Food Serving Robot Using Machine Learning and IoT

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Abstract— **With the Internet of Things (IoT) gradually evolving as the subsequent phase of the evolution of the Internet, it becomes crucial to recognize the various potential domains for application of IoT, and the research challenges that are associated with these applications. Ranging from smart cities to health care, smart agriculture, logistics and retail, to even smart living and smart environments, IoT is expected to infiltrate into virtually all aspects of daily life.**

This study features the multidimensional tasking of hotel industry with the growth of IT enabled services. Hotel industry in current scenario is highly relying on computerized system for most of its operations and management reports. To remain competitive, it is very much essential to achieve high guest satisfaction. As the era of industrial revolution 4.0 is coming, most of robots are developed to replace the human works and services. However, in Vietnam, putting robots in service industry such as waiter robot serving in restaurants is still very limited. This study presents the initial development of restaurant serving robot using line following approach.
Robots are programmed to come to a specific table by mapping data. Based on the image recognition algorithm implemented on microcontroller.

Keywords---Machine learning, IoT, serving robot, artificial intelligence, computerized robot, robotic waiter, node MCU, ultrasonic sensor, motor driver, servo motor .

I. INTRODUCTION

Artificial intelligence and its adaptive developments are the prevailing technologies in the modern era. There has been enormous growth and evolution in this field over the decades. Almost every day, the industry designs and develops several new technological products. Recent updates in smart applications, smartwatches, and mobile phones are received at a very fast rate

In recent years, robotic technology has been focused to develop on wide range of applications from military to civil and industrial. Among them, wheeled mobile robot is the most common type of robot that is developed for consumer purpose. The mobile robot is maximized its efficiency by integrating smart sensors, image processing technology, and so on.

Due to the modernization in robotic technologies, many new designs and mechanisms are being implemented which are able to read human thoughts and understand actions.

Robotic technology are coveted in many industries including restaurants and it's because they can increase accuracy, reduce cost and increase safety for human beings. In fact, safety is one of robotics' greatest benefits as many dangerous or unhealthy environment do not require human element. There is less of a need for young people to work as waiters in hotels and fast food establishments as the global information technology sector grows. Over the past few decades, there has been an increase in interest in research and development initiatives for social services and healthcare.

Application of IoT and purpose of intelligent robot

Potential applications of the internet of Things are not only numerous but also quite diverse as they permeate into virtually all aspects of daily life of individuals, institutions, and society. According to the applications of IoT cover broad areas including manufacturing or the industrial sector, health sector, agriculture, smart cities, security ,hotels and emergencies among many others.

A waiter robot that could be used in restaurants, where robotics technology is quickly replacing manual labor, is the aim of this project. Nowadays, the Shortage of employees has become a huge conundrum for restaurant owners, not only in this industry but also in other businesses also. even with the deployment of good cooks and management. Robots are also can be use to replace cooks for cooking purpose but in these paper we will be working on how robot can be used in hotel industry to overcome shortage of labor. In this project we build robot for food serving using IoT and machine learning algorithms with low budget and cost effectively.
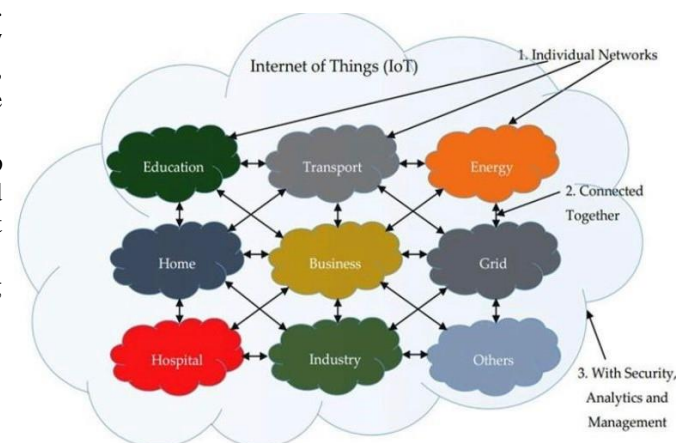
II. LITERATURE REVIEW

In modern industry, robots play a major role and contribute to completing tasks in a smart manner while offering additional collaboration, flexibility, and safety. Society is continuously evolving and will be enhanced over the next few years with the evolution of these technologies. The robotics industry and artificial intelligence technologies are the major contributors to this   evolution.The production and manufacturing phases are completely altered by Industrial and robotic automation, In order to increase product and economy, automation is implemented into these phases.

