IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 7.301
Volume 3, Issue 4, April 2023

# Deep Learning based Automated Billing Cart

**Apurva Sutar[1], K. J. Karande[2], A. D. Harale[3]**
Scholar, Department of Electronics and Telecommunication Engineering[1]
Professor, Department of Electronics and Telecommunication Engineering[2]
Assistant Professor, Department of Electronics and Telecommunication Engineering[3]
SKN Sinhgad College of Engineering, Pandharpur, Maharashtra, India
Correspondence Author: apurvasutar05@gmail.com

**Abstract:** *Nowadays, shopping malls have become an integralpart of life and people in cities often go shopping malls in order to purchase their daily requirements. In such a place, the environment must be made hassle-free. Our system is mainly designed for edible objects like fruits and vegetables. For edible products like vegetables and fruits, bar-codes and RFID tags cannot be used as they have to be stuck on each of the items and the weight of each item has to be individually measured. The proposed system consists of a camera which detects the commodity using Deep Learning techniques and a load cell which measures the weight of the commodity attached to the shopping cart. This system will generate the bill when the customer scans the item in front of the camera which is fixed on to the Cart. There are many methods for implementation of object detection. Methods like R-CNN use region proposal to generate bounding box and then run a classifier throughout the bounding box. Then the duplications are eliminated using post-processing technique. R-CNN is a slow method for object detection. For this reason, we use YOLO model.*

**Keywords:** Billing Cart; YOLO; RFID; Deep Learning; Microcontroller.

## I. INTRODUCTION

The Neural Networks have taken the world to next level. we are seeing neural networks daily and even we are using them[1-5]. From Apple's Siri to Google's Assistant, all are made of neural networks Neural networks for object detection has been used in here. Humans can see an object and are able to identify what object it is and the location of the object. The human neural system is fast and accurate enough to identify the object instantly[6-13].

Implementation of the human visual system in computers using neural networks have been helping us to do things like driving cars without specialized sensors[14-22]. There are many methods for implementation of object detection. Methods like R-CNN[23-25] use region proposal to generate bounding box and then run a classifier throughout the bounding box. Then the duplications are eliminated using post-processing technique[26-32].

R-CNN is a slow method for object detection. For this reason, we use YOLO model (You Only Look Once). In YOLO, a single convolutional network predicts multiple bounding boxes and class probabilities for them[33-39]. There are several advantages for using this YOLO model. Yolo is extremely fast when compared to other models for object detection. The mAP of YOLO is more than twice of other real time object detection models[40-47].

Load cell is a weight measuring device. It uses the electrical and mechanical properties of metal. When force is applied over the metal, there is a change in the shape and an elastic deformation occurs, which in turn causes the resistance of the gauge to change. The basic idea behind the load cell is Wheatstone bridge, if there is a change in resistance between two terminals, then there is a potential drop[48-55].

The weight sensor used here is a load cell interfaced using HX711 amplifier module. HX711 is a 24-bit ADC module[56-59] designed for weight scaled and can be directly interfaced with the load cell[60]. The input multiplexer selects either Channel A or B differential input to the low-noise programmable gain amplifier. There is an on-chip power supply regulator that eliminates the need for external power supply[61-66].

There is no external programming required for HX711. There is an introduction of the related work, methodology and system description and working of the system. At last, there is a conclusion[67-71].

## II. LITERATURE REVIEW

A smart shopping cart has been developed within this [1] paper to make basic purchases easier. This replica is secured to the trolley for easy viewing. Every item with an RFID tag on it is scanned using an RFID reader that is part of the system. The smart trolley is where the money is processed. Name and cost of the item was displayed on LCD panel. This [2] essay makes use of RFID and Arduino. The quantity of the item and its weight are displayed all along with price details. Suppose if that doesn't matches database, a buzzer will play.

Another illustration is a smart cart that runs on Arduino and has RFID, IR Sensor, and ultrasonic devices [3]. The associated amount is forwarded to the billing department when the product tag is read by the reader. The hard duplicate is available for pickup from the desk once the account has been settled.

Smart Cart with Automatic Accounting - In this [4] piece, the author designs an approach that allows for an intuitive accounting trolley. With the additional features that compute and update the client bill, they serve as a representation of the system. The item and amount will be displayed on the LCD screen. By going to the billing desk, they can pay the balance right immediately.

Due to rising consumer interest and spending, there's have been more smaller and bigger shopping malls than ever before [5]. To increase the standard of shopping, the conventional billing system needs to be continually improved. That shopping cart was generates the purchase bill directly on the cart with the help of an RFID reader, improving the current system. This will save both the time of shoppers and the workload of Mall workers.

At a desk, the invoice that is presented on screen was transferred to system memory via an intelligent cart that uses automated billing, product details, and product recommendations using RFID. This is made feasible by the RFID module's ability to wirelessly exchange the bill. One of this system model's drawbacks is that we have to enter a key after the entire amount of goods and their prices have been displayed. After that, there won't be any merchandise additions or deletions[6].

