurate movement compensated heart rate detection?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishment of a baseline performance for time series analysis: (i) of PPG plus 3-axis accelerometer data on an embedded MCU or (ii) of rPPG data plus movement data via image capture on an IoT Edge system so as to provide robust heart rate detection compensated for movement leading to development of production device and systems utilising such methods.
References *Reference material available.*	Non-contact Pain Recognition from Video Sequences with Remote Physiological Measurements Prediction https://arxiv.org/pdf/2105.08822.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Papers** PPG and rPPG https://arxiv.org/pdf/2104.09313.pdf PPG https://www.mdpi.com/2079-9292/10/14/1715 rPPG https://arxiv.org/abs/2007.08213 rPPG https://arxiv.org/pdf/2004.12292.pdf **Reference Code** PPG https://github.com/MAlessandrini-Univpm/rnn-ppg-har rPPG https://github.com/ZitongYu/PhysNet **Dataset** https://github.com/yangze68/BH-rPPG-dataset https://sites.google.com/view/ybenezeth/ubfcrppg https://osf.io/fdrbh/
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge| Heart Rate Detection

Wearable PPG sensor with 3-axis accelerometer

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

Time Series Data

PPG and 3-axis accelerometer data

AI App Algorithm → Heart Rate

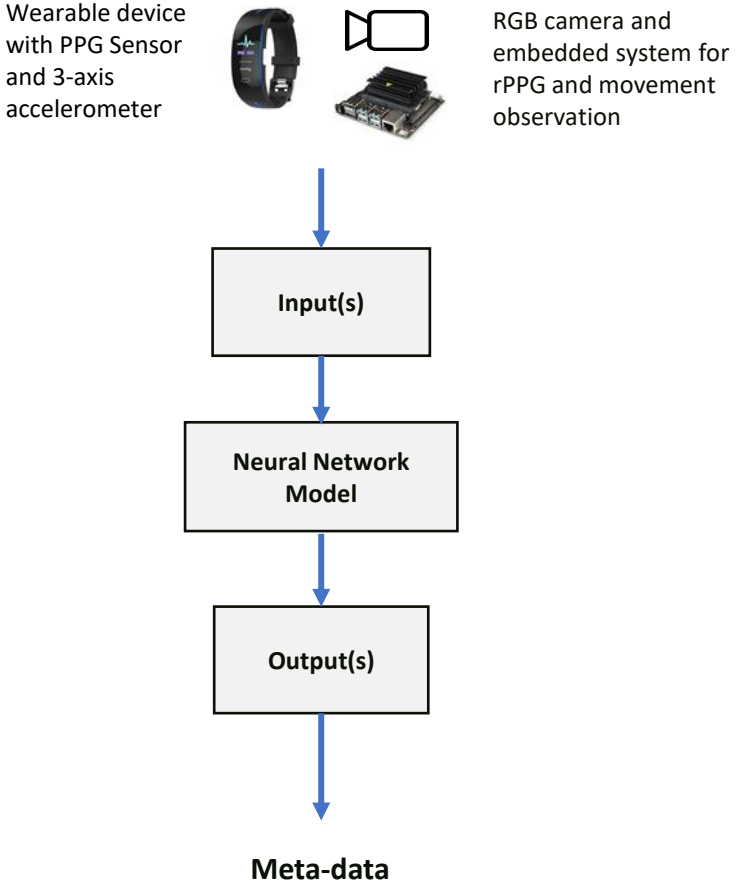
rPPG and observed movement data

Heart Rate estimation compensated for patient movement using Time Series Analysis of PPG or rPPG and Motion Data

Healthcare Challenge| Heart Rate Detection

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• PPG (photoplethysmography) sensor data • 3-axis accelerometer data OR • Image from RGB camera. • 2D Face Location within image.
	Data Format		• Time series data • JSON meta-data OR • RGB image of [width x height] for rPPG (remote photoplethysmography) • 8bit grayscale image of [width x height] for movement observation • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☑ Time Series
Output *Please indicate the output data format and type.*	Description		• Heart rate estimation compensated for motion data.
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	PPG or rPPG	Uncorrected waveform with potential movement induced noise.
		Motion Data	x / y / z acceleration data in m/s^2
	Output	Heart Rate (BPM)	Measured value compensated for movement induced noise



Healthcare Challenge| Heart Rate Detection

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out appropriate to each method based on reference datasets of signal and ground truth for PPG and image stream and ground truth for rPPG. For each method , the result is the %age error in estimated heart rate versus the ground truth. Deployment metrics will be collected and measured for latency, samplerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy of heart rate measured compared to ground truth.
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame or Sample Rate	60 Frames or Samples/sec
	Accuracy	TBA	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	N/A
	Availability	TBA	Storage	TBA
Target Platforms per Method	Bonseyes Developer Platforms |ST Microelectronics STM32H747 Bonseyes Developer Platforms |NVIDIA Jetson Nano			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	ST Microelectronics STM32H747 for PPG or NVIDIA Jetson Nano for rPPG

