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ALZGAR – ALZheimer's GARden



Executive Summary

Alzheimer's disease (AD) is the most frequent form of dementia, hindering independence and memory and causing a progressive withdrawal from family and society. The more the patients are isolated, the faster the disease progresses. Therefore, engaging patients in social activities and encouraging them to build and maintain strong relationships is crucial to preserve their independence and provide them with a better quality of life.

We collaborate with *Il Paese Ritrovato* (*The Rediscovered Village*), the first AD assisted care home in the form of a village ever built in Italy, managed by *La Meridiana*. A localization system allows to track the position of the patients through the use of Bluetooth antennas and wristbands worn by the residents. Our project, Alzheimer's Garden (ALZGAR), aims to understand the social behavior of AD patients living in *Il Paese Ritrovato* and to promote sociability among them to improve their quality of life and slow down the progression of the disease.

By analyzing the data collected through the existing localization system, we gain insight into the behavior of the residents to guide the design of novel space organizations and propose activity scheduling solutions, ultimately promoting socialization. We introduce objective indexes to measure sociability and attendance of places, as none are available in the literature. We outline the patients' social profiles and draw the social network of the village. We determine the correlation between sociability and possible influencing factors, observing that the weather does not affect the sociability of the residents, being most facilities indoors, whereas other factors such as the season and the patient's bedroom floor do play an important role.

To assess the utilization and social utility of social places, we analyze where residents spend their time in the village, identifying highly frequented areas, such as the cinema, and unpopular ones, such as the garden.

Considering the statistical and architectural analyses we carried out and the thorough state-of-the-art knowledge on AD-sensitive architecture, we propose predictive tools and architectural interventions. We propose the Community Behavior Prediction Table, a visual tool leveraging predictive models to support caregivers in organizing activities, along with extensive analyses and examples on how to leverage this tool to schedule state-of-the-art, AD-designed activities. This tool can prove to be valuable for the caregivers of *Il Paese Ritrovato*, since the compatibility of an activity with the location it is held at and the social profiles of the participants engaged is crucial to guarantee therapeutic benefits to the dwellers.

As we wish to promote sociability among residents, we analyze the accessibility of the social places of *Il Paese Ritrovato*. Despite being easily accessible, the two main outdoor locations cover peripheral areas of the village, resulting in residents rarely spending time outside. As such, we focus the architectural design on the gardens to make them attractive to dwellers, considering also that these areas provide excellent sensory stimuli to the residents, ultimately improving their wellbeing. Therefore, we develop sensory maps to investigate intimate and subjective aspects of each patient through their sensory memories and routines, and propose spatial installations. Space thus becomes part of a non-pharmacological therapy.



Alzheimer's Disease effect on visuospatial abilities and cognition

To evaluate the impact of the proposed solutions we plan to compare the trends of sociability of the community and the attendance of places before and after the interventions. Moreover, we will gather feedback from doctors, psychologists, and caregivers to improve the evaluation of the proposed solutions and enhance them further.

The data awareness obtained from our analyses will be of great help to caregivers, doctors, and psychologists to enhance social activities in assisted care homes, provide patient-specific treatments, and deepen the comprehension of the disease. The architectural enhancements will mitigate the risk of crises and promote mental stability.

Keywords

Alzheimer's Disease, Ambient Assisted Living, Data-driven design, Social behavior, Social wellness assessment.

Project description written by the Principal Academic Tutor

The ALZGAR project aims at investigating innovative solutions for the monitoring of fragile people in an Ambient Assisted Living (AAL) context: *Il Paese Ritrovato*, the first Italian village for the treatment of Alzheimer's disease. *Il Paese Ritrovato* is organized as a small village, where residents lead an almost normal life, are free to move and to interact with each other in wide-open spaces, but are in a protected context where they can get the necessary treatment. The village hosts 64 patients, monitored by a technological infrastructure. In particular, a localization system continuously monitors their position in the buildings and in the garden.



Il Paese Ritrovato – The Piazza and the Apartments

ALZGAR project tackled an important challenge: understanding the social behavior of the residents and the attendance/use of the different parts of the environment. The social behavior is one of the components of an individual's well-being together with the physical and mental/cognitive dimensions that can guarantee a good quality of life.