Collaborative robots are the derivatives of conventional industrial robotics with advancements in AI and ML software. These robots can sense their surroundings, understand, learn, and act by making appropriate decisions. As several processes are changed to self-adapting processes. the environment where they are implemented has also changed. The demand for customized orders can be addressed easily by the organizations with these changes. The design of robots makes use of clouds, artificial intelligence, big data, and other advanced information technologies. Sales, marketing, and manufacturing fields are impacted by the advancements in these domains. For example, the Autodesk tool is used for faster design and building of drones that enable early delivery of the finished product to the customer. Several skills and engineering domains are brought together with robotics.

The journey of the industrial revolution from Industry 10 to 4.0 is massive. In the eighteenth century, with the introduction of the steam engine, the first industrial revolution began. In the nineteenth century, the second industrial revolution started with the use of electricity. In the twentieth century, the third industrial revolution began with the use of computers. The fourth industrial revolution currently involves Industry 4.0 with technologies such as big data, IoT, and robotics. When the data and services available on the web are interlaced with the actuators and sensors, they are collectively called the Web of Things (WoT), which is a modification of loT.

Third-party web services may be required for integrating devices, robots, and sensors. Enhanced and flexible ser- vices can be created by integrating the devices and sensor data of one company with the data of a recycling company. Hence, IoT can be driven with WoT as a key element. Digital industrial technology or Industry 4.0 focuses on real- time data, robotics, automation, and machine learning, con- tributing to a whole new market revolution. Digital assistants, autonomous robots, and expert systems used in smart machines belong to Industry 4.0. With the rise in   Industry 4.0, robotic technology and manufacturing are also increasing exponentially. Robotics in Industry 4.0 aims in developing a smart industry in which technologies like loT are used to establish alternatives during disturbances, and products find their own way through the production chain . Wireless control of high-end loT chips, robotics, and big data are used in an automated smart factory. Each device can communicate with and control the other in this setup.

III. DESIGN OF FOOD SERVING ROBOT

In this we will see what methods and tools are use in the building the robot. Hardware and software are the tools that are used to build this project and methods are the processes that we use to integrate the hardware and software.

There are different hardware components that we use for the project. The hardware components that are used for the project are as follows:

1. Node MCU
2. Ultrasonic sensor
3. Motor Driver
4. Servo Motor
5. DC Motor
6. Connecting Wires
7. Battery
8. IR sensor

The Software components that are used for the project are as follows:

1. IDE
2. Anaconda Navigator

The technologies which are used for the project are as follows:

1. Convolutional Neural Networks (CNN)
2. k-Nearest Algorithm

Working of Components

1. Hardware Components

i.   NodeMCU
The Node MCU (Node Micro Controller Unit) is an opensource software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. is an open-source firmware for which open-source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (microcontroller unit). Strictly speaking, the term "Node MCU" refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source.
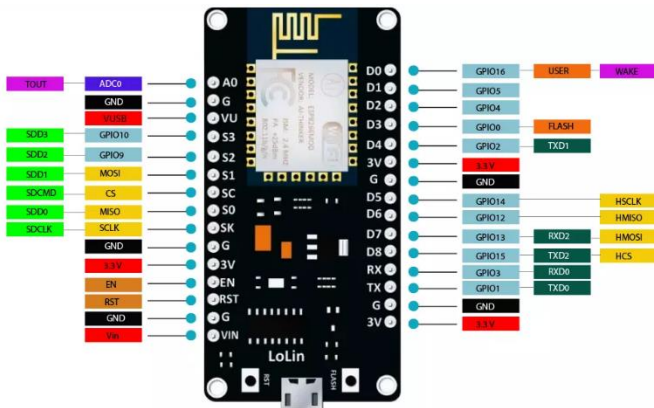
ii.   Ultrasonic Sensor