BONSAPPS

AI-as-a Service for the Deep Edge

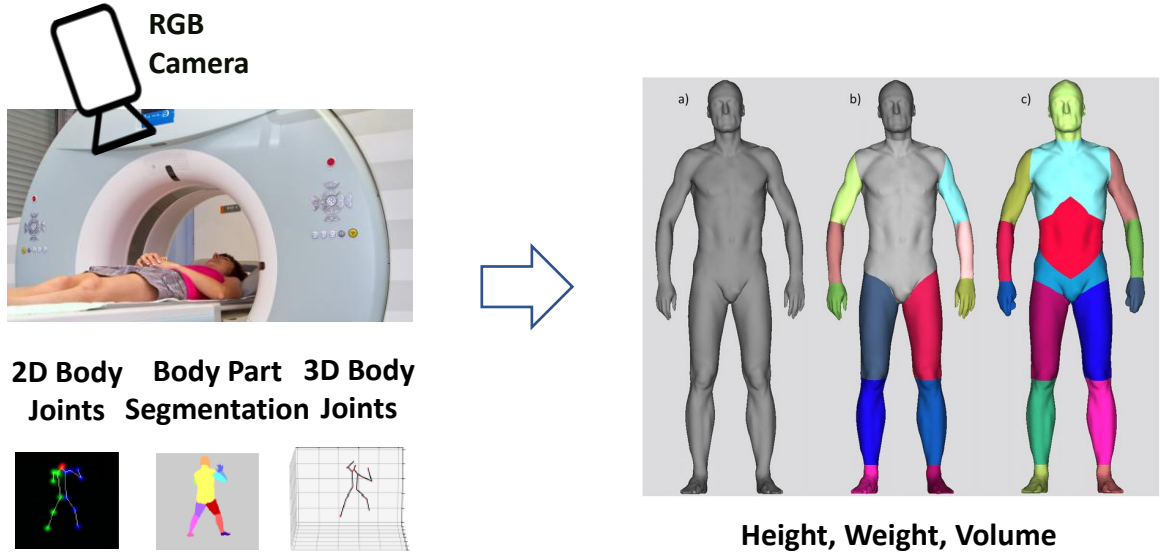
Industry Challenges | Health

3D Body Detection

H.3

Healthcare Challenge | 3D Body Detection

Overview



3D Body Detection provides information on a patient's body using body part segmentation and 3D joint estimation from 2D estimation. Height, weight and volume information estimates can be made in order to support patient care workflow in, for example, body scanning operations. The patient's image to be collected via an RGB camera and the image to be processed on an IoT Edge embedded system.

Must work across all body types. Must be robust in clinical environments with variable lighting conditions.

Industry (AI Solutions)	☐ Automotive ☑ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☑ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

