Decree of the Rector n. 1289 of 04/12/2023

Competition for awarding 1 research grant at the University of Udine

DISCLAIMER:
The official and legally binding call for applications is in Italian only. This document cannot be used for legal purposes and is only meant to provide information in English on the call for applications (Decree of the Rector n. 1289 of 04/12/2023). Please refer to the official call published on: https://www.uniud.it/it/albo-ufficiale

Any change and integration will be made available on the above mentioned web page. Therefore, no personal written communication regarding the examination date and/or competition results shall be provided to applicants.

Annex 1

Competition Notice for the award of 1 research grant for carrying out research activities at the University of Udine on the following subject: “Tracking in Egovision for Applied Memory (TEAM)” SSD: ING-INF/05 (principal investigator, Christian Micheloni).

Research fellowship financed with the resources of the research project PRIN 2022 PNRR, Prot. n. P20225MSER, titled “TEAM - Tracking Enables Application Memories”. Public call No. 1409 of 14/09/2022 – PRIN 2022 PNRR M4C2 Inv. 1.1. CUP G53D23006680001.

Art. 1

A selection procedure is hereby announced for the award of 1 research grant at the University of Udine, as identified in Attachment A which constitutes an integral and substantial part of this call.

The research grant is linked to the research project and is subject and conditioned upon the relative funding.

Specifically, the project is placed within the context of the Italian National Recovery and Resilience Plan (i.e., PNRR) – Mission 4: Education and research, Component 2: From research to business, Investment 1.1: Fund for the National Research Programme (PNR) and Research Projects of Significant National Interest (PRIN), funded by the EU-Next GenerationEU. Project PRIN 2022 PNRR, Prot. n. P20225MSER, titled “TEAM - Tracking Enables Application Memories”. CUP G53D23006680001.

The fellowship may be renewed, in compliance with Art. 22, Law No. 240 of 30 December 2010 (as in the text in force before the implementation of the Conversion Law of the D.L. 36/2022, L. 79/2022), Law No. 11 of 27 February 2015, and the current regulations of the University of Udine for awarding research grants, issued with the Rector’s Decree No. 182 of 31 March 2021. The renewal is subject to the scientific coordinator’s positive assessment of the researcher’s activities, an adequate scientific rationale, and a corresponding financial covering.

The activities pertaining to this research fellowship will be monitored for compliance with the PNRR’s Do No Significant Harm principle (hereinafter DNSH), that is, they will not cause significant harm to the environment.
This call guarantees equal generational, gender and territorial opportunities.

The research findings resulting from the fellowship, as well as the related data, will be published in compliance with the Open Science and FAIR Data principles.

The research fellowship does not give rise to any right with regards to accessing University posts.

Any personal communication to candidates related to this selection will be sent exclusively to the email address indicated when registering for the selection, as mentioned in Art. 5.

Art. 2
The research grant described in this competition announcement and the required qualifications to apply for the position are identified in Attachment A. The lack of the admission requirements leads to the automatic exclusion from the competition procedure.

Possession of a PhD or equivalent degree obtained abroad or, only for the interested areas, of a medical specialization accompanied by an adequate scientific production, constitutes a preferential qualification for awarding the research fellowship of this selection, if it has not been provided as a mandatory requirement.

For the only purpose of the admission to the competition, the Examining Board (Art. 7) shall assess the equivalence of the qualification obtained abroad, except for the evaluation of the medical specialization qualification to which Article 38 of the Legislative Decree 165/2001 and subsequent modifications and additions, and EU regulations on the matter, shall be applied.

The Examining Board will proceed to the evaluation of the qualification obtained abroad according to the documentation attached to the application form. The Examining Board may exclude the candidate if the submitted documentation does not provide sufficient information for the assessment. Therefore, applicants must enclose all the documentation in their possession relating to their qualification in order to provide the Examining Board with sufficient information for assessment.

Candidates holding a qualification issued by a European Research Area country, if successful, must submit, if not already attached to the application form one of the following options:
- Supplement Diploma in English issued by the competent University.
- CIMEA Certificate of comparability of the foreign qualification, issued by CIMEA (Information Centre on Academic Mobility and Equivalence) via the "diplome" service at https://cimea.diplo-me.eu/udine/#/auth/login

Candidates holding a qualification issued by a non-European Research Area country, if successful, must submit, if not already attached to the application form one of the following options:
- Declaration of the on-site value of the qualification and the certificate relating to the degree with examinations and grades. A certificate in a language other than Italian or English must be accompanied by an official translation into one of these languages (certified by the competent diplomatic-consular authority or certified by a court in Italy).
- CIMEA Certificate of comparability of the foreign qualification, issued by CIMEA (Information Centre on Academic Mobility and Equivalence) via the "diplome" service at https://cimea.diplo-me.eu/udine/#/auth/login
If the Supplement Diploma or the statement/attestation of comparability are not available when signing the contract, the applicant must demonstrate that he/she has requested the documentation and submit it as soon as possible.