It is an electronic device that measures the object distance by ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound. It has two main components: the transmitter and the receiver. Here we have used this sensor for obstacle detection. It sends an ultrasonic pulse out at 40kHz which travels through the air if there is an object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated. An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target.

iii.   Motor Driver

Actually, a motor cause pressure is some factor that reasons the motor to move in reaction to instructions or inputs (excessive and low). It takes use of the controller's low voltage to be able to pressure a motor that requires a high enter voltage. The time period "motor force," or definitely "power, "refers to device velocity manage system. Many commercial processes, including assembly lines, must function at variable charges depending at the commodity. Whilst process conditions necessitate pump

or fan go with the flow adjustment, adjusting the pressure's velocity can be greater power efficient than different float manipulate methods. Motor driver makes use of a bigger chip or discrete fets which could control better currents and voltages than a microcontroller pin's normal Sv/three.3v. They enable you to control a considerably large load with a noticeably tiny sign. It's critical to understand that even as talking approximately motor drivers and controllers, the sort of motor have to additionally be considered. The s is a brushed de motor.
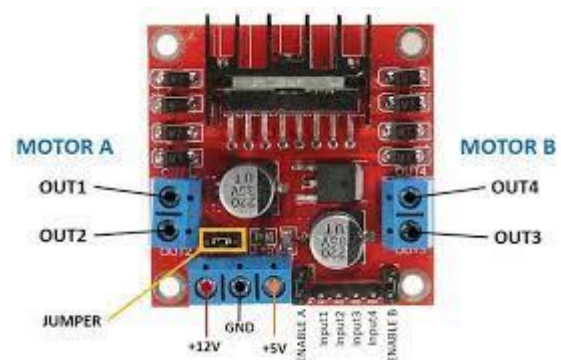
iv.   Servo Motor

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. A Servo Motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft.

v. DC motor

DC motors have high sustained torque. This makes them ideal for robotics applications that require a constant force. Furthermore, DC motors have a wide range of speed capabilities that make them ideal for robotics applications that require accurate speed control. So we used dc motor for moving the robot from one place to another through set of wheels . We used total 4 dc motor which have attached wheels to it they are all driven by 12 v power supply .

vi. Connecting Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. When building electronics projects, little thought is given thought is given to the connecting wire. While it is possible to 'get away with almost anything for many projects, it is sometimes necessary to connect the various electronics components using the right wire. For example, it is often useful to use colored connecting wire to indicate such items as electronics wire used for connecting the supplies, signals, and grounds. In this way it is easier to identify the different signals and lines, and this reduces the possibility of errors. In addition to this it is sometimes necessary to have connecting wire of a particular size to ensure the connections are made in the right manner. If the wire is too thick it may not be easy to accommodate in some situations, whereas thicker wire may be needed for higher currents of physical strength or robustness in other situations.

vii. IR sensor

An infrared (IR) sensor is a type of electric sensor that detects and responds to infrared radiation in the environment. William Herschel, an area expert, discovered infrared radiation via coincidence in 1800. Whilst comparing the temperature of every color of mild, he discovered that the temperature just beyond the red mild become the maximum great (separated through a crystal). Because IR has an extended frequency than seen mild, its miles invisible to the naked eye (but it is as but on a comparable Electromagnetic range). Anything that produces warmth emits infrared radiation (that is, something that has a temperature over more or less five ranges kelvin)

viii. Batteries

The battery can be fully charged in 5 hours using a 12V-20Ah rechargeable battery circuit. The battery can be fully charged in 5 hours using a 12V-20Ah rechargeable battery circuit

2. Software Components

i. IDEs

PyCharm and Arduino IDE is used for the development of this project. PyCharm is an integrated development environment used for programming in Python. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

ii. Anaconda Navigator

Anaconda Navigator is a desktop graphical user interface (GUI) included in Anaconda® Distribution that allows you to launch applications and manage conda packages, environments, and channels without using command line interface (CLI) commands.