Both indoor and outdoor residents' positions have been analyzed: indoor, an analysis of the social behavior considering also the lockdown period due to Covid-19 has been carried out; outdoor, where a small garden, a little orchard, and some streets are located around a central nucleus of shops, non-invasive architectural installations were proposed to stimulate the senses and memory of the residents. This is the first village that allows such an analysis and by identifying possible issues, it is possible to propose innovative solutions.



Il Paese Ritrovato – The Handcrafts Laboratory

The team proposed new indicators related to the social well-being of patients that can provide doctors with relevant information about the residents' behaviors, a new tool to support caregivers in organizing activities and architectural interventions to enhance the environment, and make it more attractive and functional to the needs of the residents.

Team description by skill

Name	Degree	Technical Skills	Soft Skills
Gloria Bellini	Mathematical Engineering	Statistics, Graph Theory	Teamwork, Adaptability
Marco Cipriano	Computer Engineering	Machine Learning, Programming, Data Science	Adaptability, Problem Solving, Teamwork
Nicola De Angeli	Comp. Sci. and Engineering	Machine Learning, Database, Programming	Creative Thinking, Critical Thinking, Teamwork
Jacopo Pio Gargano	Comp. Sci. and Engineering	Artificial Intelligence, Cloud Computing, Data Science	Communication, Leadership, Time Management
Matteo Gianella	Mathematical Engineering	Statistics, Data Analysis, Machine Learning	Communication, Teamwork
Gianluca Goi	Architecture	Graphics, Modelling	Creative Thinking, Teamwork
Gabriele Rossi	Management Engineering	Business Analysis, Statistics	Communication, Problem Solving, Teamwork

Goal

As AD is a disease that hinders independence and memory, ultimately causing a progressive withdrawal from family and society, understanding social interactions of affected people is crucial to develop patient-specific treatments that slow down the progression of the disease. Research shows that the more patients are isolated, the faster the disease progresses.

As such, the ultimate goal of Alzheimer's Garden is to understand the social behavior of Alzheimer's disease patients living in *Il Paese Ritrovato* to promote sociability among them so as to improve their quality of life and slow down the progression of the disease.

Specifically, on one hand, we aim to assess the sociability of patients through precise measures. On the other hand, we aim to analyze the attendance and the accessibility of the places inside the facility to identify the less frequented ones and propose architectural redesigns to promote sociability and support therapeutic activities.

Understanding the problem

The goal of ALZGAR is to understand the social behavior of the residents of *Il Paese Ritrovato* to improve their quality of life. To reach our goal, we partake in on-site inspections to better understand the many aspects of the life in the village, such as the architectural layout, the daily routine of the residents, the problems faced by caregivers, and the social activities planned throughout the week.

The village features a series of apartments with common areas surrounding a large town-like ensemble of shops and other facilities, while green open areas are situated on the perimeter. The ensemble is reminiscent of a typical small town in northern Italy, so that the residents recognize themselves not as patients

but as part of a community. The Caregivers at *Il Paese Ritrovato*, who are disguised as business owners and workers, are specialized in dealing with residents experiencing crises and complications related to AD. A schedule of activities is compiled each week to stimulate residents and encourage social behavior.

Subsequently, we identify the stakeholders involved in the project, including people and organizations that are actively interested or indirectly affected, and outline the needs of each one of them by also engaging in face-to-face dialogue with residents, caregivers, and staff of *Il Paese Ritrovato*. We find that, beyond the residents constituting our main focus, we need to take into consideration the needs of *La Meridiana* co-operative, caregivers and doctors of *Il Paese Ritrovato*, as well as the relatives of the residents.