Any exclusion from the selection procedure due to lack of eligibility requirements, absence of required documents, failure to sign the selection application or submission of the selection application in a manner different from what is provided for in this call for applications will be communicated to applicants exclusively at the email address indicated in the application form.

Art. 3
The research grant referred to in this call for applications cannot be awarded:

a. to employees of Universities and the entities referred to in Article 22, section 1, of Italian Law no. 240 of 30 December 2010 (in the text prior to the reform introduced by Law no. 79 of 29 June 2022);

b. to those who have already been awarded research grants pursuant to Italian Law no. 240 of 30 December 2010 (prior to the reform introduced by Law no. 79 of 29 June 2022) for the maximum period provided by law, even if not continuously, excluding the period in which the grant was used in conjunction with the doctorate, up to the legal term of the relative course;

c. to those who have already benefited from research grants and fixed-term researcher contracts provided for, respectively, in Articles 22 and 24 of Italian Law no. 240 of 30 December 2010 (in the text prior to the reform introduced by Law no. 79 of 29 June 2022), for a total of 12 years, even if not consecutive;

d. to anyone who has a degree of kinship or affinity, up to and including the fourth degree, with:
   - the Rector, the Director General or a member of the Board of Directors of the University of Udine;
   - the scientific supervisor or a professor/researcher belonging to the department or organisation hosting the research grant in question.

The research grant provided for in this call for applications cannot be combined:

a) with scholarships of any kind, except for those granted by Italian or foreign institutions to supplement, by means of stays abroad, the fellow's training or research activities;

b) with other research grants;

c) with an employment relationship, even if part-time, without prejudice to the relevant provisions for employees of public administrations.

The grant awarded under this call for applications is also incompatible with simultaneous attendance at university degree courses, either Bachelors, specialist or Masters, research Doctorates with scholarships and medical specializations, in Italy or abroad.

Art. 4
Applicants must enclose with their application, under penalty of exclusion, the following documents:

a) their professional scientific CV, highlighting the candidate's aptitude for carrying out and implementing the research project (Attachment A);

b) their identity card, their passport or any other identification document¹;

c) (for candidates with a foreign qualification only) certification or self-certification of both the academic qualification required for the admission to the selection, and of the exams (with

¹ Please be aware that the residence permit is not an identification document.
evaluation) took during the period of study abroad, and of any other document that can be useful to the evaluation of the degree by the Examining Board.

Applicants can attach to the application, publications and any other certification considered useful to demonstrate the qualification based on the research program (Attachment A) and to certify any research activity accomplished at public or private institutes (indicating the starting and ending date and the duration).

The documents and qualifications mentioned above must be submitted in Italian or English. Those that are not as requested will not be evaluated. Documents originally written in a language other than Italian or English must come with a translation in Italian or English, that the candidate will do on its own responsibility. The translation can be an abstract concerning the thesis.

Italian and Community candidates wishing to submit qualifications referring to conditions and facts attested by Public Administrations must proceed exclusively with self-certification. Non-EU citizens legally residing in Italy may self-certify only data that can be verified or certified by Italian public bodies. They may also use declarations in lieu when provided for by an international convention between Italy and the declarant's country of origin. Non-EU citizens not residing in Italy cannot self-certify.

Only the qualifications possessed by the candidate on the date the application form is submitted and submitted in accordance with the procedures set out in Article 5 will be assessed.

Failure to submit mandatory documents provided for in this article will constitute grounds for exclusion from the selection.

Art. 5

The submission of the applications for the present call starts on December 14, 2023 at 2:00 pm (Italian time) and ends on January 30, 2024 at 2:00 pm (Italian time).

The application to take part in the selection must be completed, under penalty of exclusion, using the appropriate online procedure, available at the link https://pica.cineca.it/

The procedure involves an applicant registration step, for those who do not already have an account, and then an application completion step.

Once completed, the online application must be signed in the manner described in the online procedure (manual signature with attached identity document or digital signature), under penalty of exclusion from selection. The application does not have to be signed if you access the above-mentioned online procedure using your SPID ID.

The qualifications referred to in Article 4 must be attached to the application in .pdf format. Individual .pdf files may not exceed 30MB.

The application for participation in the selection is automatically sent to the University of Udine with the definitive closing of the online procedure.