3. Incorporated Technologies

i. Convolutional Neural Networks (CNN)

Character recognition is done through machine learning

algorithm which is Convolutional Neural Network (CNN). The agenda for using this algorithm is to enable machines to view the world as humans do, perceive it in a similar manner, and even use the knowledge for a multitude of tasks such as Image & Video recognition, Image Analysis & Classification, Media Recreation, Recommendation Systems, Natural Language Processing, etc. The advancements in Computer Vision with Deep Learning have been constructed and perfected with time, primarily over one particular algorithm. ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.

ii.   k-Nearest Algorithm

The k-nearest neighbors algorithm, also known as KNN or k-NN, is a non-parametric, supervised learning classifier, which uses proximity to make classifications or predictions about the grouping of an individual data point. While it can be used for either regression or classification problems, it is typically used as a classification algorithm, working off the assumption that similar points can be found near one another. K Nearest Neighbor (KNN) is a very simple, easyto-understand, and versatile machine learning algorithm. It's used in many different areas, such as handwriting detection, image recognition, and video recognition. KNN is most useful when labeled data is too expensive or impossible to obtain, and it can achieve high accuracy in a wide variety of prediction-type problems. KNN is a simple algorithm, based on the local minimum of the target function which is used to learn an unknown function of desired precision and accuracy. The algorithm also finds the neighborhood of an unknown input, its range or distance from it, and other parameters. It's based on the principle of "information gain"—the algorithm finds out which is most suitable to predict an unknown value.

IV.METHODOLOGY

Regarding to the above said trouble we're going to advocate a food deliver robot for the meals industry (hotels/eating places). This robot is ready for simplest the purpose of the food serving and makes the Artwork efficient and less human interruption inside the approach. As soon as the user can region the food on the robot it'll circulate in line with the assigned table and it consists of the 12 volts battery , IR sensor and ultrasonic sensors for the higher performance and to discover the assigned table through the IR sensor.

Here the NodeMCU is used to establish the connection with the software and hardware components. NodeMCU communicates though the HTTP request and response procedure with help of Wifi.

Fig .9 shows the block diagram of Autonomous robot for delivering orders in Restaurants by using Arduino Uno. Robot having two wheels and one freewheel is mounted along with different sensors and module i.e. ultrasonic sensors and IR sensors.

Ultrasonic sensors are used to detect the obstacles in the path. It transmits the signal continuously if any obstacle come then the transmitted signal get disturb and the reflected signal known as echo which is received by the ultrasonic receiver. If the obstacle is detected in between 20cm to 5cm robot will stop else it will follows the given path & the distance is calculated by using Eq.(1) & Eq.(2).

$$Distance = 17150 * Time \ ....(1)$$
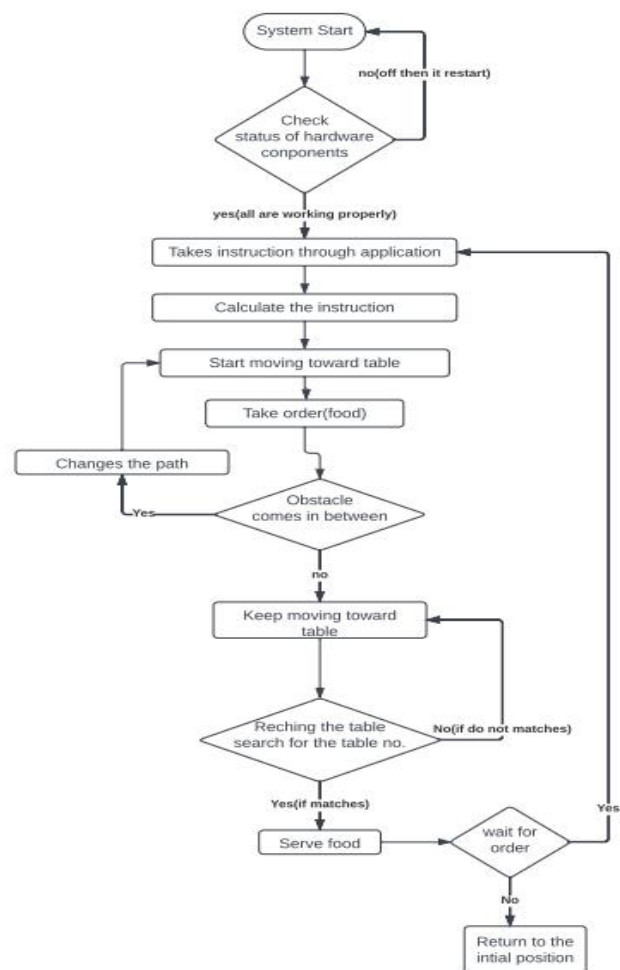$$Distance = Pulse\ Duration * 17150 \ ....(2)$$

