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IOT ENABLED 3D PRINTER AND 3D OBJECT AUDIO LABELLING FOR BLIND

Pratham Athreya U[1], Sanjana K[2], Sudeep S[3] ,Yashaswini M[4],

Dr Sharath Kumar Y H[5]

Student, Department of Information Science, Maharaja Institute of Technology Mysore, India[1-4]

Professor & Head, Department of Information Science, Maharaja Institute of Technology Mysore, India[5]

Abstract: 3D printing is one of the prominent technological advancement which is making huge difference in the additive manufacturing industry .Since 3D printing is the only way where an object can be developed as a 3 dimensional object with help of CAD modelling. Although the 3D printers can be operated manually it has many disadvantages.3D printers can be handled efficiently with remote monitoring capabilities which reduces the man power and overcomes disadvantages such as system breakdown in the middle of printing process, to keep an eye whether the equipments used are working properly etc. On the other hand, there are many technological improvements happening to help and assist the visually impaired and blind people. But they cannot see things as we can see. The only way in which we can help them visualize the things around us is using the 3D object/model and touch. Thus it is possible to convert the 3D printer into remote monitoring device and also provide assistance to blind is with the help of Internet of things. Using the ESP8266 NodeMCU and sensors such as TTP223, DHT11,Ultrasonic sensor, relays the various parameters such as temperature, 3 direction movement of the object, starting or stopping the object printing are controlled. Using this IoT enabled FDM 3D printer the 3D objects and the models are printed with the help of CAD modelling and embedded with the touch sensor. Whenever the blind people touch the object, they can visualize how it actually is at the same time receive an audio description about that object which makes them independent. This work is major consideration in the field of historical education and tourism places.

Keywords: 3D printer, iot, audio labelling ,ESP8266 , Blynk.

I. INTRODUCTION

In today's fast growing world, everyone's way of living is dependent on the technology in most of the activities. From start of the day till the end of the day technology has become so important that it simplifies every aspect. Mobile phones and tabs to contact people who are far away, accessing information ,controlling .The internet is connecting us to a world of information with just a few clicks .Technology streamlines processes, automated processes ,and remote collaboration .Technology has lead to the transformation of the way we actually lead our life making it too simple .This rapid growth in technology should not only benefit and reduce human efforts but also improve the life of the people who are disabled ,visually impaired or blind and contribute for a social cause .Instead of focusing on just one technology for developing the solutions has become old practice .Nowadays advancements are happening by combining various technologies , integrating to provide better and efficient solutions.

We come across so many objects ,models ,things ,structures ,monuments in historical places etc .The only way in which all these can be duplicated in a realistic way is by using the 3D models.3D represents the object which is in all 3 dimensions .The only technology able to achieve this is 3D printing/additive manufacturing. It can be achieved by the device called as 3D printers.3D printers are made up of many components such as nozzle, heat bed, heat sink, cooling head. Any object can be printed using this device by printing multiple layers on top of one other [6].Various materials are available for printing such as Fibre ,plastic etc., object to be printed is designed using CAD and fed to the device using the STL file software. The working of this device is dependent on various factors such as temperature, humidity, movement of the 3 dimensional axis. Therefore a remote monitoring has be done to keep track of all these parameters and enable the printer to work efficiently, without causing any fault to object. Internet of things comes in to picture, by placing sensors, relays and controlling boards and programming these hardware using the IDE (Internal Development Environment. The system uses the microcontroller which has WiFi module able to provide access from remote places integrating it with the Arduino IDE. The tasks can be performed by reading the parameters and act accordingly. The software called Blynk is used to provide an interface for the admin or device handlers where they can see the current information, able to on/off the device at times of emergency such as over heating, empty material etc.

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Along with that being visually impaired can be very challenging and difficult. According to WHO, there are 285 million people visually impaired and 39 million who are totally blind around the world. The only way a blind person can feel the things is by touching them and hearing them. Every time visually impaired can't be dependent on the other person telling them what the object actually is and how it appears to look. Thus we can make use of the tactile way to help the visually impaired people be independent in all the fields by bringing together the concept of touch (tactile) and hear. Traditional methods including using the Braille language but people without the knowledge of that cannot know about various things and printing the objects in 2D cannot provide the complete visualization. Thus with the help of IoT enabled 3D printer the required object (here dog bone and MITM College Logo) is printed and there embedded with the tactile touch sensor to detect the touch of blind people [5]. Once they touch the object they get to know objects/models are and knowledge about the objects through the audio description.