The University Administration:
- is not responsible if it is impossible to read the submitted documentation in electronic format due to damaged files;
shall not accept or take into consideration qualifications or documents received in paper form or by any means other than what is specified in this article.

Reference to documents or publications already submitted in connection with other competitions is not allowed.

The Administration is not responsible for any missing document or communication because of inaccurate indication of residence and/or address submitted by the candidate during the application. Also, the Administration is not responsible if the candidate has not communicated changes in this information, or has communicated them too late. The Administration is also not responsible for any postal or telegraphic problems not attributable to the Administration itself.

Applicants are advised not to wait until the last few days before the closing date to submit their application. The University accepts no responsibility for any malfunctions due to technical problems and/or overloading of the communication line and/or application systems.

Art. 6
The selection procedure is held in accordance with the modality indicated in Attachment A.

The test will aim to assess the general preparation, experience and aptitude for research of the candidate. It will consist in the evaluation of the professional scientific curriculum, of the publications and qualifications presented, and of the interview, where foreseen.

Art. 7
The Examining board for the competition is identified in Attachment A of the present competition announcement, of which it is an integral part.

At its first meeting, the Examining board shall appoint its President and Secretary, and establish the criteria and methods for evaluating the qualifications and the interview, where foreseen.

The results of the qualifications assessment must be disclosed to applicants during the interview, where foreseen.

The Examining board can award a maximum of 100 points (one hundred out of one hundred) to the selection.

At the end of the evaluation procedure, the Examining board shall formulate the general merit list based on the overall score of each candidate, and draw up the minutes of the whole competition procedure.

Based on the ranking list, the assignment is awarded to candidates who have obtained a minimum overall score of 70/100 (seventy out of one hundred).

The Examining board's judgement is final.

The ranking list will be made public exclusively through publication on the University's official website.

Applicants will not be notified of the outcome of the evaluation.
Those who do not declare their acceptance of the research grant and do not present themselves at the research centre within the deadline communicated by the latter, even if not formally, shall lose the right to receive it. Exceptions to this term will only be granted in cases of documented force majeure.

Art. 8
The research activity cannot be started before signing the contract defining the terms and conditions of the collaboration.

The activity covered by the research grant must have the following characteristics:

a) it must be carried out as part of the research programme covered by the grant and not be a merely technical support to it;
b) it must have a close connection with the realization of the research program for which the winner of the grant has been awarded the contract;
c) it must be continuous and, in any case, temporally defined, not merely occasional, and in coordination with the overall activity of the University;
d) it must be carried out autonomously, solely within the limits of the programme prepared by the programme supervisor, without predetermined working hours.

The researcher is required to submit a detailed written report on the work carried out and the results achieved, accompanied by the opinion of the scientific supervisor, to the reference organisation at the intervals set out in the contract. The researcher must also submit interim reports and timesheets, if requested by the reference organisation.

Either the fellow or the reference organisation may withdraw from the contract.

The reference organisation may terminate the contract not only in the cases referred to in Article 9, sections 2 and 3, of the "Internal rules for awarding research grants pursuant to law 240 of 30 December 2010" of the University of Udine, but also in the event the research project and therefore the financial coverage on which the research grant is based cease to exist.

Art. 9
The following legal dispositions shall apply to the grant referred to in this call for applications:

- for tax matters, the provisions of Article 4 of Italian Law no. 476 of 13 August 1984, as subsequently amended and supplemented;
- for social security matters, the provisions of Article 2(26) et seq. of Italian Law no. 335 of 8 August 1995, as subsequently amended and supplemented;
- for mandatory maternity leave, the provisions of the Italian Ministerial Decree of 12 July 2007;
- with regard to sick leave, the provisions of Article 1(788) of Italian Law no. 296 of 27 December 2006 and subsequent amendments.

During the period of mandatory maternity leave, the allowance paid by INPS according to Art. 5 of the Italian Ministerial Decree of 12 July 2007 is supplemented by the University up to the full amount of the research grant.

The grant will be paid in monthly instalments.
Art. 10
The data collected as part of the procedure referred to in Art. 5 are necessary to properly manage the selection procedure, for any subsequent management of the research grant and for purposes related to managing services provided by the University. The University of Udine is the Data Controller. At any time, the data subject may request access, rectification and, depending on the University's institutional purposes, cancellation and restriction of processing or oppose the processing of their data. The data subject can always lodge a complaint with the Italian Data Protection Authority. The complete disclosure is available on the University of Udine website in the "Privacy" section, accessible from the home page www.uniud.it Direct Link: https://www.uniud.it/it/pagine-speciali/guida/privacy

Art. 11
For all matters not expressly mentioned in this call for applications, refer to the regulations in force on the subject cited in the introduction and to the "Internal rules for awarding research grants pursuant to Italian Law no. 240 of 30 December 2010" of the University of Udine, issued by Rector's Decree no. 182 of 31 March 2021.

