The MAGIC Project: a Tool for Promoting Safety in Agriculture during COVID-19 Pandemic

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Abstract. COVID-19 pandemic poses a threat to global health highlighting the importance of prevention and measures of social distancing. In agriculture, cultivation operations carried out in open field by farm workers represent a serious danger in this sense. Social distancing of the workers during the labor day is not always easy to be maintained, especially for the very close rows among the plants. In 2020, the researchers of the Mechanics Section of the Department of Agricultural, Food and Forest Sciences in collaboration with the Department of Engineering of the University of Palermo, presented a project entitled "Design of a real time Monitoring and control system for AGrIcultural workers to limit the SARS-Cov-2 virus" (acronym MAGIC) to the Italian Ministry of University and Research. The aim of the project was the design of a real time monitoring and control system for workers in agriculture in order to monitor, record and control any violations of the distance among the workers. The system is based on the use of a small device equipped with a uniquely stored serial number that securely emits an alarm signal to both the worker and the manager when the distance between two employees is below the permitted threshold. A central manager perform a historical "track" that lists all the subjects with whom a person has come into close contact. The system was tested at a farm in Sicily during winter pruning in vineyard..

Keywords: Bracelet, Distancing, Tracking, Wearable device.

1 Introduction

Following the COVID-19 pandemic outbreak, social distancing has become an important method to prevent the infection and to contain the spread of the contamination. In agriculture, cultivation operations carried out in open field by farm workers represent a serious danger in this sense.

The importance of 1–2 m physical distancing for preventing the diffusion of respiratory diseases can be traced back in the seminal researches of Wells (1934) and Turner et al. (1941), in which most of the exhaled droplets (>100 μm) was found to land within a distance between 1 and 2m. Coherently with such findings, during the COVID-19 Pandemic, the most relevant healthcare institutions issued specific recommendations in such regard. For example, the World Health Organization (WHO) has advised health care personnel to maintain a 3-foot (1-m) distance from persons showing symptoms of respiratory disease [1]. The US Centers for Disease Control and Prevention (CDC) recommended a 6-foot (2-m) separation [2], while other countries such as Australia and Germany established a 1.5-m distancing rule in public places [3]. As a direct consequence of such scientific evidences, almost all the governments on global scale to counteract the spread of the pandemic have enforced social distancing rules.

Despite the several Internet of Things (IoT) technologies potentially available for supporting the respect of voluntary or mandated social distancing measures, the effectiveness of social distancing systems and applications has been frequently questioned mainly because of the several technical issues which make the systems poorly reliable and effective [4, 5].

The specific working environment may significantly influence the effectiveness of a solution in counteracting the spread of the infection through self-distancing. In particular, a recent study [6] demonstrate that the COVID-19 incidence rate is significantly higher in regions with more agricultural workers; a 1% increase in the number of hired agricultural workers in a county is associated with a 0.04% increase in the number of COVID-19 cases per person and 0.07% increase in deaths per person. An explanation to such evidences can be found in the nature of agricultural jobs, which frequently requires the formation of teams working in close proximity to each other, thus being exposed to a higher risk for infection.

In such context, the objective of the proposed research is to develop and validate a technological system for social distancing specifically designed for agricultural workers, taking into account the specific issues related to the activities performed and the operating environment.

2 Materials and Methods

2.1 Description of the Research Project

In 2020, the researchers of the Mechanics Section of the Department of Agricultural, Food and Forest Sciences (SAAF) in collaboration with the Department of Engineering of the University of Palermo, presented a project entitled “Design of a real time Monitoring and control system for AGrIcultural workers to limit the SARS-Cov-2 virus” (acronym MAGIC) to the Italian Ministry of University and Research. The aim of the project was the design of a real time monitoring and control system for workers in agriculture in order to monitor, record and control any violations of the distance among the workers.

The project goal was to develop a technological solution for risk prevention from COVID-19 in agricultural operations in open field, aimed at countering and containing the effects of any future pandemics. The system consists of tracing contacts in the workplace to selectively isolate employees at risk of COVID-19, allowing the rest of the farm to continue working safely.

The system is based on the use of a token, i.e. a small device (wrist/arm band) equipped with a securely stored unique serial number, which emits an alarm signal to the worker when the distance between two employees is at a minimum below the permitted threshold. A central manager can perform a historical "trace" that lists everyone with whom a person has had close contact (and for how long). This functionality is achieved through the construction of an archive in which proximity contact with other tokens is recorded in an anonymous and secure way and the ability to receive and process information on the tokens for which the user's infection has been determined.

2.2 Tracking device

The device for tracking the position of agricultural workers is shown in Fig. 1.

Fig. 1. Device for tracking the position of agricultural workers.

