Arianna Rana

europass

ESPERIENZA LAVORATIVA

15/02/2024 – ATTUALE Bari

Assegnista di ricerca CNR - Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato

Partecipazione nell'ambito di ricerca **STRIVE - le Scienze per le TRansizioni Industriale, Verde ed Energetica**, DIT.AD022.207 e **AGRO-SENSING 2 - proximal and remote sensing, analytics and modeling for Precision Agriculture**, DIT.AD022.180, per la tematica:

1. Sviluppo e integrazione di sistemi multi-sensoriali per la percezione ambientale di robot terrestri in ambienti dinamici e non strutturati.

15/02/2022 – 14/02/2024 Bari

Assegnista di ricerca CNR - Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato

Assegnista di ricerca nell'ambito di ricerca **PON E-CROPS - Tecnologie per l'agricoltura Digitale Sostenibile**.
Attività svolte:

1. Sviluppo del Digital Twin di una piattaforma robotica e di un ambiente vitivinicolo per la validazione di algoritmi di navigazione autonoma in ambiente simulato.
    a. Creazione del modello URDF del robot;
    b. Creazione dell'ambiente agricolo simulato.
2. Sviluppo in ROS di un algoritmo per la navigazione autonoma per un veicolo robotico per applicazioni in ambito agricolo. Tramite sensori a basso costo, quali una camera RGB-D, un ricevitore GNSS e un'unità di misurazione inerziale (IMU), il robot è capace di localizzarsi e di navigare attraverso la vigna seguendo una traiettoria parallela ad una certa distanza, evitando la collisione con le piante. L'algoritmo proposto è strutturato in due moduli:
    a. Localizzazione: il robot stima la sua posizione relativa, nello specifico distanza e orientamento rispetto al filare, individuando un piano segmentato sul filare di piante. Inoltre, le informazioni derivanti dal ricevitore GNSS e dall'IMU sono state fuse tramite un Information filter con quelle ricavate dalla camera al fine di migliorare la stima della posizione;
    b. Controllo: il robot riesce a seguire il filare grazie a una legge di controllo non lineare che ha come input l'errore di distanza e quello di orientamento del robot dal filare. La stabilità della legge di controllo è stata dimostrata teoricamente. La dimostrazione si basa sulla legge di Lyapunov. L'algoritmo è stato anche testato in un ambiente simulativo ricostruito in Gazebo. La sperimentazione ha confermato le conclusioni teoriche.

Partecipazione nell'ambito di ricerca **Horizon 2020 ATLAS - Agricultural Interoperability and Analysis System, DT-ICT-08-2019, Id. 857125**.
Attività svolta:

1. Integrazione di algoritmi di image processing sviluppati in ROS con applicazione web sviluppata in Flask;
2. Gli algoritmi sono stati testati e validati durante esperimenti effettuati sul campo reale.

Configurazione di due moduli GPS U-Blox ZED-F9P, uno montato a bordo del robot, l'altro posizionato in campo aperto e utilizzato come riferimento per lavorare in modalità RTK. Il sistema consente la localizzazione in tempo reale del robot nel mondo con una precisione di posizionamento elevata, consentendo al robot di eseguire in modo efficace compiti di ispezione in contesti agricoli, come i vigneti in cui è importante avere una precisione elevata a causa del ridotto spazio operativo.

Sviluppo di algoritmi per il controllo manuale tramite joystick di un robot 4 ruote sterzanti e motrici. Il robot può assumere 4 modalità distinte:

1. 2 ruote sterzanti;
2. 4 ruote sterzanti;

3. rotazione sul posto;
4. sterzata laterale che permette al robot di muoversi in tutte le direzioni senza cambiare orientamento.

07/2023 – 01/2024

Membro commissione d'esame Università di Bari Aldo Moro

Partecipazione a commissione d'esame in quanto cultrice della materia per "Fondamenti di informatica per la comunicazione" per corso di laurea in Scienze della comunicazione triennale presso Università di Bari Aldo Moro.