Art. 12
The procedure supervisor is Dr Sandra Salvador, Head of the Research Services Area of the University of Udine.
The Responsible office at the University of Udine is "Area Servizi per la Ricerca - Ufficio Formazione per la Ricerca", via Mantica n. 31 - 33100 Udine, Italia.
To request information about the call for applications, please complete the following form available on the University of Udine website:
https://helpdesk.uniud.it/SubmitSR.jsp?type=req&accountId=universityofudine&populateSR_id=42105
Attachment A

**Responsabile scientifico della ricerca / Principal investigator:**

Nome e cognome / Name and surname: Christian Micheloni  
Qualifica / Position: Professore Ordinario / Full Professor  
Dipartimento / Department: Scienze Matematiche, Informatiche e Fisiche (DMIF) / Mathematics, Computer Science and Physics  
Area MUR / Research field: 09 - Ingegneria industriale e dell'informazione  
Settore concorsuale e Settore scientifico disciplinare / Scientific sector: 09/H1; ING-INF/05 - Sistemi di elaborazione delle informazioni

**Titolo dell'assegno di ricerca / Topic of the research fellowship “assegno di ricerca”:**

*I bandi sono consultabili dal sito dell’Ateneo, del MUR e di Euraxess / The calls are available on the University, MUR and Euraxess websites*

**Testo in italiano:**

Tracking in Egovision per memoria applicata (TEAM).

**Testo in English:**

Tracking in Egovision for Applied Memory (TEAM).

**Obiettivi previsti e risultati attesi del programma di ricerca in cui si colloca l’attività dell’assegnista di ricerca / Foreseen objectives and results of the research programme performed by the research fellow “assegno di ricerca”:**

*I bandi sono consultabili dal sito dell’Ateneo, del MUR e di Euraxess / The calls are available on the University, MUR and Euraxess websites*

**Testo in italiano:**

Abstract del progetto  
I dispositivi indossabili, come gli smart glasses ed i visori per la realtà aumentata, offrono una prospettiva unica catturando la vista dell’utente, consentendo applicazioni incentrate su di esso che agiscono come assistenti personali. Questi dispositivi mirano a comprendere in modo completo il modo in cui gli utenti interagiscono con l’ambiente circostante, comprese le interazioni attuali con gli oggetti, le interazioni passate e, potenzialmente, la previsione di quelle future. Le ricerche precedenti si sono concentrate sulla modellazione delle interazioni utente-oggetto a livello di una semplice categorizzazione o in modo indipendente dalla classe, spesso da una prospettiva statica (brevi clip o fotogrammi statici), il che limita la capacità di catturare interazioni a lungo termine. Inoltre, questi approcci operano tipicamente offline, richiedendo l’accesso continuo a un buffer video per la rielaborazione o la ricerca, il che non è pratico. Al contrario, la comprensione umana delle interazioni tra oggetti è basata sull’istanza (concentrandosi su oggetti specifici), a lungo raggio (seguendo la storia di un oggetto) e opportunistica (trovando oggetti che potrebbero essere necessari per compiti futuri), piuttosto che strettamente orientata al compito. Per raggiungere questa comprensione simile a quella umana, il progetto TEAM mira a consentire ai dispositivi indossabili di scoprire automaticamente oggetti potenzialmente utili, di seguirli nel tempo e nello spazio e di monitorare le loro relazioni con altri...
oggetti (ad esempio, identificando l’origine di un oggetto). Questo approccio mira a migliorare le capacità dei dispositivi indossabili di fornire un’assistenza più intuitiva e completa agli utenti in vari compiti e scenari.

Più specificamente, l’obiettivo è sviluppare principi algoritmici che elaborino un video in ingresso, rappresentato come una sequenza di fotogrammi, e producano una struttura di dati che memorizzi le informazioni rilevanti che si verificano tra l’indossatore della telecamera e gli oggetti circostanti. In una fase successiva, all’algoritmo viene fornita in input una stringa che rappresenta una domanda su un oggetto specifico o un’immagine che lo mostra esplicitamente e l’algoritmo dovrà fornire in output una rappresentazione adeguata, ad esempio un elenco di bounding-box, della posizione temporale e spaziale dell’oggetto, analizzando la memoria e confrontando l’input dato con essa.