II. ORGANIZATION

The 1st section of this paper gives the introduction about the technological trends and need for IoT in field of 3D printing and for the blind. In the 3rd section we discuss about the survey on various related works. 4th section provides problem statement.5th section hardware, various tools and the libraries used for implementing. 6th section provides the design and implementation of the system followed by the conclusion and future enhancements and references used.

III. LITERATURE SURVEY

A. R Ramlan in his paper provides the information about the growing 3D printing technology. In this paper he has given detailed study about the different types of 3D printing, types of materials used for 3D printing, and the various applications in the field of manufacturing. [1]

B. Swee King Phang , Norhijazi Bin Ahmad and Chockalingam Vaithilingam Aravind collectively proposed the use of Rasperry Pi microprocessor, temperature sensor(PT100) and programming language for connecting the information flow from these hardware, html, java Script , Restful API and the mobile app to display the remote monitoring [2]

C. Octoprint is an agent providing 3D printing connectivity services to be able to connect to the internet. Eko Prianto , Herlambang Sigit Pramono , Yuchofif explains, IoT-based Octoprint provides a web interface to control 3D printers, enabling users to start printing jobs by sending Gcode to a 3D printer connected via a USB port. Octoprint is free, open-source software that allows to remotely perform and monitor all aspects of a 3D printer using a Raspberry Pi [3]

D. M Salam proposed an iot solution model using two sensor nodes, a server mirror node, an IoT Broker node and a HMI node. His idea of methodology is as follows: an Android-based application is used for the HMI, and other nodes have been designed and developed based on embedded system architecture. The wireless communication between the nodes has been carried out using IEEE 802.11 communication protocol and with the help of Math Works application.[4]

E. Glasgow explains the use of Talkit++ for deigning the models such as elephant model, palace model, horse model and enabling it through the audio information storage Also explains the difficulties of detecting the model using the camera and touch .[5]

IV. PROBLEM STATEMENT

3D printers have revolutionized the manufacturing industry by enabling rapid prototyping and customized production , there is a need to enhance their functionality by incorporating IoT capabilities. The lack of integration with IoT infrastructure hinders efficient communication, data exchange, and automation, ultimately hampering the productivity, reliability, and scalability of 3D printing processes. Without access to real-time information, such as material levels, temperature, and print progress, users are unable to make timely adjustments, optimize workflows, and ensure quality control. This limitation impacts both individual users and industrial applications, where efficiency and precision are crucial.

Persons with visual impairments have difficulties and insufficient access to range of everyday objects. Also they do not have access to objects of cultural and historical heritage such as sculptures, structure, locations of the place on the map and so on. Even though there are many technological aids that could assist them for various works and helping them to overcome their disabilities, there doesn't exist a system that can make them know or visualize the range of real world objects. The traditional systems use the 2D planar way of representing the shapes of the objects and label them using the Braille. But blind cannot get the exact idea of the shape of object in 2D that of in 3D.

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The main objective is

- ✓ To design and establish IoT based monitoring system
- ✓ To design and develop an IoT based 3D object audio labelling model for blind and visually impaired

V. REQUIREMENTS

A. *ESP8266 NodeMCU:*

TABLE I : TECHNICAL SPECIFICATIONS

Microcontroller	ESP-8266 32-bit
NodeMCU Model	Amica
NodeMCU Size	49mm x 26mm
Carrier Board Size	n/a
Pin Spacing	0.9" (22.86mm)
Clock Speed	80 MHz
USB to Serial	CP2102
USB Connector	Micro USB
Operating Voltage	3.3V
Input Voltage	4.5V-10V
Flash Memory/SRAM	4 MB / 64 KB
Digital I/O Pins	11
Analog In Pins	1
ADC Range	0-3.3V
UART/SPI/I2C	1 / 1 / 1
Wi-Fi Built-In	802.11 b/g/n
Temperature Range	-40C - 125C

B. *Sensors:*

TABLE II : SENSOR REQUIREMENTS

S No	Name	Description
1	DHT11	To sense the temperature and humidity
2	TTp223	Touch detection
3	Ultrasonic sensor	To calculate the distance between the objects
4	Relay	To on and off

C. *Arduino IDE:*

The Arduino Integrated Development Environment (IDE) is a software tool for writing, compiling and sending code to the Arduino development board. It provides a user-friendly interface that simplifies the process of creating and running Arduino projects. The IDE supports the Arduino programming language, which is a simplified version of C/C++. It provides various functions and libraries for easy communication with Arduino hardware such as sensors, actuators, and instructions. The IDE also includes scripts with features such as keywords and initialization to make coding more efficient.It provides a compiler that translates the code into machine language and a boot loader that allows the code to be uploaded to the Arduino board via a USB connection. In addition, the IDE provides an interface for debugging and monitoring the data exchange between the Arduino board and the computer. Overall, the Arduino IDE is a powerful tool that allows both beginners and experienced users to create and distribute projects on Arduino boards.

