Application of Automatic Food Spoilage Detection

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ABSTRACT: ***Adaptable sensor research has been investigated in the previous decades with the goal of expanding innovative gadgets with requisition in many machinery scopes, such as food diligence. Foodborne illness is one of the most serious health concerns. This article has developed a hybrid technique that can provide accurate information on the consistency of food items throughout storage. Smart bowls utilize a variety of sensors to record the development of factors such as the amount of microorganism agents, gases, temperature, humidity, and storage duration to monitor the consistency and preservation of food products. This technique focuses on the creation of a dish that can detect and characterize rotten food in front of a human nose. The MQ4 methane sensor is at the heart of the technology, and it detects the presence of hazardous gases like acetone and ethanol in damaged food. These sensors have opened the path for smart food detection thanks to their inclusion in food detection technologies.***

KEYWORDS: ***Arduino, Gas Detection, Intelligent Food Detection, Smart Bowl, Sensor Calibration.***

1. INTRODUCTION

All living creatures need nourishment to become strong and safe. It is a crucial and important substance that includes essential proteins, carbs, lipids, and other nutrients that are required for life, growth, and vital activities in an organism's body, as well as to give energy for function. Dieting relies on the body's immersion and implementation of food, which is aided through absorption. Plants are the primary source of food, converting solar energy into food via photosynthesis. Species that eat plants are usually food sources for other animals. Social function, physiological function, and psychological function are the three primary functions of food [1].

The goal and method of dining with family members, friends, and others is closely linked to this position's social role. Some food is provided here by family, friends, and others, and we anticipate to be given food as well [2]. The sharing of food is an important element of social gatherings such as festivals, meetings, and parties. Psychological function: People consume food not just to satisfy hunger, but also to express feelings such as love, affection, irritation, and so on. Physiological function: Physiological food is food that mainly supplies energy, growth, control, and illness protection.

Food quality and safety have always been in high demand since food is one of the main sources of energy for living creatures. With Cisco Inc. projecting 50 billion connected devices by 2020, technologies like the Internet of Things (IOT) provide an area of unfathomable impact, potential, and development. The majority of these IoT gadgets, on the other hand, are simple to hack and compromise. Because the computation, storage, and transmission capacities of these IOT base devices are often limited, they are more vulnerable to assaults than other endpoint devices such as smartphones, tablets, or PCs. It's a technology that allows you to connect anything, anyplace, at any time [3]. By incorporating IoT into food detection technology, individuals will be able to enhance their quality of life by detecting the state of their food and allocating data received from the application. Currently, the use of IOT technology in food detection applications is still in its infancy, with a long way to go for improvements. Food deterioration, cleanliness, and safety are critical components in preventing food waste and keeping oneself healthy. Food quality must be controlled to avoid spoilage, decomposition, and other problems caused by natural causes such as spoilage, darkness, humidity, and temperature. As a result, by placing quality monitoring systems in food shops, health may be preserved while waste is reduced. These natural variables capable of causing food spoiling, decomposition, and trouncing are identified by these factor of feature inspection devices [4].

Food may be kept fresh for a long time by keeping it in the refrigerator and preventing it from spoiling or decomposing. Food deterioration and breakdown occur throughout the composition process, but the main issue arises from inefficient food handling methods and inapplicable air conditions during food storage and transit [5]. Food poisoning may be detected in a variety of ways, including if the food becomes overripe, a gas begins to erupt from the food, the color of the food begins to change, and humidity and temperature changes. As a result, the main aspect of monitoring system is the detection system, which is capable of detecting over ripeness, darkness, humidity, and temperature difference during food storage and transit [6].

Almost everyone nowadays is impacted by the foods they eat on a daily basis; this is not due to junk food, but rather to preserved veggies, which are harmful to human bodies. When food is kept, its nutritional value, oxygen content, temperature, and moisture content vary over time. This variation in food quality aids in food monitoring. Almost everyone nowadays pays attention to the information supplied or offered in the packets to identify the expiration date of the food, which is a significant issue that arises from blindly trusting the presented data and putting one's health at danger. This article has designed a bowl incorporating a monitoring and detecting device at every step of the supply chain to offer safe food. This gadget, often known as a bowl, protects the user's health by maintaining the appropriate atmospheric conditions for preserving food quality. To identify changes in the food, an inquiry and completion of frequent food measurements are needed. The data will then be exchanged with the user's smartphone through a Wi-Fi module. The main function of the systems for detecting, analyzing, monitoring, and regulating food is to monitor each individual activity of the food using various electronic sensors. The process is controlled by an Arduino microcontroller, which controls and collects data, which is then compared and analyzed with previously gathered data. If the computed results vary from the specified values, the microcontroller prevents the required quality from spoiling or being contaminated [7]. The goal of the smart food detecting system was to identify and regulate food items in order to prevent them from spoiling.