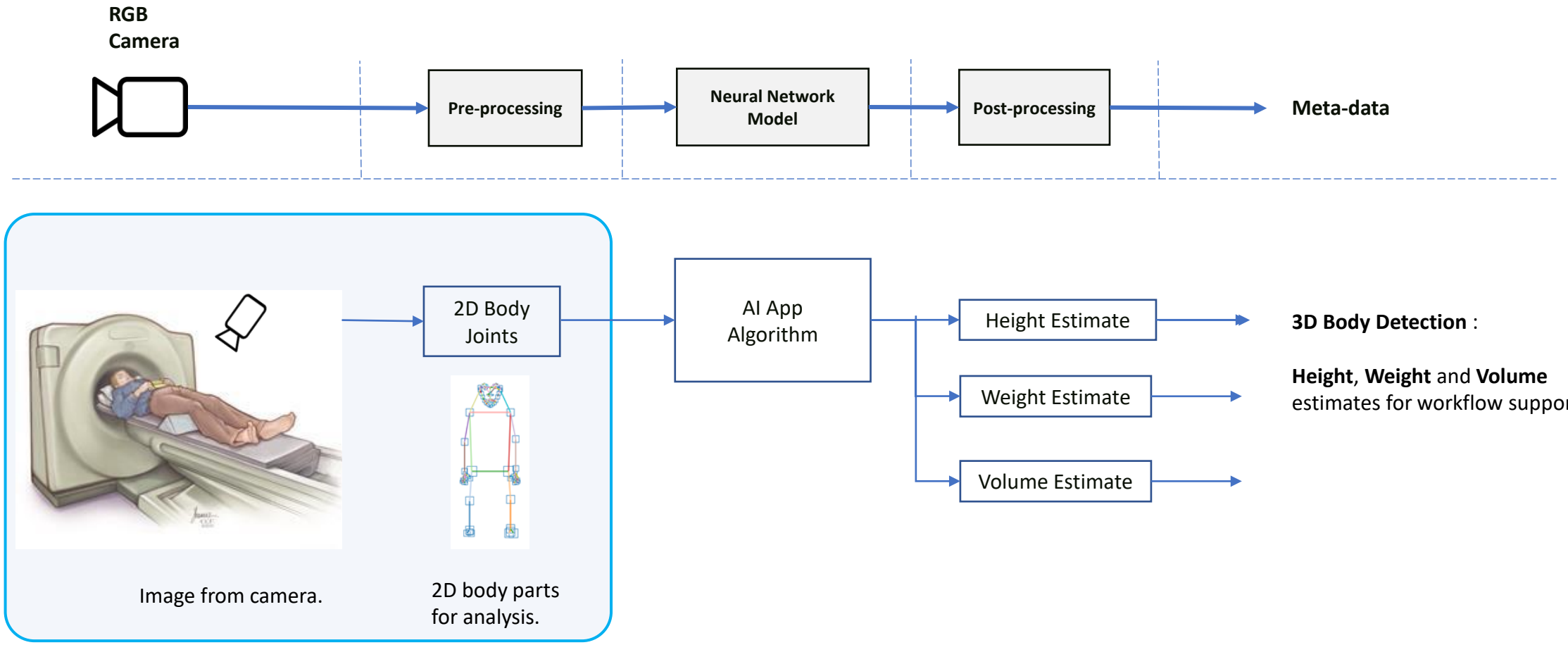
Healthcare Challenge | 3D Body Detection Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Within some patient care workflows there is a need for automatic estimation of patient parametric data to assist in management of the work flow, for example in helping with the set up and control of some equipments. An automated estimation of a patients Height, Weight and Volume has potential to be of great use in such applications as, for example, management of the CT scanning process.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can 3D Body Detection from images collected via an RGB camera and processed on an IoT Edge embedded system provide a sufficiently accurate estimation of patient Height, Weight and Volume?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishment of a baseline performance on an edge platform of automatic observation of patient Height, Weight and Volume leading to development of production systems to assist in the management of patient workflow.

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://arxiv.org/pdf/2107.02259.pdf **Reference Code** https://github.com/gulvarol/bodynet **Datasets** https://www.di.ens.fr/willow/research/surreal/data/ https://github.com/fleinen/SURREALvols SURREALVols adds body part volumes and the person's body height to the SURREAL dataset.
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge | 3D Body Detection

Overview



3D Body Detection :

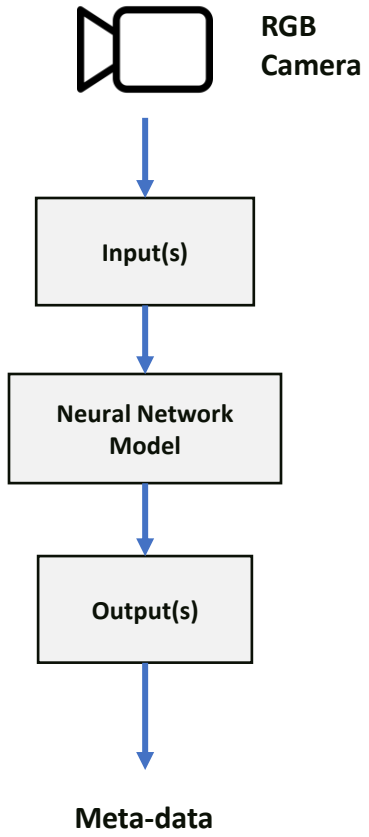
Height, **Weight** and **Volume** estimates for workflow support.

Available as Datatool for Reference Datasets

Healthcare Challenge | 3D Body Detection

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB camera.
	Data Format		• 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Height, Weight and Volume estimates
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	Image from camera	Image from workspace including human subject
	Output	Body Characteristic Estimates	• Height in metres • Weight in kilograms • Volume in cubic metres



Healthcare Challenge | 3D Body Detection

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is an %age error in the estimate of height in metres, weight in kilograms and volume in cubic metres . Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy of Height, Weight and Volume estimates
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	**Model Accuracy**		**Deployment**	
	Metric	TBA	Frame Rate	0.2 FPS
	Accuracy	10% of volume	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	TBA
	Availability	TBA	Storage	TBA
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson Nano			