The device has dimensions 58 x 96 x 32 mm and GPRS connection and Bluetooth 5.2. The battery is 200 mAh (Li-ion) whose duration covers the working day of 6.5 hours. A Bluetooth 5.0 LE module is inserted (Fig. 2) with dimensions of 12.9 x 15.0 x 2.2 mm, with a frequency of 2.4 GHz and TX Power +19 dB, 32-bit 38.4 MHz ARM CPU, memory of 512 kB (flash program memory) and 64 kB RAM data memory. The temperature range is -40°C + 85°C.

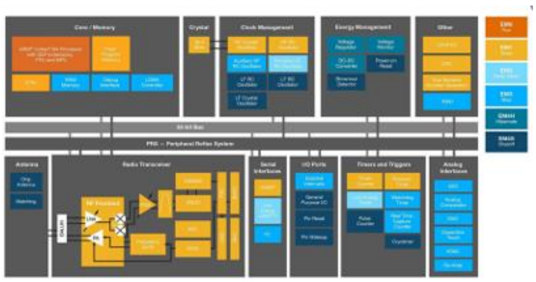

Fig. 2. Bluetooth module of the device.

The system is completed by a GPRS-GPS module (Fig. 3) with dimensions of 17.6 x 15.7 x 2.3 mm, with a frequency of 850/900/1800/1900 MHz. The GPRS is multi-slot class 12/10, GSM compliant phase 2/2+, low consumption battery, class B GPRS mobile station and 322 Mbit flash memory, 32 Mbit RAM. The GNSS multi constellation with GPS and GLONASS receiver has sensitivity tracking -167 dBm.

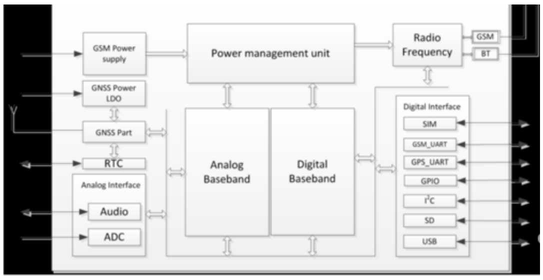

Fig. 3. GPRS-GPS module.

The system records the workers' position in real time throughout the working day by sending the position data (latitude and longitude) to a cloud whose access is password protected. The signal is sent and recorded every 5 seconds, which allows for accurate tracking of movements. The bluetooth system registers close contact and, precisely, when the mutual distance between the operators is less than 1.5 m. The system can be worn both on the arm and on the operator's side using a special belt. The system has been tested both in the laboratory and in the open field and the results obtained are very encouraging. The positions of close contacts among the employees have been archived on the cloud platform and are available for any checks in the event that COVID 19 infections occur among the employees.

The device had to be extremely easy to operate, with pre-established settings and no need for any action by the operator. Solution was thus to develop a smartband involving NFC technologies (radio signals on the Bluetooth frequencies) with a unique identification code (ID) and capable of measuring the distance from another smart band. When two smartbands are in proximity, hence, an acoustic alert is generated, thus helping people respect the necessary safety distance. The device also records which other smartband wearers it has been in close contact with, thus enabling contact tracing in case of COVID-19 infection.

The system is finally connected to a cloud platform which allows to maintain an anonymous centralized database to perform risk-analysis and alerts notifications to the managers (who is demanded the task to alert the workers in case of possible contagion). Thus, while contact tracing is based on a decentralized approach, the system also implements some centralized functions. To perform contact matching and notification by storing the contact information from the smartbands to de centralized database. In such system, only the data of potentially infected workers are shared with the centralized server, which only holds the anonymous codes of the smart bands, while the workers' names can only be associated knowing the restricted list of associations between the smartband and the workers. This allows more effective privacy policies compared to the centralized contact tracing solutions. the debate on the privacy and security aspects on the use of such systems has thus been addressed.

2.3 Field tests

The experimental field tests were carried out in January 2022, on a vineyard in a farm located in the province of Palermo, during the manual pruning operations. The experimental site belongs to the Protected Designation of Origin (PDO) Alcamo winegrowing area, at an altitude of 300 m above sea level, with irregular orography. The variety is Catarratto Lucido, grafted onto a vigorous 1103P rootstock and drip-irrigated system. The vineyard is fifteen years old and has a total extension of 8 ha, the rows are 2.40 m apart, with 0.95 m between the vines in the rows, the orientation of the rows is NE-SW. The vines were trained on a vertical shoot positioned trellis and pruned to two buds per spur, spaced approximately 15 cm apart in a single cordon, in total each vine has 6 spurs.

The vineyard planting consists of steel-galvanised poles, 2.50 m long, which are placed at a depth of 0.90 m in the ground, with the remaining part (1.60 m) providing support for the vegetation, each pole is spaced in the row approximately 5 m apart from the other. Each pole supports three different types of metal wires, these are positioned at different heights. The vineyard is equipped with an irrigation system with in-line 4 L h^{-1} pressure compensated emitters, spaced 0.95 m apart. The drip irrigation lines were placed approximately 50 cm above the ground.