Uno dei problemi principali da affrontare per raggiungere il suddetto obiettivo è quello di seguire gli oggetti in video egocentrici in prima persona (FPV) per lunghi periodi di tempo. Questo modulo ha lo scopo di fornire informazioni continue sulla posizione degli oggetti e sulle loro interazioni con l’indossatore della telecamera, il che è fondamentale per capire come oggetti specifici si muovono e cambiano nel tempo. Il tracking degli oggetti in FPV è notoriamente impegnativo, anche in scenari di breve durata. In questo caso, il progetto mira a tracciare più oggetti nei video per lunghe durate, in modo simile al Multiple Object Tracking (MOT). A differenza del MOT tradizionale, l’algoritmo di tracking obiettivo del progetto non cercherà di rilevare e tracciare tutti gli oggetti, ma solo quelli rilevanti per chi indossa la telecamera. La ricerca prevede l’integrazione di recenti architetture di deep learning, tra cui le reti siamesi, le deep discriminative networks, e le architetture transformer, con i paradigmi MOT e gli inductive bias dell’FPV, come la posizione delle mani dell’utente. Questa combinazione dovrebbe fornire un approccio olistico, robusto ed efficiente in grado di tracciare vari oggetti di interesse in tempo reale.

**Obiettivi del progetto**

Questo progetto di ricerca mira a creare algoritmi avanzati di visual object tracking a lungo termine in grado di identificare con precisione oggetti multipli in video egocentrici FPV estesi. L’obiettivo primario è quello di esplorare la possibilità di sviluppare un algoritmo online, potenzialmente in tempo reale, che possa funzionare efficacemente in scenari di visione FPV difficili. Queste sfide includono problemi come le occlusioni degli oggetti causate dalle interazioni tra la persona e gli oggetti, i rapidi movimenti della telecamera, la sfocatura dovuta al movimento della testa e le variazioni nell’aspetto degli oggetti sia all’interno di una classe che tra le varie classi.

Per raggiungere questi obiettivi, il ricercatore sfrutterà i dati e le risorse disponibili nel laboratorio di Machine Learning and Perception. Inoltre, potrà attingere alle risorse del Image Processing Laboratory dell’Università di Catania. Su richiesta del ricercatore, è possibile organizzare un periodo di ricerca presso tale istituto.

Nel complesso, i contributi attesi da questo progetto comprendono:

- Progettare e sviluppare un algoritmo online, indipendente dalla classe
| Descrizione del progetto | L’attività di ricerca di questo assegno di ricerca rientra nel progetto "TEAM: Tracking in Egocentric Videos for Applied Memory" finanziato dal programma PRIN 2022 PNRR del Ministero dell'Università e della Ricerca. Le attività sono svolte in collaborazione con l’Image Processing Laboratory dell'Università di Catania (Catania, Italia).

L’attività di ricerca si concentrerà sul problema di visual object tracking a lungo termine di oggetti precedentemente rilevati da altri moduli. Il modulo di tracking mira a fornire un elenco di localizzazioni di oggetti che descrivono l'evoluzione dell'oggetto e il suo stato di interazione con l'indossatore della telecamera. Queste informazioni temporali fondamentali per sapere dove si muovono specifiche istanze di oggetti o come cambia il loro stato. L'obiettivo è tracciare più oggetti nel video per lunghi periodi di tempo. L'impostazione avrà una stretta relazione con il Multiple Object Tracking (MOT), poiché l'algoritmo di tracking dovrà tenere traccia di diverse istanze di oggetti, potenzialmente della stessa categoria, allo stesso tempo. Pertanto, la ricerca esplorerà i metodi che consentono agli algoritmi MOT di lavorare in scenari a lungo termine, in cui il riferimento agli oggetti multipli deve essere mantenuto anche in presenza di frequenti occlusioni (ad esempio, dovute alle mani dell'osservatore della telecamera che coprono gli oggetti). A differenza dei MOT tradizionali, l'algoritmo di tracciamento non avrà l'obiettivo di rilevare e seguire tutti gli oggetti, cosa che probabilmente non sarà fattibile in uno scenario egocentrico in cui la telecamera si muove velocemente e gli oggetti tendono a entrare e uscire frequentemente dal campo visivo. Per superare le limitazioni si prevede di utilizzare spunti specifici della visione in prima persona, come la posizione delle mani dell'utente (Dunnhofer et al., 2022). Il ricercatore esplorerà le più recenti architetture di deep learning, visto il loro ampio successo in una moltitudine di domini in cui è richiesto il tracking. In particolare, si prevede di fondere le metodologie di tracking di singoli oggetti, con i più recenti paradigmi MOT. In passato, la MOT è stata affrontata principalmente con l'approccio del tracking-by-detection, ma un lavoro molto recente (Yan et al., 2022) ha rivelato come la combinazione di tracker di oggetti singoli all'interno della logica MOT possa portare benefici per tenere traccia simultaneamente di più oggetti. |
Il progetto mira a sviluppare algoritmi avanzati per le telecamere indossabili, in particolare nel contesto della realtà aumentata. Questo campo è in rapida evoluzione, con l'introduzione di nuovi set di dati, competizioni di ricerca e algoritmi, e l'emergere di dispositivi indossabili di consumo come occhiali intelligenti e visori per la realtà aumentata. Il mercato della realtà aumentata è stato valutato a 25,33 miliardi di dollari nel 2021 e si prevede una crescita del 40,9% dal 2022 al 2030. Gli occhiali indossabili con fotocamera incorporata, come Ray Ban Stories, Meta's Quest e Project Aria, Apple Vision Pro, sono già disponibili al grande pubblico. I principali operatori stanno esplorando modi per potenziare questi dispositivi con la computer vision. L'obiettivo del progetto è creare algoritmi innovativi in grado di comprendere il comportamento degli utenti e di integrare perfettamente il mondo reale e quello virtuale in questi dispositivi indossabili. I risultati di questo progetto daranno un contributo significativo sia alla ricerca che all'industria in questo campo in rapida espansione.