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson Nano

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Automotive

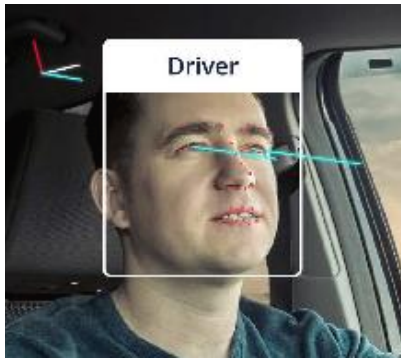
Gaze Detection

A.1

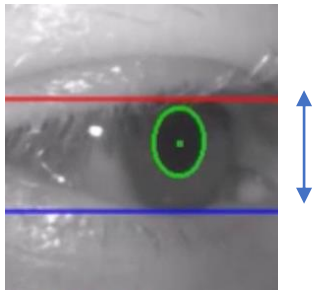
Automotive Challenge | Gaze Detection

General Description

RGB or IR Camera



Eye Closure



Gaze estimation reveals where a person is looking. It is an important clue for understanding human intention. In driving, gaze can be combined with gestures to understand intended interaction with objects, or used with eye state information to determine if the driver is distracted or drowsy to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Gaze Detection

Detailed Description

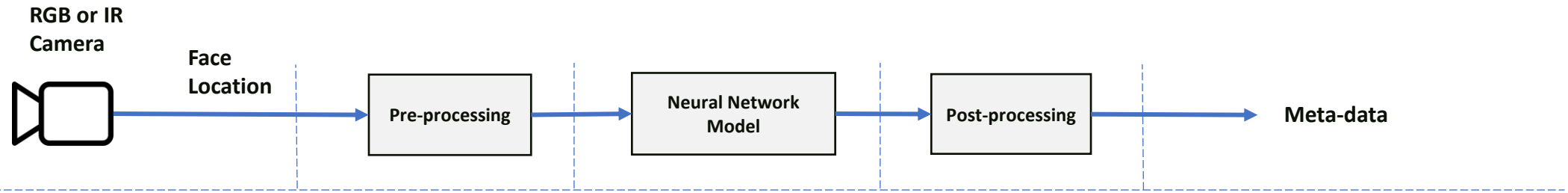
BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Distraction while driving is common but it is widely considered dangerous due to its potential for causing distracted driving and crashes. A high number of crashes are related to conducting calls on a phone and texting while driving which takes drivers “eyes off the road” that results in drivers being distracted, decreasing the driver's awareness on the road, leading to more car crashes.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can eye gaze and state be accurately detected to be used to detect distraction and drowsiness?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting dangerous driver activities leading to developing a production system deployed to production vehicles from 2024 onwards with the goals to reduce the number of accidents and save lives through early detection and warning of dangerous driver activities.
References *Reference material available.*	Mobile phone use & distraction (PDF) (Report). Centre for Accident Research & Road Safety - Queensland (CARRS-Q). September 2015. https://research.qut.edu.au/carrsq/wp-content/uploads/sites/45/2017/12/Mobile-phone-distraction-email.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved .*	**Reference Paper** https://arxiv.org/pdf/2105.14424 **Reference Code** https://github.com/yihuacheng/GazeTR **Datasets** MPIIFaceGaze **(**https://www.perceptualui.org/research/datasets/MPIIFaceGaze/**)** Office/home environment with real lighting with mall headpose and small gaze angles with low resolution web cameras and participants sitting. ETH-X Gaze **(**https://ait.ethz.ch/projects/2020/ETH-XGaze/**)** Lab environment and simulated lighting with large headpose and gaze angles and high resolution cameras with participants sitting.
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Gaze Detection

Technical Specifications | Overview



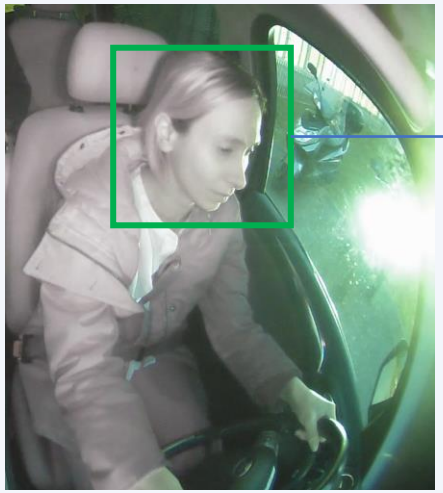


Image from camera and available face location.

Crop and Resize

Cropped region for analysis.

AI App Algorithm

Left Gaze Vector

Right Gaze Vector

Open / Closed

Visibility

Gaze (yaw/pitch euler angle): "left-right“ and "up-down" rotation around the vertical/ horizontal axis. Yaw is positive when the person is looking to his/her right. Pitch is positive when the person is looking up.