Pruning operations consist of selecting the fruit buds to leave on the vine to provide grape production, these operations are divided into the cutting of shoots and the removal of shoot residues. To perform these operations the worker has first to select the two buds to be left on each spur and then cut the shoot, usually requiring about 2 minutes. Afterwards, the worker has to remove the pruning residues, an operation that takes about 2 minutes. Therefore, the total time required to prune each vine is about 4 minutes. During the field tests, three devices were worn on the arm by the PhD students of the SAAF Department of the University of Palermo (Fig.4).

Fig. 4. Fiedl tests during pruning operations in vineyard.

The tests consisted in carrying out the pruning operations by simulating close contacts of the PhD students who wore the devices.

3 Results

Fig. 5 shows the tracking lines obtained throughout the field tests by the three devices during pruning operations in the vineyard. The red (worker A), blue (B) and green (C) dots represent the position of each operator wearing the device.

The close contact events among the operators are marked by asterisks. During these events, the alarm signal emitted by the device warned the operator that the distance limit had been reached.

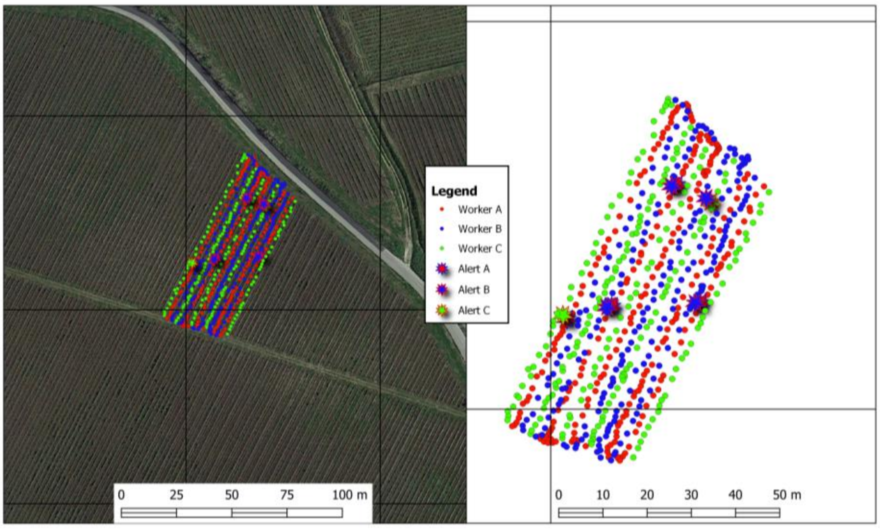

Fig. 5. Tracking lines obtained during the field tests by the three devices during pruning operations in the vineyard and close contact events among the operators (marked by asterisks).

Fig.6 shows the position of the single device registered by GPRS-GPS module as displayed by the software including day and time.

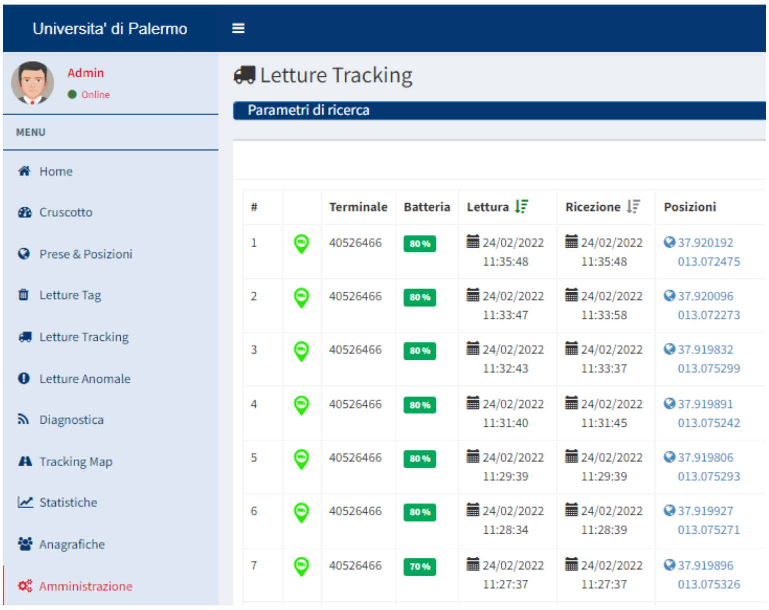

Fig. 6. Positions of the device registered by GPRS-GPS module as displayed by the software, including day and time.

