VINSENT: AN IOT SOLUTION FOR OPTIMAL WINE BARREL MANAGEMENT IN MOLDAVIAN WINERIES

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Abstract. This piece of work was produced as part of an IoT project that follows Problem Based Learning (PBL) methodology. The project focuses on providing an accurate and efficient IoT solution to monitor the fermentation and ageing processes in winemaking. The usage of this device can result in a better final product that is more consistent and has higher quality.

Keywords: Internet of Things (IoT), sensor technology, real-time monitoring, winemaking

Introduction

The art of producing wine has been practised for thousands of years. Nowadays it evolved into a sophisticated and intricate process, involving a blend of art, science and tradition.

Winemakers face many challenges in the production process, especially in monitoring the fermentation process and ageing. The process requires careful observation of temperature, yeast, and oxygen levels. If the fermentation conditions are not just right, the wine may spoil or turn into vinegar. This can also help the winemaker to identify any potential issues with the ageing process, such as fluctuations in temperature or oxygen levels.

Traditional methods for monitoring this process can be time-consuming, inaccurate, and inefficient, requiring frequent manual checks of each barrel.

Problem statement

Monitoring the temperature, oxygen, and timing is critical in wine fermentation and ageing. High temperatures can cause yeast to die, while low temperatures can slow down or stop the fermentation process. Exposure of wine to a limited amount of oxygen can result in enhancing the wine's flavour by making it deeper and more complex, but too much oxygen can cause wine to oxidize and develop off-flavours. Timing is also critical, as fermentation and ageing processes must be timed correctly to achieve the desired alcohol level and flavour profile [1-2].

Other important factors that need to be monitored in winemaking are humidity, light, pH and CO_2 also it's beneficial to check the level of wine in the barrels to avoid leaks. Humidity levels should be kept constant and relatively high (75-85%) to prevent the evaporation of alcohol and other volatile compounds from the wine. If the relative humidity is lower than this range, it can accelerate the wine's maturation, which could result in a substandard product. Conversely, if the relative humidity exceeds 85%, there is a possibility of fungus and mould growth, which can affect the wine's quality. Exposure to light, especially UV light, can cause wine to develop an unpleasant flavour. The pH of the must (grape juice) is an important factor in the fermentation process. Yeast performs best at a pH between 3.0 and 4.0, so winemakers may need to adjust the pH of the must. Generally, winemakers want to maintain a certain level of CO_2 in the barrel during fermentation to ensure that the yeast is able to carry out the fermentation process properly [3-5].

Objectives

As Moldavian wines are continuously gaining popularity and recognition at various wine competitions, our team wants to help local winemakers make good quality wine that will increase interest in Moldavian products.

The main objective of this project is to develop a smart cork device that can be inserted into wine barrels. It must increase the efficiency of the fermentation and wine ageing procedures by reducing the need for manual checks and adjustments. This can allow winemakers to focus on other aspects of the winemaking process and increase overall productivity.

The proposed project aims to develop a functional prototype of the device, evaluate its performance, and provide recommendations for its commercialization and implementation. The outcomes of the project could be of significant value to the wine industry in Moldova.

Solution concept

The development of VinSenT - a smart cork device designed for winemaking process monitoring using sensor technology, could provide a more accurate and efficient method for observing fermentation and ageing processes, allowing winemakers to optimize them. The device will be designed and developed using ESP32 MCU [6] and smart sensor technology. It will be equipped with temperature, pressure, humidity, and other sensors to collect data on the wine-making processes. The data collected will be transmitted wirelessly to a centralized system for real-time monitoring and analysis. A diagram of the project architecture can be viewed in Fig. 1 from below.
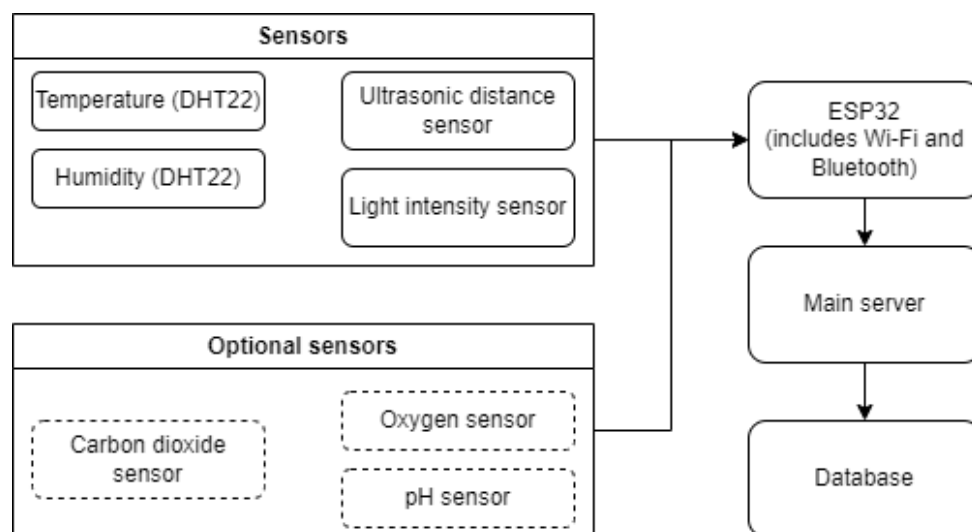

Figure 1. Project Architecture

The IoT project will involve various sensors to collect temperature, humidity, light, distance, and potentially oxygen, CO2, and pH data. The gathered information will be transmitted to the ESP32 MCU, which will then send all the collected data to the server. This data will be presented in an application that will notify the user in case of any deviations from the desired settings.

Conclusion

To sum up, the creation of VinSenT (Wine Sensor Technology), a device equipped with smart sensors for monitoring the winemaking process, can enhance the precision and effectiveness of observing fermentation and ageing processes in winemaking. This can enable winemakers to improve the quality and consistency of the final product while optimizing productivity. The project's outcomes have the potential to bring substantial benefits to the wine industry in Moldova.

References

1. What's the best temperature for wine fermentation? [online]. 2020. [cited 03.03.2023]. Available: https://olavin.com/wine-fermentation-temperature.html
2. What is Oxidation and What Is It Doing to Your Wine? [online]. 2019. [cited 03.03.2023]. Available: https://www.jjbuckley.com/wine-knowledge /blog/what-is-oxidization-and-what-is-it-doing-to-your-wine-/1015
3. Is Sunlight Bad For Wine? [online]. 2021. [cited 05.03.2023]. Available: https://dunavox.com/page/news/details/is-sunlight-bad-for-wine_109
4. Humidity Control in Wine Cellars and Barrel Rooms. [online]. 2023 [cited 05.03.2023] Available: https://www.coolmist.com.au/humidity-control-in-wine-cellars-and-barrel-rooms
5. The Importance of pH in Wine Making. [online]. 2022. [cited 05.03.2023]. Available: https://sensorex.com/2022/11/27/ph-wine-making/
6. Internet of Things with ESP32. [online]. 2018. [cited 08.03.2023]. Available: http://esp32.net/