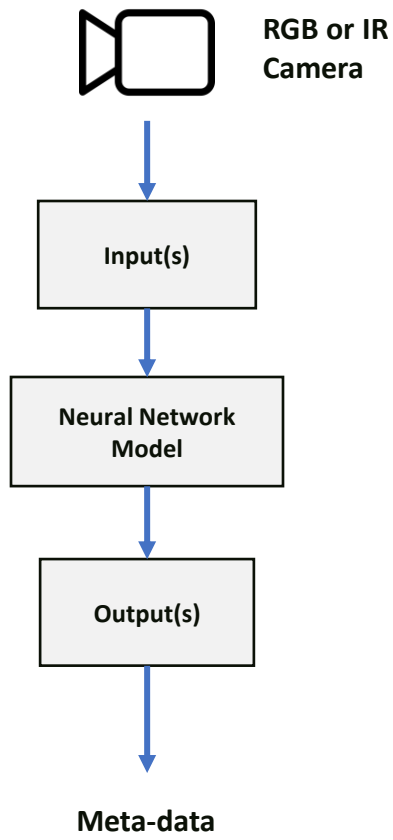
Eye Open/Closed (true/false): True if eye is open and false if eye is fully closed.

Eye Visibility (confidence): Level of eye visibility, 1 if eye is fully visible, and 0 if eye is not visible at all.

Automotive Challenge | Gaze Detection

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB or IR camera. • 2D Face Location within image.
	Data Format		• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Gaze • Eyes Open/Closed • Eye Visibility
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Face Location	Location of face bounding box within image (x,y,width,height) in pixels. (0,0) is top left of image.
	Output	Gaze	Gaze yaw/pitch as euler angle. "left-right“ and "up-down" rotation around the vertical/ horizontal axis. Yaw is positive when the person is looking to his/her right. Pitch is positive when the person is looking up.
		Eyes Open/Closed	Eyes open/closed as binary true or false. True if eye is open and false if eye is closed.
		Eye Visibility	Eye visibility as confidence value between 0.0 and 1.0. Level of eye visibility, 1.0 if eye is fully visible, 0.5 if eye is partially visible, and 0.0 if eye is not visible.



Automotive Challenge | Gaze Detection

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is gaze angle error in degrees. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Gaze Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame Rate	60 FPS
	Accuracy	<=4.0 degrees	Peak Memory	200 MB
	Ethics Bias	<=1.0 degrees	CPU % Usage	<10%
	Availability	99%	Storage	20 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Automotive

Body Part Tracking

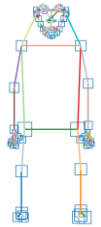
A.2

Automotive Challenge | Body Part Tracking

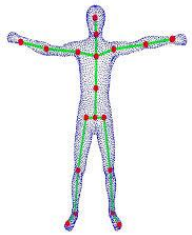
General Description

RGB or IR Camera

2D Body Joints



3D Body Joints



Body part tracking estimates where a person is located in 2D and 3D. It is an important for understanding human behavior and activities. In driving, body part tracking can used to understand driver activities that are linked with distraction, or to detect out of position poses to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Body Part Tracking