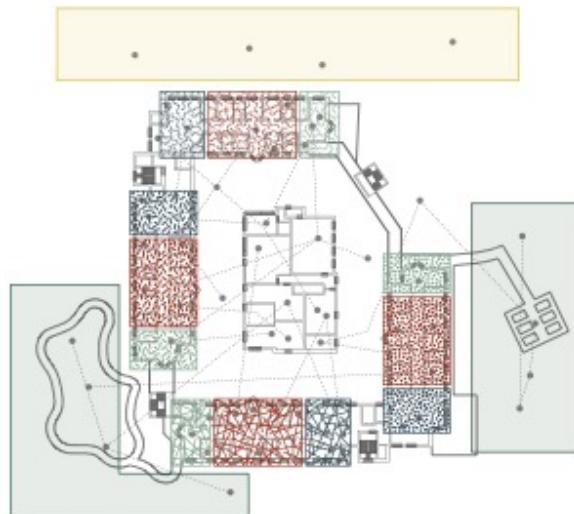
Our solution needs to be sustainable, compliant with privacy and architectural regulations, beneficial to the well-being of residents and caregivers, technologically advanced, and compatible with the current technical infrastructure of the village. We then translate the needs of the stakeholders into precise, measurable requirements to clearly define what constitutes a valid solution for us.

Exploring the opportunities

The data at our disposal consists of the localization of the residents collected through Bluetooth wristbands every 10 seconds. We may leverage this data to understand which places are frequented by residents throughout the day. Moreover, we may gather insights into the social behavior of residents, spotting interactions with and isolation from the rest of the community. Predicting the behavior of residents can be useful to plan activities in the village accordingly and to prevent social isolation by intervening on specific patients.

To assess the impact of a social activity we may resort to synthetic control techniques, estimating the community sociability level in the case the engagement did not happen and comparing it with the actual sociability measured.

Furthermore, we may analyze external factors, such as the weather, to understand how these may be influencing the sociability of the residents.



Il Paese Ritrovato – Blueprint

From a technological standpoint, we believe the introduction of security cameras and microphones is crucial to identify social gatherings more precisely, allowing us to distinguish casual encounters from actual interactions leveraging powerful

computer vision and speaker recognition techniques. However, the introduction of new technological devices is potentially invasive, possibly violating privacy regulations, besides constituting a considerable economical investment.

Thanks to the information collected from periodical surveys and interviews we would be able to understand how dwellers feel about themselves and the other community members, who they interact the most with and which places are the ones they prefer and why. Moreover, we may validate the gathered sensor data and the information provided by dwellers by taking into consideration the reliable opinion of caregivers, as they spend most of their time in close contact with the dwellers. As such, we may identify leaders and followers, specific social patterns, and socially isolated residents. However, conducting surveys and interviews would pose an additional burden on caregivers and residents, with the latter not being able to always provide reliable answers because of their mental condition.

From an architectural perspective, we may identify the most and the least frequented places by analyzing accessibility and attendance. We may propose architectural interventions in the form of spatial redesign and AD-specific installations for the places that are in need of intervention. In order not to confuse the residents, these must be non-invasive, not hindering their familiarity with the facility and comfort.

Therefore, the direction of work we choose to take is that of leveraging the existing technological solutions and proposing non-invasive spatial redesigns at *Il Paese Ritrovato*. Specifically, we aim to analyze the sociability and places attendance of the village through data analysis, predict the social behavior of the residents, and introduce installations to stimulate their senses, with the ultimate aim of slowing down the disease progression and improving the quality of life of the residents of *Il Paese Ritrovato*.

Generating a solution

Taking into account our team composition and objective, we identify two main lines of work for the project. To leverage the data at our disposal, we analyze the movement of the residents by leveraging statistical and machine learning techniques to extract patterns, gather insights, and model their social behavior. The knowledge gained is useful to identify the places in the village that are suitable for social interaction and the ones in need of enhancements, as well as to provide a way to predict the future social behavior of the community of patients and use it as a tool to support the organization of social activities.



Alzheimer's Disease Activities – Handcraft

Meanwhile, we also investigate the state-of-the-art solutions in architecture that promote social interactions to identify the ones that are better suited for our scope. We also focus our attention on the design of buildings and spaces for people with AD, especially outdoors. We propose some possible implementations

to *La Meridiana* in the context of *Il Paese Ritrovato* by leveraging the knowledge gained from our data analysis, intervening on places that are rarely visited by the residents. Many areas of intervention are green outdoor areas, which are particularly beneficial to AD patients as they provide sensorial stimuli that help preserve their mental stability.



Architectural Proposals - Gardens to Compose and Sound Houses

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