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D. Blynk:

Blynk is a popular Internet of Things (IoT) platform that allows users to easily create custom dashboards and manage their IoT activities via mobile apps. Blynk provides a user-friendly interface to create and configure virtual dashboards called dashboards that can be accessed and controlled using the Blynk mobile app. Platform, Arduino, Raspberry Pi, ESP8266 etc. It supports various hardware platforms such as With the Blynk app, users can create personalized dashboards by adding widgets such as buttons, sliders, graphics, and instructions that can be linked to the body of their IoT project. The application communicates with devices using the internet, allowing users to monitor their devices anywhere in the world as long as they have an internet connection and IoT as a secure connection. The platform provides libraries and APIs for reports that facilitate Blynk's integration with various hardware platforms and programming languages, and visualize data in real time. It is widely used by enthusiasts, makers and professionals to rapidly prototype and deploy IoT applications without programming skills.

VI. METHODOLOGY

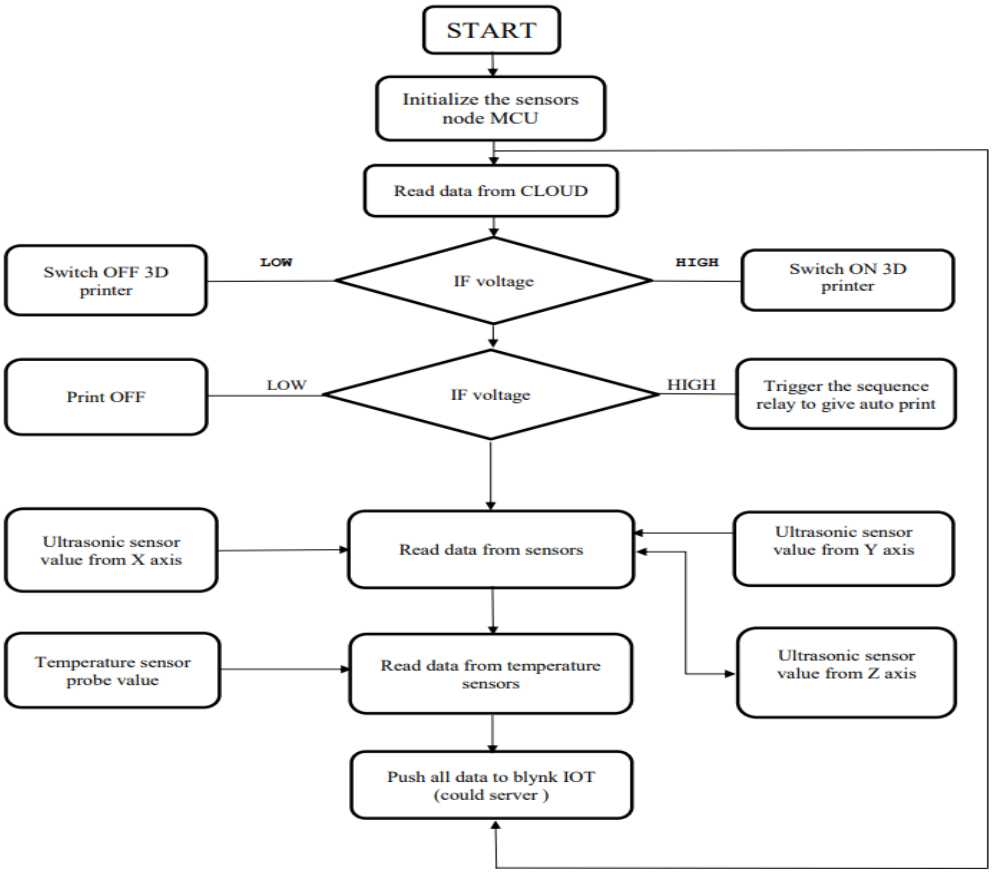

Fig 1.Block Diagram of Proposed System for IoT enabled 3D printer

Working Principle:

First the circuit connections are made between the ESP8266 NodeMCU board and the all the available sensors. The ESP8266 consists of 11 digital i/o pins and 1 analog input pin and also consists of the 4 ground pins and TX and RX pins each. 1 Vin where the voltage is supplied to the MCU board .3 3.3V pins. The sensors have 3 pins , they are GND, Data, and Vin pin. The pins of the sensors are connected to the corresponding MCU board pins . The board is connected to a constant power supply to run the components.