Detailed Description

BONSAPPS
AI-as-a-Service for the Deep Edge

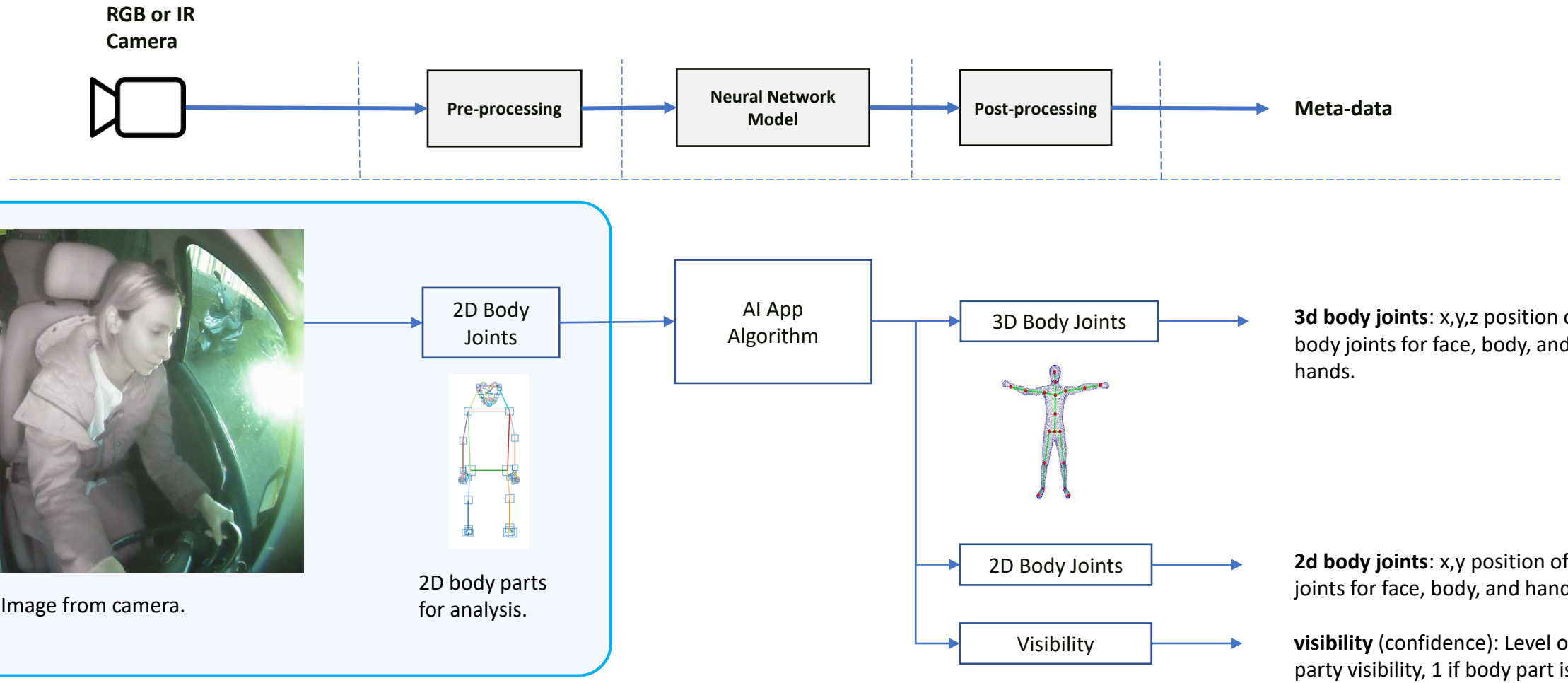
User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Understanding the position of the human body is important in observing drivers as this can provide very useful information for ensuring safety. For example, detection of a driver turned around to look in the back seat of a car can indicate: (i) a potentially dangerous situation at a time when the driver is in control of a moving vehicle, or; (ii) a situation where an automated vehicle handing over manual control to the driver is not recommended until the driver returns to a correct position.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can body parts be accurately tracked such that this information can be used to detect potentially dangerous positioning of a driver's body?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting dangerous driver body positioning leading to developing a production system deployed to production vehicles from 2024 onwards with the goals to reduce the number of accidents and save lives through early detection and warning of dangerous driver activities.
References *Reference material available.*	Over the next years, the number of autonomous vehicles is expected to increase. This new paradigm will change the role of the driver inside the car, and so, for safety purposes, the continuous monitoring of the driver/passengers becomes essential. This monitoring can be achieved by detecting the human body pose inside the car to understand the driver/passenger's activity. https://arxiv.org/pdf/2012.13392.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Papers** https://arxiv.org/pdf/2105.02465.pdf https://arxiv.org/abs/2107.13994 http://users.ics.forth.gr/~argyros/mypapers/2021_01_ICPR_Qammaz.pdf https://arxiv.org/pdf/2103.10455.pdf https://arxiv.org/pdf/2010.13302v1.pdf **Reference Codes** https://github.com/jfzhang95/PoseAug https://github.com/paTRICK-swk/Pose3D-RIE https://github.com/FORTH-ModelBasedTracker/MocapNET https://github.com/zczcwh/PoseFormer https://github.com/zczcwh/DL-HPE **Datasets** http://vision.imar.ro/human3.6m/ http://gvv.mpi-inf.mpg.de/3dhp-dataset/ http://humaneva.is.tue.mpg.de/datasets_human_1 https://github.com/zhezh/occlusion_person https://people.eecs.berkeley.edu/~zhecao/hmp/
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Body Part Tracking