ISTRUZIONE E FORMAZIONE

01/11/2023 – ATTUALE

Dottorato di Ricerca interateneo con l'Università degli Studi di Bari "Aldo Moro" in Ingegneria e Scienze Aerospaziali – DRISA Politecnico di Bari - Università degli Studi di Bari "Aldo Moro"

05/09/2024 – 11/09/2024 Volterra (PI), Italia

2nd Doctoral Summer School on Robotics and Intelligent Machines – DRIMS2 Sant'Anna, Scuola Universitaria Superiore Pisa

03/04/2023 – 07/04/2023

DeepLearn Spring School Università degli studi di Bari Aldo Moro, IRDTA

09/2022 – 09/2022

Esame di stato con abilitazione alla professione di ingegnere Politecnico di Bari

22/04/2019 – 22/12/2021

Laurea magistrale in ingegneria dell'automazione Politecnico di Bari

Utilizzo di :
1. Matlab e Simulink
2. Framework ROS e Gazebo
3. Controllore predittivo (MPC)
4. MSC Adams

Studio di:
1. Manipolatori e di robot mobili
2. Azionamenti elettrici
3. Linguaggio di programmazione per PLC

Campo di studio Elettronica e automazione, Autoveicoli, navi e aeromobili | **Voto finale** 110/110 | **Numero di crediti** 120 | **Tesi** Pianificazione e inseguimento della traiettoria per un robot mobile agricolo

04/2021 – 09/2021

Tirocinio formativo Start-up Robodyne

Sviluppo di un algoritmo per la navigazione autonoma di un robot mobile cingolato in ambiente agricolo. L'algoritmo è stato verificato in ambiente simulativo in cui è stato ricreato un vigneto. Il robot è capace di seguire una successione di punti GPS e di correggere l'heading ad ogni punto raggiunto.

Utilizzo di:
1. Framework ROS
2. Ambiente simulativo Gazebo
3. Solidworks e plugin Solidworks to URDF Exporter

Campo di studio Autoveicoli, navi e aeromobili, Elettronica e automazione | **Numero di crediti** 6

04/11/2014 – 25/02/2019

Laurea triennale in ingegneria informatica e dell'automazione Politecnico di Bari

Campo di studio Elettronica e automazione | **Voto finale** 91/110 | **Tesi** Progettazione della WebApp per la visualizzazione degli allarmi e delle planimetrie con i suggerimenti dei punti di intervento per le squadre di intervento

COMPETENZE PROFESSIONALI

Linguaggi di programmazione

1. Matlab
2. Pyhton
3. Latex
4. Conoscenza base di CSS
5. Conoscenza base di HTML

Framework

1. Robot Operating System (ROS)
2. Gazebo
3. Flask
4. Conoscenza base di Django

CONFERENZE E SEMINARI

IEEE Access | Journal

(Submitted) Towards Digital Twin of Off-Road Vehicles using Robot Simulation Frameworks

Digital twins provide a powerful tool for testing and maintaining products and processes in several application fields, including manufacturing, smart cities, healthcare, and agriculture, aiming to optimize operational efficiency, resource usage, and planning accuracy. Research presented in this paper deals with the development of the digital version of off-road vehicles.
Two different robot simulation frameworks are investigated. The first one is based on Gazebo, an open-source 3D robotics simulator, to test and validate the algorithms developed in the ROS framework; the second one adopts the vehicle mechanical assembly in MSC Adams, a multibody modeling software used to study the dynamics of complex mechanical systems. Both models are developed for a tracked robot that uses an innovative articulated passive suspension system on either side that allows each ground wheel to move independently with respect to the vehicle body, providing remarkable adaptability to irregular terrain. In addition, a Gazebo model is developed for a four-wheel drive/steering robot, including robot sensors such as GNSS, IMU, and visual sensors and a model of a typical agricultural environment (i.e., a vineyard). The paper presents the details of model design and implementation while investigating the best choice in developing the digital twin of off-road vehicles operating in the field. Additionally, an agricultural scenario has been selected as a use case to facilitate the evaluation of the analyzed frameworks. The study suggests that Gazebo could serve as a suitable robot simulation framework for creating digital twins of vehicles, provided it incorporates real-time sensor measurements designed for identifying soil-wheel interaction dynamics.

29/10/2024 – 31/10/2024 2024 IEEE International workshop on Metrology for Agriculture and Forestry (MetroAgriFor)

(Submitted) Vision-based Aphrophoridae foam detection for sustainable management of Xylella fastidiosa