The configured circuit is connected to the 3D printer to convert it into IoT enabled. The next step is to configure the Arduino IDE to work with the ESP8266. Programming is done to read the data from the sensors and make the relay

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effectively work with the 3D printer using the COM port. The next step is to configure the Blynk dashboard or the android app. This is done by logging onto the blynk website by providing the credentials and selecting the ESP8266 board and respective ports in the further process. Once the initial configuration has been done, templates must be added in order to give the interface for the admin/user to remotely monitor just by pressing the buttons and also track information through the dashboard and app. Since NodeMCU provides WiFi module capabilities, one should change their hotspot name and the password to the one that has been fed in the IDE program so that the device can be accessed from anywhere if it is power supplied.

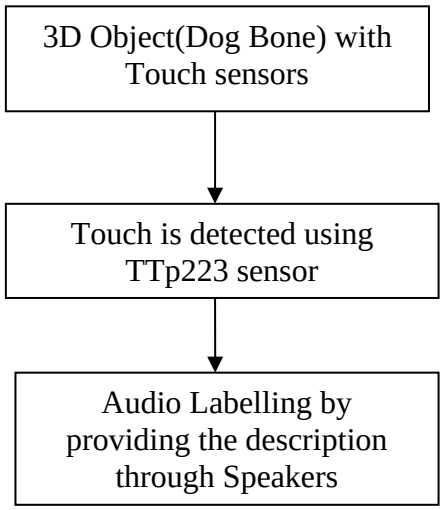

Fig 2.Block Diagram for 3D printed object Audio labelling

Once the blynk dashboard and the android app has been setup now it's time to plug in the power supply cable of the 3D printer. The power board is already battery powered and the sensors get initialized through the NodeMCU board. Sensors start reading the data for different parameters that has been configured, and sends the data to the IDE for which the programming is done. Once the data is ready in the cloud, it is read from the cloud and used for remote monitoring the device. Blynk dashboard will provide an option to switch on/off the device, hence if the device is being supplied with the voltage, user can on the device and also switch it off by clicking the button. This happens due to the HIGH and LOW inputs being sent to the pins. Secondly, user can start or stop the printing process and a separate button will be provided for the same. When the device is already on with power being supplied to it, remotely one can start the printing process and stop it if any abnormalities are observed and relays are exclusively used for this control. Next, with the help of the sensors such as temperature, humidity, ultrasonic sensors for x, y, z movement, the data is read from them and passed to the cloud and same data is read from cloud to the apps to track whether the temperature at which the object is printed is enough, 3 dimensional movements are proper or not. Any abnormality has been observed the the user can switch of the printing process or the device in the worst scenarios.

Once the 3D printer is converted to IoT enabled 3D printer, now using the same, the 3D objects are printed, here in the project the MITM logo and the DOG BONE 3D objects are printed by placing the design in the memory chip into the 3D printer. Once the 3D object is ready, Now the object has to be audio labelled with the help of tactile/touch sensor, whose gnd, data and vin pins are connected to respective pins in the Arduino board. Now the sensor is intern connected to the speaker so that whenever the touch has been encountered, the audio description is given about the object, for the blind people.

VII. CONCLUSION

Using the trending technologies like 3D printing and the Internet of things we have proposed the model where the 3D printing device can be remotely monitored and the major parameters involved are the temperature, humidity, distance and movement of the 3 axis, power on/off of the device and the printing start and stop. Along with that using the IoT it we have developed an efficient 3D audio object labeling for visually impaired people or blind, where they can easily visualize the objects and models. This especially is very helpful for the students or people who are not having the idea of Braille and also overcomes the disadvantages of the 2D planar objects used in the older systems for audio labeling.

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VIII. FUTURE ENHANCEMENT

The future of the technology is always evolving and changing for the better needs of the people. Thus it is possible to combine the artificial intelligence and the machine learning algorithms to the 3D printer and efficiently automate the process of printing. Integrating it with the navigating systems as tactile maps to get the direction is one of the future considerations for blind people.

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