Technical Specifications | Overview

BONSAPPS
AI-as-a-Service for the Deep Edge

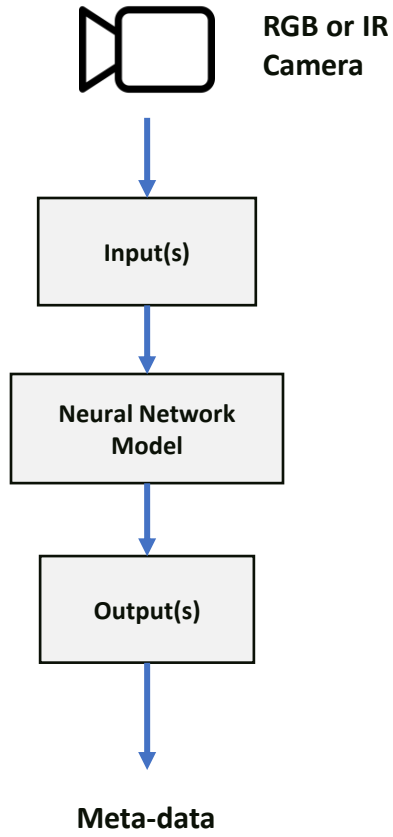


Available as Datatool for Reference Datasets

Automotive Challenge | Body Part Tracking

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB or IR camera. • 2D Body Part Locations within image.
	Data Format		• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• 2D Body Pose • 3D Body Pose • Body Part Visibility
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Body Part Location	Estimated 2D x,y locations of body joints
	Output	2D Body Pose	Refined 2D x,y locations of body joints from 3D estimate
		3D Body Pose	3D x,y,z locations of body joints
		Body Part Visibility	Body joint visibility confidence



Automotive Challenge | Body Part Tracking

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is 3D body party location error in mm. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Performance	Model Accuracy		Deployment	
	Metric	MPJPE	Frame Rate	20 FPS
	Accuracy	<= 25mm	Peak Memory	300 MB
	Ethics Bias	<= 10mm	CPU % Usage	<50%
	Availability	99%	Storage	100 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	3D Body Part Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Automotive

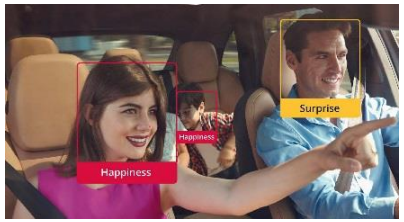
Gesture Recognition

A.3

Automotive Challenge | Gesture Recognition

General Description

RGB or IR Camera



Hand Gestures

Gesture recognition determines a gesture given movements from hand, body, or face body parts. It is an important for understanding human behavior from non-verbal cues or provide commands. In driving, gesture recognition can used to send control commands to human-machine-interfaces, or to detect dangerous behaviors such as micro-sleeps to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Gesture Recognition

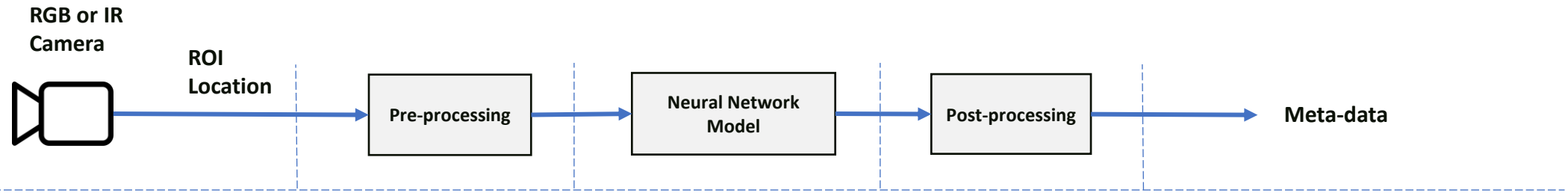
Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Understanding human behaviour from non-verbal cues and the provision of commands through gestures is important to improved human-machine-interfaces (HMI). In driving, gesture recognition can used to send control commands to HMI, or to detect dangerous behaviours such as micro-sleeps to ensure safe driving when using automation technology.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can gestures be accurately tracked such that this information can be used to detect commands and potentially dangerous driver states?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting gestures leading to developing a production system deployed to production vehicles from 2024 onwards with the twin goals of (i) reducing the number of accidents and saving lives through early detection and warning of dangerous driver states and (ii) increasing useability through improved HMI.
References *Reference material available.*	Gesture recognition is technology that uses sensors to read and interpret hand movements as commands. In the automotive industry, this capability allows drivers and passengers to interact with the vehicle — usually to control the infotainment system without touching any buttons or screens. https://arxiv.org/pdf/2107.12167 https://arxiv.org/ftp/arxiv/papers/2102/2102.10497.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://openaccess.thecvf.com/content_ECCVW_2018/papers/11134/Hou_Spatial-Temporal_Attention_Res-TCN_for_Skeleton-based_Dynamic_Hand_Gesture_Recognition_ECCVW_2018_paper.pdf https://arxiv.org/pdf/2004.03259.pdf https://arxiv.org/pdf/2001.05833.pdf https://arxiv.org/pdf/1907.09658.pdf **Reference Code** https://github.com/V-Sense/ACTION-Net https://github.com/abedicodes/ResNet-TCN https://github.com/mit-han-lab/temporal-shift-module https://github.com/BlurryLight/DD-Net-Pytorch **Dataset** https://deepmind.com/research/open-source/open-source-datasets/kinetics/ http://crcv.ucf.edu/data/UCF101.php https://20bn.com/datasets/something-something/v1 https://20bn.com/datasets/something-something/v2 https://20bn.com/datasets/jester http://www-rech.telecom-lille.fr/DHGdataset/ https://research.nvidia.com/publication/online-detection-and-classification-dynamic-hand-gestures-recurrent-3d-convolutional https://gibranbenitez.github.io/IPN_Hand/ http://jhmdb.is.tue.mpg.de/ http://tosca.cs.technion.ac.il/book/shrec.html
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Gesture Recognition