1.1 E-noses for detection of foods and beverage spoilage:

Quality assurance methods in the food processing sector must be quick and include everything from organoleptic testing to microbiological inspections. Human sensory panels often analyze food deterioration qualitatively by evaluating air samples and determining whether foods are acceptable or unsuitable. Gas chromatography and mass spectrum analysis are then used to perform quantitative characterization. In contrast to this technique, e-noses can detect odours continuously and are not affected by individual sensitivity. Bacterial contamination of food and beverages may result in offensive odors as well as hazardous chemicals. As a result, many sectors are interested in using the e-nose to monitor storage quality deterioration as well as identify microbiological contamination. The vapors generated by microorganisms engaged in sausage fermentation were the subject of one of the first reports of e-nose technology being used in food analysis [8].

Different quantities of spoilage bacteria and yeasts, as well as early detection of milk deterioration, were studied. These investigations found that after two and five hours of incubation, an e-nose system could differentiate between volatile profiles of various species implanted in milk-based medium. Furthermore, three Pseudomonas aureofacien bacterial concentrations were readily distinguished. Despite the fact that they are still in the early stages of development, these investigations corroborate the findings of previous research that looked into the use of various gas sensors in the detection and identification of bacteria and molds in milk and dairy products. Other investigations using an e-nose to identify various microbial species seeded in potable water found that the lowest microbial concentration detected by an e-nose is 102 - 104 cells/mL. Many fungal species have been identified as playing a significant part in the breakdown of foodstuffs, in addition to bacteria. Various fungal species have been identified from food, and research has been conducted on fungal species isolated from cereal grains and moldy bread.

The goal of this research was to use e-noses for early detection and discrimination techniques for fungus species in cereal grains and bakery goods before apparent growth. The findings suggest that sensor arrays may be used to quickly regulate and improve the quality of food products. In investigations on the identification of mycotoxigenic fungus in grains, similar promising findings were found. Gas mixtures from spoilage bacteria previously isolated and inoculated on a particular medium were examined in the experiments described above. Direct detection of vapors in food samples is a distinct technique. Following that, GC-MS characterization of vapors was linked to the detection of contaminating microorganisms. The e-nose is based on several gas sensors in these studies, and the volatile chemicals are calculated based on the individual sensor responses. All of the aforementioned findings are intriguing, and additional research into inducing particular response patterns in gas sensors may aid in both qualitative and quantitative food spoilage analyses.

In this patent claims, author Per Pinstrup-Andersen suggested food security, in which nutritional security is the primary objective of interest, and a combination of food availability, clean water, and proper sanitation is estimated. The author of this article discussed food security, which is defined as the process of determining an appropriate diet need. This paper's idea of food security has been widely used at the home level to ensure food security. Because of inadequate sanitation and dirty water in the nations, family food security is restricted to show the food security of each person. As a result, keeping track of each person's health and diet

is very tough. In this research review, food security is a useful concept for estimating family food security in conjunction with individual anthropometric estimations for all human beings.

Because rotting food is a major health concern, author Nihad Benabdellah et al. suggested an application in which an electronic nose is used to identify the smell in ruined meat before utilizing a TGS822 gas sensor. These sensors detect harmful gases in rotting meat, such as acetone and ethanol. The electric nose is placed in the refrigerator, where the reorganization components overlap to determine the quality of the meat before it is detected by the human nose.

Prof. Kadam P. R et al. proposed a model to identify spoiling in raw milk in this article. Many additional techniques for detecting milk deterioration have been developed since the beginning. The research aids in identifying germs that are hazardous to human health that is present in raw milk. So, to identify bacteria in real-time, this article suggested a system that monitors the quality of milk consumed by individuals or distributed for the production of dairy products. Different sensors are linked to the Arduino board in this article, and the data gathered by the system is sent to the user through an Android app to determine the quality of milk. This system includes sensors such as pH level indicators, bacteria detection using an electric technique, a gas sensor to identify gases in raw milk, magneto elastic sensors for remote query detection, a Wi-Fi module for real-time application, and a control system [9].

