AI for Healthy Meal Preparation in Smart Cities

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Abstract

INTRODUCTION: 'Food is medicine'. Eating healthy fresh cooked foods is increasingly becoming a challenge, especially among working professionals, elderly people, people in care homes and those getting medical care, as they find it difficult to cook everyday meals and to make sure they take in all necessary nutrients regularly.

OBJECTIVES: With the intervention of Robotics and AI, food preparation and delivery can be made efficient in a way it supports overall health and wellbeing.

METHODS: The proposed idea is a smart city AI scheme with robots engaged in food preparation tasks such as chopping, grating etc, robotic kitchens assembled to prepare foods as per the dietary needs of various groups of people and delivery bots and drones to effectively deliver meals, fruits and necessary supplements on a daily basis and also pick up leftovers for effective waste management. This can also be extended to smart hospitals for providing nutritious meals to patients to aid in faster recovery and also avoid the carelessness and haste in food preparation when human workers are involved.

1. Background

Eating healthy is slowly becoming a priority for a lot of people these days and people are willing to spend more money to buy or make healthy wholesome food. At the same time, it is also a challenge to make sure to take in healthy meals on a regular basis, especially among working professionals, elderly people and people getting medical care, because of the time and effort it demands.

A good number of people are dependent on house help and restaurants for their everyday meals, but it is still hard to ensure they get wholesome meals with all required nutrients on a regular basis. Human prepared meal plans catered to meet nutrient requirements which are becoming increasingly prevalent are quite expensive. Also, the availability of such healthy meals should not be a luxury that only the privileged can enjoy and relish. Hence creating a system that can provide healthy nutrient rich inexpensive meals to everyone alike, becomes important in order to create a healthier and more energetic society [10].

In this day and age, making use of technology and AI to form a system that can provide healthy everyday meals is scalable and efficient and can cater to a large number of people.

2. Smart City Ecosystem

A smart city is an ecosystem of smart capabilities that work with one another to make the city a desired place to live and work. Artificial intelligence (AI) plays an important role in the future development of smart cities. A Smart city AI framework is an intelligent network of connected objects and machines transmitting data using wireless technology amongst themselves in some cases and to the cloud [17].

By providing the necessary infrastructure, communication platform and enabling access to relevant

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data to integrate any new technological system, smart cities provide a suitable ecosystem to such an initiative.

Smart cities, in general, also have a health service system that uses technology such as wearable devices, IoT, and mobile internet to dynamically access medical information of people, connect people and institutions related to healthcare together and also actively manages medical ecosystem needs in an intelligent manner [4].

IoT, mobile Internet, cloud computing, big data, 5G, microelectronics, artificial intelligence and biotechnology form the main components of smart healthcare. Technology applications and apps also encourage healthier behaviour in people and assist them with the proactive management of a healthy lifestyle. It puts consumers in control of health and well-being [23].

One of AI's biggest potential benefits is to help people stay healthy so they don't need to visit a doctor, or at least not as often. The use of AI and the Internet of Medical Things (IoMT) in consumer health applications is already helping people in different ways [3].

3. Robots for food preparation

With AI and robotics becoming more accessible, robots are increasingly becoming a commonplace for the food and beverage industry. The early uses of robots in the food industry were primarily for packaging and palletizing operations [7]. Now, they are used for various food processing operations from the farm to fork, such as salad making, mixing, chopping, dairy and cheese processing operations like stirring curds, slicing cheese, meat processing operations such as cutting, sorting and packaging and many more [21].

A number of tech firms are now developing robots that can cook and plate up entire meals, both for commercial and domestic kitchens. They can turn on the oven and hob, pick up and put down saucepans and spatulas, stir, whisk and flip [15].

A robotic kitchen has various robots performing different food preparation tasks for different ingredients and an assembler to bring everything together, combine as needed and to arrange entire meals. For example, A steamer component cooks grains and pasta, and a separate element dispenses sauces and garnishes. The different components can be in different temperature-controlled lanes [5], [25].

The robotic kitchen also includes food safe bins where staff in-charge can place ingredients to be cooked. As an alternative, the ingredients are deposited at intervals automatically into bowls that travel through the kitchen on a conveyor belt. An AI vision system, that's integrated with the robot, identifies the food and the robot picks it up, and cooks it as per the instructions fed to it. The robot then places food in a hot holding area [11].