Il progetto mira a sviluppare algoritmi per sistemi indossabili in grado di elaborare in modo efficiente i video in tempo reale e di consentire un ragionamento a lungo termine. A differenza dell'attuale tecnologia indossabile, che si concentra sull'analisi video a breve termine per compiti quali il riconoscimento degli oggetti, la posizione dell'utente e le azioni in corso, questi algoritmi consentiranno di comprendere a lungo termine le interazioni tra utente e oggetto. Questa tecnologia ha applicazioni nel campo della salute, dove può essere utilizzata per misurare le capacità cognitive e assistere gli utenti in compiti come la ricerca di oggetti. Inoltre, può essere utile in ambito industriale, aiutando a monitorare il comportamento dei lavoratori e garantendo un uso sicuro e corretto degli oggetti. Questa tecnologia potrebbe trovare impiego anche in settori in cui gli occhiali intelligenti vengono utilizzati insieme a piattaforme robotiche, come le catene di montaggio, la logistica e la produzione.

I risultati del progetto saranno condivisi attraverso conferenze e riviste internazionali rilevanti, favorendo il coinvolgimento della comunità di ricerca. Questa divulgazione ha lo scopo di avvantaggiare sia il progetto, ricevendo un feedback dalla comunità, sia la stessa comunità scientifica, introducendola a nuove sfide e metodologie. L'attenzione principale del progetto sugli aspetti più avanzati della computer vision per la comprensione delle scene stimolerà i ricercatori a esplorare idee e soluzioni innovative, facendo progredire le prestazioni e ampliando le conoscenze scientifiche nel campo.

**Abstract**

Wearable devices like smart glasses and augmented reality headsets offer a unique perspective by capturing the user's view, enabling user-centric applications acting as personal assistants. These devices aim to comprehensively understand how users interact with their surroundings, including current interactions with objects, past interactions, and potentially predicting future ones. Previous research has focused on modeling user-object interactions at a broad category level or in a class-

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agnostic manner, often from a static perspective (short clips or static frames), which limits their ability to capture long-term interactions. Additionally, these approaches typically operate offline, requiring continuous access to a video buffer for re-processing or searching, which is not practical. In contrast, human understanding of object interactions is instance-based (focusing on specific objects), long-range (tracking an object's history), and opportunistic (finding objects that may be needed for future tasks), rather than strictly task-oriented. To achieve this human-like understanding, the project aims to enable wearable devices to automatically discover potentially useful objects, track them over time and space, and monitor their relationships with other objects (e.g., identifying an object's origin). This approach seeks to enhance the capabilities of wearable devices to provide more intuitive and comprehensive assistance to users in various tasks and scenarios.

More specifically, the goal is to develop algorithmic principles that process an input video, represented as a sequence of frames, and output a data structure storing the relevant information occurring between the camera wearer and the surrounding objects. Then, at a later stage, the algorithm is inputted with a string representation of a question about a specific object or with an image explicitly showing it, and it should give as output a proper representation, e.g. a list of bounding boxes, of the temporal and the spatial location of the object, by analyzing the memory and comparing the given input with it.