Technical Specifications | Overview



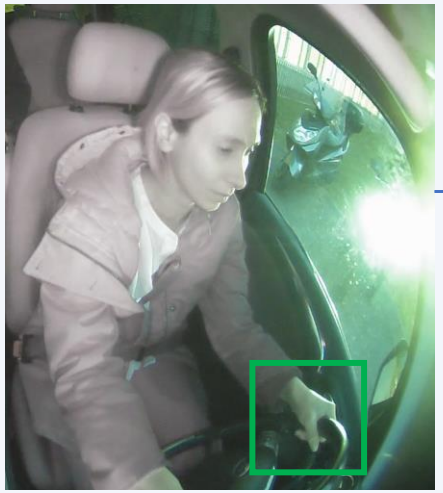
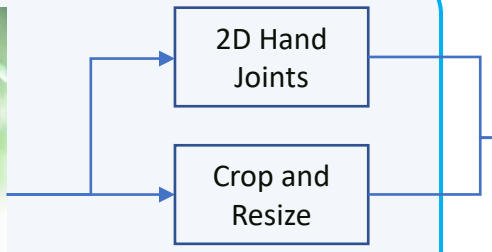


Image from camera and available ROI location.

Cropped region for analysis.



Available as Datatool for Reference Datasets

gesture : detected gesture from hand, face or body.

Gestures related to Hands

- Static Control (Thumbs up/down, etc ...)
- Dynamic Control (Slide right/left, etc ...)
- Dynamic Activity (Using object, playing game, hands on wheel etc ...)

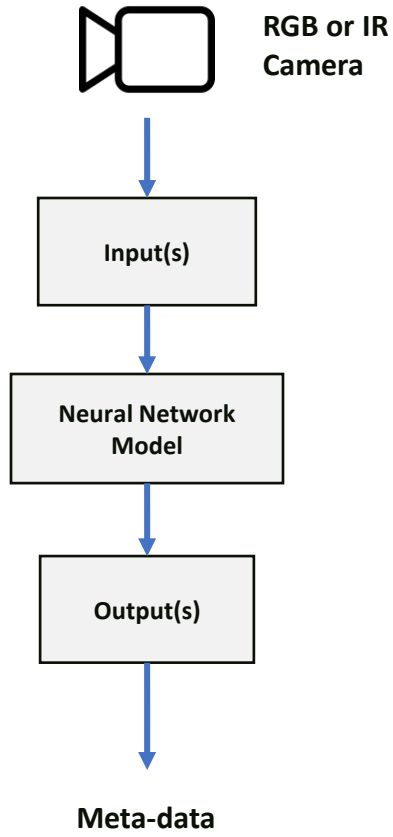
Gestures related to the Head and Pose

- Drowsiness (Nodding, micro-sleep, blinks)
- Health Conditions (Unconscious, seizure, physical impairment, etc)
- Expected Visual Movements (Look left/right/up/down, turn back seat, blind spot, mirrors etc)

Automotive Challenge | Gesture Recognition

Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB or IR camera. • 2D Hand Part Locations within image.
	Data Format		• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Gesture
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Hand Part Location	2d skeleton joint information
	Output	Gesture	Recognized gesture of sequence



Automotive Challenge | Gesture Recognition

Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is gesture recognized. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Gesture Confusion Matrix
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	Confusion Matrix	Frame Rate	10 FPS
	Accuracy	95%	Peak Memory	100 MB
	Ethics Bias	< 1%	CPU % Usage	N/A
	Availability	99%	Storage	50 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

BONSAPPS

Thank you!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101015848. Neither the European Commission (EC) nor any person acting on behalf of the Commission is responsible for how the following information is used. The views expressed in this document are the sole responsibility of the authors and do not necessarily reflect the views of the EC.