The chef's movements can be recorded while making a recipe in a similar kitchen setup as the robot and then transferred onto the robotic arms. Those movements would then be streamlined by the robotics team, and formulate a consistent program that would produce the same dish every time [1].

It can also utilise data from the robotic assembly line and other inputs to optimise workflows, recipe development, and food scheduling. A lot of start-up companies are also developing robots that can perform complex food preparation tasks such as flipping burgers, making fried food etc [9].

Robotic kitchens are becoming increasingly popular worldwide. An initiative by a start-up in Chennai, India in building a fully automated kitchen that can cook more than 800 recipes for provided orders, with no manual effort [24].

A restaurant in Boston, called Spyce has a dynamic menu where guests can select a dietary or allergy preference on the app while placing an order, and the app instantly reshuffles an item's ingredients to fit those parameters [8],[12].

3.1 Advantages of robotic kitchens

Advantages of using robots as compared to manual labour are, they save time, consistency in adding ingredients and preparation, are more hygienic, cost effective and helps reduce food waste.

They help people save time and focus on meaningful activities. Robots have become capable of producing 350 bowls per hour and completing an order in two to five minutes. There are robots developed that can prepare 50 pizzas an hour, using 35 different toppings and cheeses [18].

Performing the various tasks needed to get a dish ready can be tedious and hard to get it right every time for a human chef. For example, griddling patties for burgers, toasting buns and spreading sauces to get a burger ready can be hard or close to impossible to get it right every time maintaining consistency and quality, but the robot chef can do it precisely, quickly and effortlessly.

Quality food gets delivered quickly and as per guests' specifications. Using robots also helps reduce food waste, avoids cross-contamination, decreases oil spillage, manage resources better and can bring in sustainability [13].

3.2 Robotic kitchen components

The main components in a robotic kitchen are robotic arms, which perform the action of picking and placing items and different types of sensors that are integrated in high-precise and lightweight frame structure. Often, there is an end-effector attached to the arms that is customised for a specific food preparation task. End-effectors include a wide variety of shaped grippers, suction cups, and other food manipulation devices specific to the size, shape, and rigidity of the food products they are handling. In addition, there is also a computer vision system to determine orientation of the food to be manipulated, attached to the robot.

Some robot chefs are integrated with natural language processing features and can respond to voice menu orders.

Robotics also requires special food-safe materials. Stainless steel is used commonly since it can withstand caustic cleaning chemicals. In addition, food-safe lubricants can be used on moving parts.

Cabinets, kitchen appliances and equipment optimised for human and robot use, are integrated and connected to the fully automated kitchens. They can also include a recipe recording system and a connected GUI screen with access to a library of recipes.

4. Delivery robots and drones

Four-wheeled, cooler-sized robots that deliver food and beverages, drones that fly to your backyard to deliver food and groceries are increasingly becoming the next future of robotics [16].

Robots are already deployed for delivering on college campuses, and in various controlled environments. The robots use satellite imagery to navigate from place to place. They are mostly connected to a centralised computing system which determines the best path for the robot to take for efficiency and safety and also optimises the routes and delivery for the different bots connected to the system at any given point. Each robot also has its own set of cameras, sensors and radar to ensure that it can avoid obstacles such as cars, animals and pedestrians [14].

5. Proposed smart city AI scheme for improving overall wellbeing

A smart city set up offers various advantages for efficient and autonomous meal preparation and delivery with robotic systems and drones. With IoT and high speed 5G network, the overall speed and performance of the system is improved [19].

Food delivery bots connected with smart city IoT infrastructure and communicating with IoT traffic controls and sensors offer efficient and safe navigation and routing through pedestrian walkways in smart cities. Exchange of information between meal preparation robotic systems and delivery systems along with the data of dietary requirements of people in the community can be properly utilised to improve the effectiveness of the scheme [2], [22].

A similar robotic kitchen set up in individual households would cost a fortune, whereas a smart city ecosystem with its connected infrastructure, shared resources and services and access to collective data and information encourages community initiatives that can be effectively implemented to improve the quality of life of its inhabitants.