Xylem sap-feeding insects, such as adult Aphrophoridae, commonly known as spittlebugs, are vectors of the plant pathogenic xylem-limited bacterium Xylella fastidiosa, a causal agent of a number of severe diseases, among which the Olive Quick Decline Syndrome (OQDS) has resulted in an unprecedented decimation of olive trees in the Mediterranean area. Aphrophoridae life cycle and behavior are characterized by a weak stage, i.e., the juvenile stage, during which the insects live solitary on stems covered by a self-produced foamy fluid (froth) protecting them from dehydration and thermal stress. Juvenile vectors are the perfect target for a control action to mitigate the transmission due to adults. In this work, an automated vision-based system to detect the nymph froth directly in the field is proposed. It exploits a semi-supervised DeepLabv3+ semantic segmentation network with ResNet18 backbone to segment images acquired by a consumer-grade camera and automatically recognize the spittles. The system is intended to guide the action and assess the efficiency of an aeraulic machine able to generate an airstream with shape and thrust proper to manage the target organisms by ex ante and ex post control action data comparison. Experimental results carried out in an area covered by wild tall grass show that the model attains relatively good classification performance with recall of 75.9% and precision of 66.4%, despite the low quality of the input images as well as the challenges arising from small item size, object resemblance in color, occlusions, and changing lighting conditions.zione...

28/08/2024 – 01/09/2024 IEEE 20th International Conference on Automation Science and Engineering (CASE 2024)

(Accepted) A Distributed Multi-Agent Control Strategy for Agricultural Row Following

This paper presents a novel approach to integrate heterogeneous agents working in an agricultural scenario. We explore a multi-agent system, comprising both agricultural robots (AgBots) and human operators, that handles various tasks such as fruit picking and crop monitoring in row-planted environments like vineyards. Our key

contribution is a distributed motion control strategy for collision avoidance, ensuring agents maintain safe distances from each other and crop rows without requiring direct communication or central coordination. The effectiveness of our approach is validated theoretically and demonstrated through numerical simulations in a Gazebo-based environment.

28/05/2024 – 29/05/2024 3° Simposio Futuro In Area - CNR Area territoriale della Ricerca Bari

Agricultural Robotics for Automatic In-field Phenotyping

25/03/2024 IEEE Access | Journal

Robot-as-a-Service as a new paradigm in ultra-precision agriculture

Robotic and multi-sensor technologies are increasingly being adopted in a number of agricultural applications, including seeding, weeding, harvesting, fertilization, and crop monitoring and analysis. However, the lack of interoperability and the predominance of manufacturer-specific closed solutions demand a careful choice of devices, sensors and data processing platforms and hinder the flexible adaption of these systems to the individual farmer's needs and knowledge exchange. The Horizon 2020 Agriculture Interoperability and Analysis System (ATLAS) project is aimed at overcoming these issues through an open, flexible and distributed interoperability network, which enables the seamless interconnection of sensor systems, machines and data analysis tools. This paper presents latest achievements in the context of the ATLAS project, concerning the development of multi-sensor data collection and processing services for in-field crop monitoring and their integration in the ATLAS network.

Link https://ieeexplore.ieee.org/document/10478531

15/11/2023 – 16/11/2023 Invited speaker at UR Computer Vision and Machine Learning week, Logroño, Spain

Robotic technologies for in-field crop monitoring

Agricultural robots promise to provide effective solutions to improve task efficiency over large fields. However, the use of farmer robots is still under investigation and several challenges, including accurate vehicle localization and control, need to be addressed to increase autonomy and safety in scarcely structured environments, such as vineyards. One of the main challenges in this respect is to make the robot able to follow a trajectory parallel to the vineyard row, avoiding collisions with the crop. To address this challenge, the developed algorithm exploits sensor data from a cost-effective multi-sensor system, which includes an inertial measurement unit (IMU), a global navigation satellite system (GNSS) receiver, and an RGB-D camera. Data from these sensors are integrated through an information filter and then employed in a control algorithm designed to enable the robot to safely follow a vineyard row. While navigating throughout the crop, the robot is able to gather and process onboard visual and depth data provided by an RGB-D sensing device to extract information on the plant health status, such as vegetation indexes and morphological measurements. All measurements are geo-referenced by an algorithm that synchronizes the positioning information obtained from the robot's localization system with the camera data. The output of the algorithm is stored in a database from which users can request information regarding a specific survey.
The autonomous navigation algorithm is developed under ROS framework and validated in a simulated environment built in Gazebo. The service for farmers, on the other hand, is developed in Flask.