Fig 9. Flow Diagram for Proposed System Work

NodeMCU is used for learning and experimental and experimental purpose. It operates on 5V power supply. In this

project we use NodeMCU as a main processor to control Robot motion. It takes the input from IR sensor and ultrasonic sensor and after processing it, it sends the data to the driver module to control the motors.

Motor driver module is used for boosting the current of NodeMCU. The average current capacity of GPIO is 40mA but for controlling the motor we require 2A current. We can interface two DC motors and one stepper motor to the motor driver module. DC motors are used to convert current electrical energy into mechanical energy. It is used for controlling the wheels of Robot. It operates on 12V power supply. DC motor has higher starting torque. In Robot we uses two wheels for taking right and left moves and one free wheel for taking turn smoothly.

Robot will start and check status of hardware components if everything is working properly then it will take the order/instructions through the application. After taking instructions through the NodeMCU through Wi-Fi it will calculate the instructions and proceed toward food counter. A person will load the tray on the hand of robot and the robot will be able to know that the tray is full through IR sensor which is placed on the hand of the robot and on the chest area of the robot.

After taking order/food in the tray it will start moving towards the table through the path if any obstacle occurs in between robot's path it will change its path and keeps moving toward the tables. The obstacle detection in robot is done through the ultrasonic sensors it will be fitted at the wheelbase of robot and can be used to detect objects or obstacles that occur in path. Each table will have particular number which can be recognized by robot through image recognition. After reaching the tables the robot will search for the table number which he had to carry the order if the number on the table don't matches the robot will keep searching, once robot gets to the right table it will serve the food. Image recognition is the most important part in the robot and it is done through CNN machine learning algorithm which is programmed in hardware for accurate image recognition in the robot. Once robot had completed its task it will check for is there another order available if not then it will go back to initial position and if there are task that are assigned to the robot then it will again use the same process to execute the task.
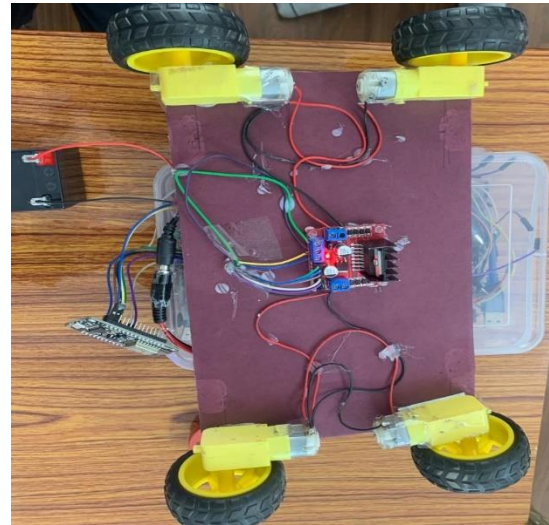

Fig 10.

V. CONCLUSION

In traditional serving system waiter will deliver the orders so that its time consuming & produces human errors. So we proposed this system to overcome these drawbacks. This paper is effectively experimented & implemented for the restaurants to deliver the order to the particular table and robot follows the particular path. So this robot is cost-effective, and it reduces human efforts. Also, this robot is utilized for various places like malls, cafes, hotels etc. Robot is designed to deliver the order to the particular table. It can improve the quality of service. When we press any key the Robot will follow the pre-defined path and reach to the desired path to deliver the order.

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