This method aids in the inspection of raw milk and the detection of milk deterioration. The method produces poor detection and does not need the development of a new instrument that can assess milk quality in real-time. As a result, this issue can be addressed using the approach described in this article. A bowl is used in this study to contain a fake spoiling detecting system that includes a proximity sensor, capacity sensor, and MQ4 methane sensor, as well as a Wi-Fi module, alarm, LEDs, a microprocessor, and an LCD. When the system is provided electricity and an internet connection, the system's food spoiling detecting function is triggered. When a human approaches the gadget, however, the proximity sensor recognizes the person's presence. When the proximity sensor detects the presence of a human, it sends data to the microcontroller.

The proximity sensor sends a signal to the microcontroller, which opens the bowl lid, enabling the user to drop the food without coming into touch with the lid. Following food deposition, a capacity sensor detects the bowl's fullness and sends data to the controller. This capacity sensor is used to keep the limit of food storage within the bowl. When food is stored in the bowl, a capacity sensor connected to the device detects the device's fill level. In the presence of a human, a mechanical aperture operated by a sensor (proximity sensor) opens up, enabling the person to deposit food without coming into touch with the lid quality of the food and sending data to the user. To keep track of the device's fill level.

1.2 Biochemical precursors and bacterial species:

The research mentioned above is centered on the development of novel quick techniques for detecting bacteria vapors on patients or in clinical specimens. In additional experiments, artificial media were used to extract metabolic pathways leading to the generation of distinct smells from each bacterium. The bacteria were isolated and inoculated in a complicated nutritional medium before being used in these studies. By generating metabolic precursors for the release of distinct smells, these investigations looked into the possibility of discriminating between disease-causing infections and other isolates. The findings revealed that clinical anaerobic Clostridium sp. isolates and Bactericides fragile isolated from intraabdominal infections may be distinguished [10]. Microorganisms that cause Helicobacter pylori infection as well as other bacteria that cause urinary tract infections were also discovered. One of the goals of these studies was to reduce the incubation period of the cultures, allowing for quicker identification of particular infections. A quick technique for identifying 10 harmful pathogens using an e-nose was recently reported: these tests indicate that a 16-hour incubation time is enough to generate detectable volatile chemicals. Gardner et al. also got significant findings by collecting bacteria like E. coli and S. aureus while they were still growing. Throughout the first hour of incubation and during the lag phase, 100 percent of S. aureus were properly identified. Because particular metabolites indicate bacterial development, it may be feasible to identify key vapors as markers of various bacterial species in the future. This may lead to the creation of specialized sensors that enhance discrimination patterns and allow for fast diagnostic screening [11].

2. DISCUSSION

The implications of electronic odor sensing devices for microbial identification in the areas of health care and food technology have been discussed in this study. There is a substantial amount of published literature that investigates various experimental settings to create and apply these novel analytical techniques. There are two issues with the e-nose technology, in our view. The first issue is with the instrument's performance

in terms of physical characteristics and data processing. These features are constantly being enhanced to characterize a huge number of smells more quickly and accurately. The second issue concerns the experimental methods used to elicit particular odor detection and identification responses. Various methods for collecting and giving precise information about the microorganism causing illness or deterioration have been suggested for this purpose. These studies are designed to identify microbial species and/or determine the chemical makeup of the smells observed. So far, the human nose's sensitivity is much superior to that of any e-nose. As a result, human panelist answers are still used to classify odors. The solutions to the issues mentioned above, as well as careful practical implementations, may offer quick and effective odor detection tools.

3. CONCLUSION

The gadget described in this research article is a food detection method that detects food quality in real-time. In the bowl, a proximity sensor is placed at the outside part of the bowl to detect the approaching person to fill the food and is installed to check the consistency of food control tools as soon as the incoming detected bowl lid is opened for filling, which includes a range of methods. The capacity sensor checks the bowl limit till the user fills it, then instructs the user to fill the limited set food container. After filling the container, mounted sensors such as the PH sensor, humidity sensor, and MQ4 methane gas sensor begin to check the food's quality. The PH sensor checks the food's PH value, the humidity sensor checks the food's darkness, and the MQ4 sensor checks the gas emitted from the food after spoilage. In addition to real-time applications, this gadget has an Android application that allows the user to obtain food quality statistics and information. The device, which is placed in the bowl, is inexpensive, small, and protects individuals and groups from being sick from contaminated food.

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