The proposed idea is a smart city AI scheme that includes fully automated robotic kitchens with robots and robotic arms engaged in food preparation tasks such as chopping, grating etc, mixing and assembling foods for various pre-programmed recipes and also pack entire meals for people individually based on their dietary needs.
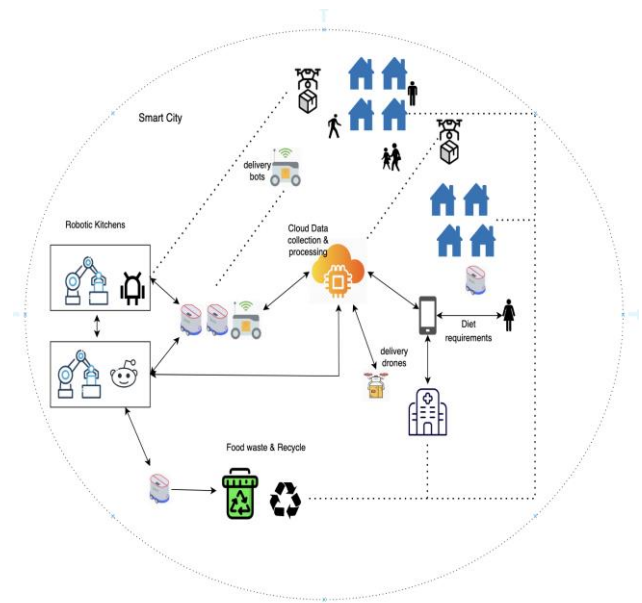

Figure 1. AI powered meal preparation system

The scheme or AI ecosystem proposed also integrates the food preparation units with delivery bots and drones to effectively deliver meals, fruits and necessary supplements on a daily basis to individual homes and care homes in the smart city and also pick up leftovers for effective waste management [6].

This can also be extended to smart hospitals within the smart cities for providing nutritious meals to patients to aid in faster recovery. The system can also be integrated securely with health records of the patients to provide daily supplements and required medications.

With the use of robots for meal preparation, the speed and consistency of the number of dishes or food units prepared is considerably increased as compared to human chefs and that provides the way to accommodate individual nutrient needs in every day's meal preparation schedule.

A centralised and decentralised cloud infrastructure and processing system becomes the backbone of the fully automated meal preparation scheme, providing connectivity and communication between the different components of the ecosystem, powering the robotic and AI components and algorithms to function seamlessly, handling and analysing data and information gathered from the smart city's IoT to formulate workflows, optimise routes and make intelligent decisions and also by integrating necessary security and fail safe mechanisms [20].

An AI powered mobile application can be integrated with the scheme for people to include their dietary requirements and receive daily notifications on meal preparation and delivery.

6. Benefits of the proposed scheme

- Everyday delivery of fresh meals and nutritious snacks for older people and people getting medical care.
- Save money and human resources.
- Variety of menu, catered to dietary needs and nutrition requirements.
- More hygienic
- Fewer mistakes as compared to human workers and reduce food waste.
- Faster meal preparation and hence
- Can be extended to use AI to analyse various body types and conditions if any, based on health data collected and to assist people to eat nutritious meals based on that.
- Cost effective as it can be built to cater to entire communities and also serve different classes of people, equally.

7. Conclusion

The impact technology and AI can have in improving the collective health of the community is significant and with the belief that nutritious food has the ability to heal and prevent illness, the intent of the proposed idea is to create a healthier and more sustainable societies and cities.

References

[1] Agarwal R, Jachowski D, Shengxi D. Robo-Chef: automatic recipe generation. Tech. Np. 2009 Nov.

[2] Amin SU, Hossain MS. Edge intelligence and internet of things in healthcare: a survey. IEEE Access. 2020 Dec 15;9:45-59.

[3] Astromskė K, Peičius E, Astromskis P. Ethical and legal challenges of informed consent applying artificial intelligence in medical diagnostic consultations. AI & SOCIETY. 2021 Jun;36(2):509-20.

[4] Brown J, Cug J, Kolencik J. Internet of Things-based Smart Healthcare Systems: Real-Time Patient-Generated Medical Data from Networked Wearable Devices. American Journal of Medical Research. 2020 Apr 1;7(1):21-7.

[5] Cha E, Forlizzi J, Srinivasa SS. Robots in the home: Qualitative and quantitative insights into kitchen organization. In Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction 2015 Mar 2 (pp. 319-326).