One of the key problems to address to achieve the aforementioned goal is to track objects in first-person view (FPV) egocentric videos for long periods of time. Such a module aims to provide continuous information about object locations and their interactions with the camera wearer, which is crucial for understanding how specific objects move and change over time. Tracking objects in FPV is known to be challenging, even in short-term scenarios. Here, the project aims to track multiple objects in videos for long durations, which is similar to Multiple Object Tracking (MOT). Unlike traditional MOT, the project's tracking algorithm won't attempt to detect and track all objects, but only those relevant to the camera wearer. The approach will involve integrating recent deep learning architectures, including siamese networks, deep discriminative networks, and transformer architectures, with MOT paradigms and FPV-specific cues, like the position of the user's hands. This combination is expected to provide a holistic, robust, and efficient approach capable of tracking various objects of interest in real-time.

**Objectives of the project**

This research project aims to create advanced long-term visual tracking algorithms that can accurately identify multiple objects in extended FPV egocentric videos. The primary objective is to explore the possibility of developing an online, potentially real-time algorithm that can perform effectively in challenging FPV vision scenarios. These challenges include issues like object occlusions caused by interactions between the person and objects, rapid camera movements, motion blur due to head motion, and variations in object appearance both within and across classes. To achieve these goals, the researcher will leverage publicly available data and resources from the Machine Learning and Perception’s lab.

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<th>RESEARCH SERVICES AREA</th>
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<tr>
<td>Research Training Office</td>
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<tr>
<td>Department Head: Sandra Salvador</td>
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<tr>
<td>Procedure Supervisor: Sandra Salvador</td>
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<td>Procedure Compiler: Francesca Mion</td>
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Additionally, he/she may tap into the resources of the Image Processing Laboratory at the University of Catania. A secondment period at such an institute can be arranged on the researcher’s desire.

Overall, the expected contributions of this project include:

- Designing and developing an online, class-agnostic, and real-time algorithm for tracking multiple objects over long durations in egocentric videos.
- Investigating the relationship between the developed solution and high-level algorithmic modules for downstream egocentric tasks, such as episodic memory.
- Validating the algorithm's performance against the state-of-the-art using publicly available datasets of FPV egocentric videos, including EGO4D and EPIC-KITCHENS.
- Publishing the findings in renovated computer vision and machine learning conferences and journals.
- Participating in research competitions focused on the project's topics by submitting the developed algorithms.

### Project description

The research activity falls within the project “TEAM: Tracking in Egocentric Videos for Applied Memory” funded by the Italian Ministry of University and Research's program PRIN 2022 PNRR. The activities are carried on in collaboration with the Image Processing Laboratory of the University of Catania (Catania, Italy).

The research activity will focus on tracking previously detected objects in a long-term fashion. The module aims to provide a list of object localizations that describe the evolution of the object as well as their state of interaction with the camera wearer. Such temporally continuous information is fundamental to know where specific object instances move or how their state changes. Tracking objects in first-person vision has been shown to be challenging even in a short-term scenario (Dunnhofer et al., 2022). Here, the goal is to track multiple objects in the video for long periods of time. The setting will have a close relationship to Multiple Object Tracking (MOT) as the tracking algorithm will need to keep track of different object instances, potentially of the same category, at the same time. Hence, the research will explore methods enabling MOT algorithms to work in long-term scenarios, where reference to the multiple objects must be maintained across the occurrence of frequent occlusions (e.g., given by the camera viewer’s hands covering the objects). Differently from traditional MOT, the tracking algorithm will not aim to detect and track all objects, which will likely not be feasible in an egocentric scenario in which the camera moves fast and objects tend to enter and leave the field of view frequently. It is expected to employ first person vision specific cues, such as the position of the user's hands (Dunnhofer et al., 2022), to overcome the limitations. The researcher is expected to explore the most recent deep learning architectures due to their extensive success across a multitude of domains in which tracking is required. More specifically, merging the most successful single object tracking methodologies, such as siamese networks, deep discriminative networks, and transformer architectures, with the most recent MOT paradigms is expected. In the past, MOT has been tackled mostly by the
| Possible application potentialities | The project aims to develop advanced algorithms for wearable devices, particularly in the context of augmented reality. This field is rapidly evolving, with new datasets, research challenges, and algorithms being introduced by researchers and the emergence of consumer wearable devices like smart glasses and augmented reality headsets. The augmented reality market was valued at USD 25.33 billion in 2021 and is projected to grow at a CAGR of 40.9% from 2022 to 2030. Wearable glasses with built-in cameras, such as Ray Ban Stories, Meta’s Quest and Project Aria, Apple Vision Pro, are already available to the general public. Major players are exploring ways to enhance these devices with visual intelligence. The project's goal is to create innovative algorithms that can understand user behavior and seamlessly integrate the real and virtual worlds in these wearable devices. The results of this project are expected to make significant contributions to both research and industry in this rapidly expanding field. The project aims to develop algorithms for wearable systems that can efficiently process video in real-time and enable long-term reasoning. Unlike current wearable technology, which focuses on short-term video analysis for tasks like object recognition, user location, and current actions, these algorithms will enable long-term understanding of user-object interactions. This technology has applications in the health domain, where it can be used to measure cognitive abilities and assist users in tasks like finding objects. Additionally, it can benefit industrial settings, helping monitor worker behavior and ensuring safe and correct use of objects. This technology could also find use in industries where smart glasses are used in conjunction with robotic platforms, such as assembly lines, logistics, and manufacturing, potentially impacting the robotics industry as well. The project's outcomes will be shared through well-established international conferences and journals, fostering engagement from the research community. This dissemination aims to benefit both the project, by receiving feedback from the community, and the research community itself, as it introduces them to new challenges and algorithms in the project's domain. The project's main focus on cutting-edge aspects of computer vision for scene understanding is expected to stimulate researchers to explore innovative ideas and solutions, ultimately advancing performance and expanding scientific knowledge in the field. |