19/10/2023 – 20/10/2023 BUILding a DIgital Twin: requirements, methods, and applications (BUILD-IT), Rome

Modeling and Simulation of a Farmer Robot for In-field Vineyard Monitoring

Digital twin technology has opened new avenues for enhancing agricultural practices through advanced simulation and control systems. In this study, we present the development and implementation of a digital twin for an outdoor mobile robot specifically designed for agricultural tasks. The digital twin comprehensively represents the robot's mechanical system, including its sensors and actuators. The digital twin simulates the robot's movement, perception, and interaction with the surrounding environment. The results of our simulations aim at demonstrating the effectiveness of the digital twin-based simulation approach in improving the performance and productivity of the outdoor mobile robot in agricultural settings

26/09/2023 – 27/09/2023 3rd Conference of the Institute of STIIMA, Bari

Advanced perception systems for in-field crop monitoring by farmer robots

An agricultural robotic service has been designed and developed with the purpose of providing farmers with measurements regarding the health status of a vineyard obtained through inspections carried out by an agricultural robot. The information extracted from an RGB-D camera mounted on the robot is georeferenced using an algorithm that synchronizes the positioning information obtained from the robot's localization system

with the camera data. The output of the algorithm is stored in a database from which users can request information regarding a specific inspection.

03/07/2023 – 06/07/2023 2023 9th International Conference on Control, Decision and Information Technologies (CoDIT), Rome

A Row Following Algorithm for Agricultural Multi-Robot Systems

Agricultural multi-robot systems (MRSs) are expected to provide effective solutions to improve task efficiency over large fields. However, MRSs for agricultural applications are still being investigated and several challenges need to be faced, including localization, control, path planning and navigation. This paper presents an algorithm for the control of a multirobot system operating in row crop fields. The proposed strategy enables a multi-robot system to follow each field row in a fully distributed way, while avoiding collision. The only assumption is that each robot can estimate the relative pose with respect to the row and the preceding robot. The theoretical demonstration of the stability of the control law is given. Moreover, numerical simulations corroborate the results.

Link https://ieeexplore.ieee.org/document/10284364

16/11/2022 – 18/11/2022 2022 International Conference on Electrical, Computer, Communications and Mechatronics Engineering

A Pose Estimation Algorithm for Agricultural Mobile Robots using an RGB-D camera

Development of a algorithm for self-locate a wheeled mobile robot by resorting on a cost-effective multi-sensor system, including an IMU, a GNSS receiver and an RGB-D camera. Specifically, an Information Filter is proposed to overcome the issues related to the measurement uncertainties of the single sensor. The strategy is developed under the ROS framework and validated in a simulated environment built in Gazebo. Simulation results show an effective performance improvement, encouraging a field validation of the proposed methodology.

Link https://ieeexplore.ieee.org/document/9988012

14/06/2022 – 15/06/2022 2nd Conference of the Institute of STIIMA, Milano

Advanced autonomous navigation techniques for mobile robots in challenging environments

Development of a novel algorithm for autonomous navigation for wheeled mobile robots in non-structured environments, such as agricultural fields. The main task of the robot is to self-locate and move autonomously along a crop field by resorting on cost-effective a multi-sensor systems,. The contribution of this work is threefold. First, a simulated agricultural environment is developed. Second, a robot model is designed and tested. Finally, a row following control algorithm is proposed. Specifically, the row-following control strategy is composed by two modules, namely, the perception module and control module. The former is an Information Filter coming from the on-board sensors with the aim of estimating the relative pose of the robot with respect to the crop row. The second module is given by a non-linear controller. The strategy is developed under the ROS framework and validated in a simulated environment built in Gazebo. Future work will deal with the validation in field test trials.

18/05/2022 Simposio Futuro In Area - CNR Area territoriale della Ricerca Bari

Intelligent sensing and perception for agricultural robots

Development of multi-sensor systems and data processing algorithms for in-field crop monitoring and characterization by (semi-) autonomous agricultural robots. Data acquired by on-board sensors are combined to make the vehicle able to:

- autonomously navigate in the crop
- extract information on the crop status

COMPETENZE LINGUISTICHE

LINGUA MADRE: italiano

Altre lingue:

inglese

Ascolto B2

Produzione orale B2

Lettura B2

Interazione orale B2

Scrittura B2

spagnolo

Ascolto A1
Produzione orale A1
Lettura A1
Interazione orale A1

Livelli: A1 e A2: Livello elementare B1 e B2: Livello intermedio C1 e C2: Livello avanzato

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Autorizzo il trattamento dei miei dati personali presenti nel CV ai sensi dell'art. 13 d. lgs. 30 giugno 2003 n. 196 - "Codice in materia di protezione dei dati personali" e dell'art. 13 GDPR 679/16 - "Regolamento europeo sulla protezione dei dati personali".

Bari, 24/09/2024

Arianna Rana