[6] Diran D, Van Veenstra AF, Timan T, Tesa P, Kirova M. Artificial Intelligence in smart cities and urban mobility. Policy Department for Economic, Scientific and Quality of Life Policies. 2021.

[7] Duong LN, Al-Fadhli M, Jagtap S, Bader F, Martindale W, Swainson M, Paoli A. A review of robotics and autonomous systems in the food industry: From the supply chains perspective. Trends in Food Science & Technology. 2020 Dec 1;106:355-64.

[8] Fürstenau D, Auschra C, Klein S, Gersch M. A process perspective on platform design and management: evidence from a digital platform in health care. Electronic Markets. 2019 Dec;29(4):581-96.

[9] Hoffmann T, Prause G. On the regulatory framework for last-mile delivery robots. Machines. 2018 Aug 1;6(3):33.

[10] Klein JA, Watson JL, editors. The handbook of food and anthropology. Bloomsbury Publishing; 2016 Aug 25.

[11] Liu B, Zhang M, Sun Y, Wang YC. Current intelligent segmentation and cooking technology in the central kitchen food processing. Journal of Food Process Engineering. 2019 Oct;42(6):e13149.

[12] Madon S, Schoemaker E. Digital identity as a platform for improving refugee management. Information Systems Journal. 2021 Nov;31(6):929-53.

[13] Moreno-Camacho CA, Montoya-Torres JR, Jaegler A, Gondran N. Sustainability metrics for real case applications of the supply chain network design problem: A systematic literature review. Journal of Cleaner Production. 2019 Sep 10;231:600-18.

[14] Mukherjee S, Baral MM, Venkataiah C, Pal SK, Nagariya R. Service robots are an option for contactless services due to the COVID-19 pandemic in the hotels. Decision. 2021 Dec;48(4):445-60.

[15] Naeem Abass M, Zohry AE, Gamal Saad Soliman S. The Possibility of using Robot as one of the Artificial Intelligence Techniques in the Food and Beverage Department in Five-star Hotels: Managers' Perspective. 2022 Jun 1;11(2):857-907.

[16] Romanjuk M. Delivery robots serving last mile B2C: an evaluation of Tallinn residents' incentives behind the usage of delivery robots in 2020 on the basis of Starship Technologies example.

[17] Rozenes S, Cohen Y. Artificial Intelligence Synergetic Opportunities in Services: Conversational Systems Perspective. Applied Sciences. 2022 Jan;12(16):8363.

[18] Rusu RB, Gerkey B, Beetz M. Robots in the kitchen: Exploiting ubiquitous sensing and actuation. Robotics and Autonomous Systems. 2008 Oct 31;56(10):844-56.

[19] Sallabi F, Shuaib K. Internet of things network management system architecture for smart healthcare. In 2016 Sixth international conference on digital information and communication technology and its applications (DICTAP) 2016 Jul 21 (pp. 165-170). IEEE.

[20] Shuaib M, Alam S, Alam MS, Nasir MS. Self-sovereign identity for healthcare using blockchain. Materials Today: Proceedings. 2021 Mar 27.

[21] Singh A, Chavan A, Kariwall V, Sharma C. A systematic review of automated cooking machines and food service robots. In 2021 International Conference on Communication information and Computing Technology (ICCICT) 2021 Jun 25 (pp. 1-6). IEEE.

[22] Suppa A, Kvist J, Li X, Dhandapani V, Almulla H, Tian AY, Kissane S, Zhou J, Perotti A, Mangelson H, Langford K. Roundup causes embryonic development failure and alters metabolic pathways and gut micro-IoT a functionality in non-target species. Microbiome. 2020 Dec;8(1):1-5.

[23] Tian S, Yang W, Le Grange JM, Wang P, Huang W, Ye Z. Smart healthcare: making medical care more intelligent. Global Health Journal. 2019 Sep 1;3(3):62-5.

[24] Vijai C, Wisetsri W. Rise of artificial intelligence in healthcare startups in India. Advances In Management. 2021 Mar 1;14(1):48-52.

[25] Wallin PJ. Robotics in the food industry: An update. Trends in food science & technology. 1997 Jun 1;8(6):193-8.