"Struttura dell'Università di Udine presso la quale verrà sviluppata l'attività di ricerca / Department or other structure of the University of Udine where research activities will be carried out:

Dipartimento di Scienze Matematiche, Informatiche e Fisiche (DMIF) / Department of Mathematics, Computer Science and Physics."
Importo dell’assegno di ricerca (al lordo oneri carico assegnista) / Total grant gross for the research fellowship:

€ 36,480,57

Durata dell’assegno di ricerca / Duration of the research fellowship “assegno di ricerca”:

18 mesi / months

Finanziamento / Financed by:


Requisiti di ammissione / Minimum qualifications necessary:

- Possesso di un diploma di laurea vecchio ordinamento (ante decreto 3 novembre 1999 n. 509) o di laurea specialistica/magistrale (ex decreto 3 novembre 1999 n. 509 e decreto 22 ottobre 2004 n. 270) o titolo equivalente conseguito all’estero;
- possesso di un curriculum scientifico professionale idoneo allo svolgimento dell’attività di ricerca contemplata.
- University degree obtained before Decree n. 509 of 3 November 1999 or specialist/Master’s degree (post decree n. 509 of 3 November 1999 and decree n. 270 of 22 October 2004) or equivalent degree obtained abroad;
- professional scientific curriculum suitable for the research activity above mentioned.

Procedura selettiva / Competition procedure:

Valutazione per titoli e colloquio / Evaluation of titles and oral exam

I risultati della valutazione dei titoli saranno resi noti agli interessati nel corso del colloquio / The evaluation of the qualifications will be disclosed to candidates during the interview

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<tr>
<th>Calendario del colloquio / Calendar of the oral exam</th>
<th>Modalità / Modality</th>
<th>Videoconferenza / Videoconference</th>
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<tr>
<td>Data / Date</td>
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Per sostenere il colloquio i candidati devono esibire un valido documento di riconoscimento. / Candidates must come to the interview with a valid identity document.
Eventuali variazioni saranno rese note esclusivamente mediante pubblicazione all’albo ufficiale on line dell’Ateneo / Any change will be made public solely through publication on the University web site http://web.uniud.it/ateneo/normativa/albo_ufficiale

Nota / Note: Le indicazioni sulle modalità di svolgimento della prova in modalità telematica saranno inviate ai candidati con successiva email da parte del Presidente della Commissione. Ai fini dell’identificazione e a pena di esclusione dalla procedura selettiva, ciascun candidato è tenuto ad identificarsi prima che il colloquio abbia inizio, esibendo il medesimo documento di identità allegato alla domanda di ammissione al concorso. Il candidato deve risultare reperibile nella giornata e all’orario indicato sul bando. Il mancato collegamento, l’irreperibilità del candidato nel giorno o nell’orario stabilito o la mancata esibizione del documento identificativo, sono motivo di esclusione dalla procedura selettiva. La registrazione delle prove orali è vietata. L’Ateneo adotterà pertanto tutti i provvedimenti in suo potere per tutelare la procedura selettiva, in conformità con la legge e con l’albo ufficiale on line dell’Ateneo /and/or the other forms of public dissemination, of videos, audios or other pictures of the selection procedures.

Commissione giudicatrice / Examining Board:

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<td><strong>Membri Effettivi / Permanent members</strong></td>
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<td>Christian Micheloni</td>
<td>PO</td>
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<td>Niki Martinelli</td>
<td>PA</td>
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<td>Matteo Dunnhofer</td>
<td>RTD</td>
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<td><strong>Membri Supplenti / Temporary members</strong></td>
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<tr>
<td>Claudio Piciarelli</td>
<td>PA</td>
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<td>Università degli Studi di Udine</td>
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<td>Carlo Dioli</td>
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