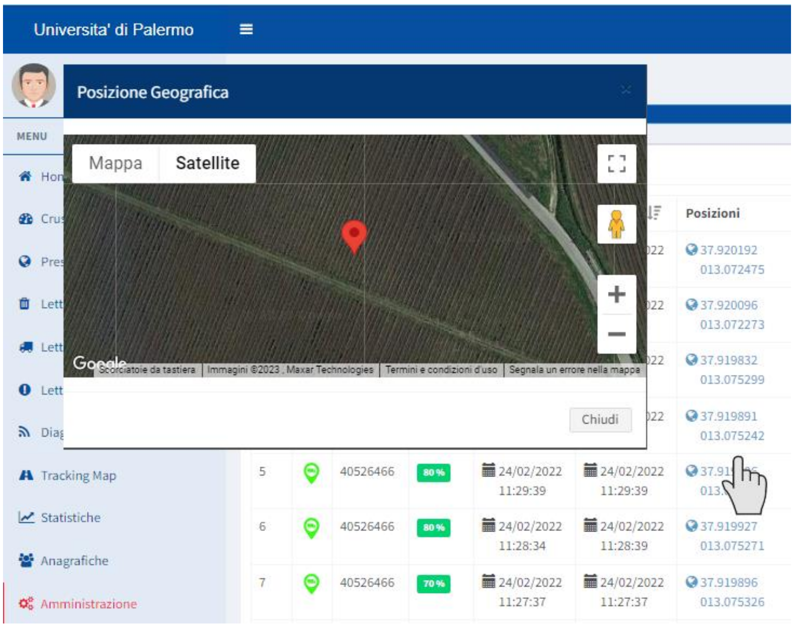

Fig. 7. Position of the device registered by GPRS-GPS module as displayed by the software when clicking on each data.

The hand-shape cursor on the right side of figure 7 allows to visualize the position and the information associated to the data.

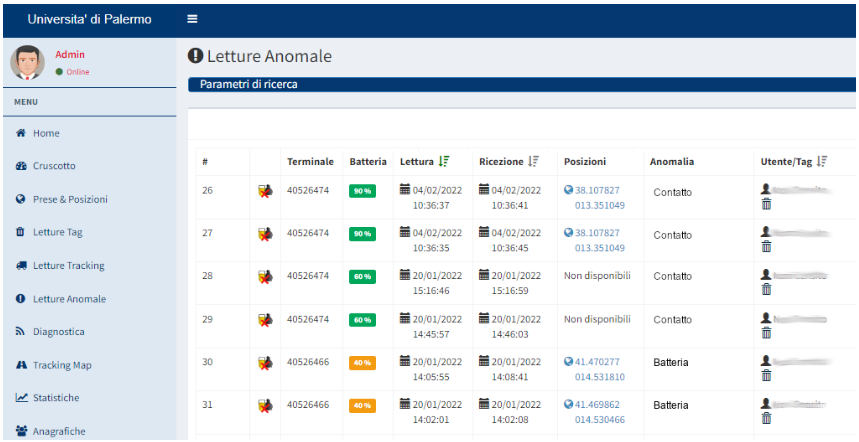

Fig. 8. Contact events among the operators and associated information.

The close contact events among the operators are registered and can be displayed in a separate sheet of the software, as shown in Fig. 8, where day, time, position, irregularity and name of the device are reported.

4 Conclusions

The research project aimed at developing and validating a technological system for social distancing specifically designed for agricultural workers.

The first field tests allowed to test the devices in the real operating conditions, i.e. during pruning operations in the vineyard.

The designed system makes it possible to avoid the closure of the agricultural activity of the farm following the contacts of the workers with the colleagues eventually infected with COVID-19. This strategic objective is achieved thanks to the tracking of the positions of all the operators present in the workplace.

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References

1. World Health Organization (WHO): COVID-19: Occupational health and safety for health workers. Interim guidance Considerations for public health and social measures in the

workplace in the context of COVID-19(2020). WHO reference number: WHO/2019-nCoV/Adjusting_PH_measures/Workplaces/2020.1, last accessed 2022/12/20.

2. US Centers for Disease Control and Prevention (CDC) https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html (2020) last accessed 2022/12/20.
3. Qian, M, Jiang J.: COVID-19 and social distancing. Z Gesundh Wiss. 30(1), 259-261 (2022).
4. Murad, S.S., Yussof, S., Badeel, R.: Wireless Technologies for Social Distancing in the Time of COVID-19: Literature Review, Open Issues, and Limitations. Sensors 22(6), 2313 (2022).
   De Fazio, R., Giannoccaro, N.I., Carrasco, M., Velazquez, R., Visconti, P.: Wearable devices and IoT applications for symptom detection, infection tracking, and diffusion containment of the COVID-19 pandemic: a survey. Front Inform Technol Electron Eng 22, 1413–1442 (2021).
5. Lusk, J.L., Chandra, R.: Farmer and farm worker illnesses and deaths from COVID-19 and impacts on agricultural output. PLoS One 16(4), e0250621 (2021).