On weekends, holidays, and particularly when there are deals and special offers, there can be a significant rush in [7] malls. Nowadays, consumers favor online shopping over mall purchases to get necessities, using sites like Amazon, etc, among others. This paper proposed a virtual cart as a solution to this issue, allowing shoppers to better navigate the challenges of both online and offline shopping.

## III. METHODOLOGY

We found the item using the YOLO approach[71]. It is determined whether or not anything will be discovered inside the grid in Fig. 1 by creating multiple matrices from the image and adding bounding boxes. It's unsuitable for using YOLO to merely identify items of tiny scale because it is equipped with the Pascal VOC dataset, where the scale size of the objects is large. The YOLO model[71] is skilled at identifying tiny items. The framework divides picture into a S X S network. A piece of work is deemed to be of high quality if it is located in a structure cell. Network cells forecast bounding boxes and the confidence value. How certain we're that item A is in container B is measured by our level of confidence. In the absence of a document, the certainty ratings are set to 0. Intersection over union (IOU) is found by using the predicted mask, the ground truth, and the expected mask[15].

The ratio to the cover section to union territory determines IOU. We must predict five values: a, k, z, i, and confidence in each bounding area. The letters (a, k, z, i) stand for rectangle box having the object. While training database, we entered this data using annotation files. The confidence indicates how likely it is that a given object will be found in the grid. We only make one class prediction per grid block. We calculate class-specific confidence scores in each box, which show the probability of all classes occurring within the box[9,10].

## IV. SYSTEM DESCRIPTION

### 4.1 Load Cell

The resistance change in a load cell is very small so that it is magnified by the resistive imbalance in the Wheatstone Bridgeshown in Fig. 2. In a load cell, the value of three of the resistors are known and the fourth resistor is a variable resistor. When the load cell is loaded with a weight, the change in strain of the strain gauge causes a change in resistance that can be seen by change in potential difference. The load cell has been calibrated up to 5 Kg. Fig. 1.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 7.301
Volume 3, Issue 4, April 2023

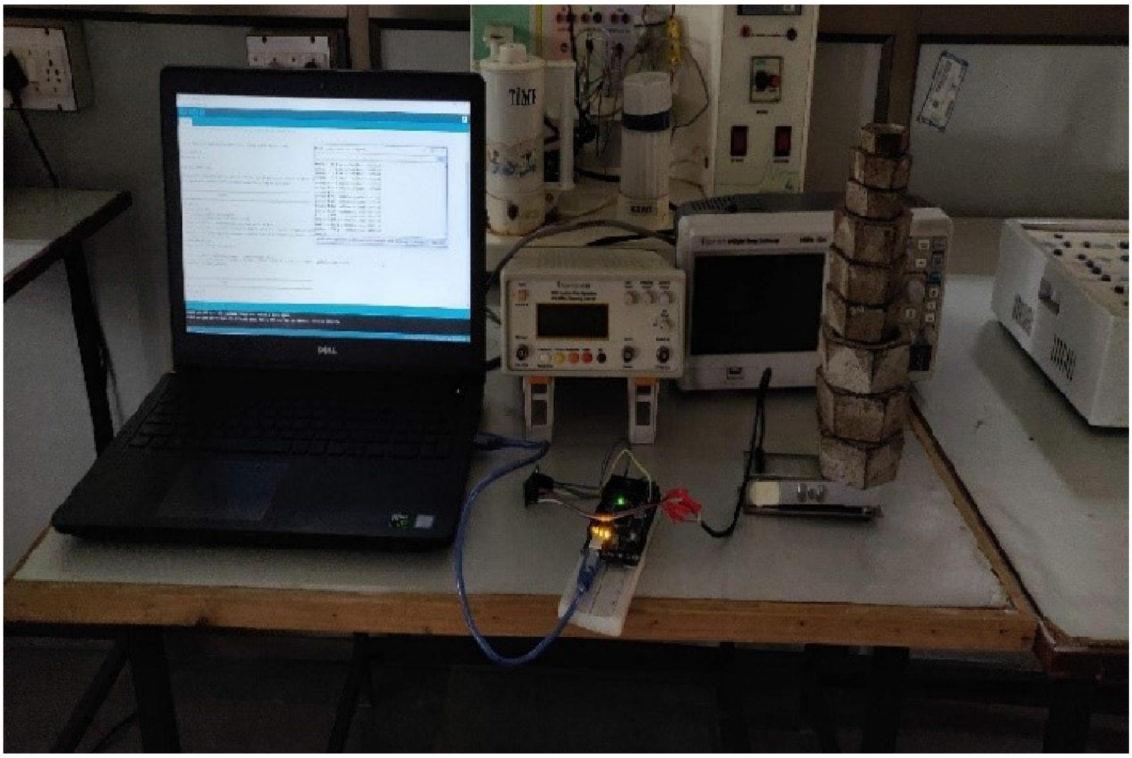

Fig.1 calibration of the load cell

The calibration curve is as shown in Fig. 2.

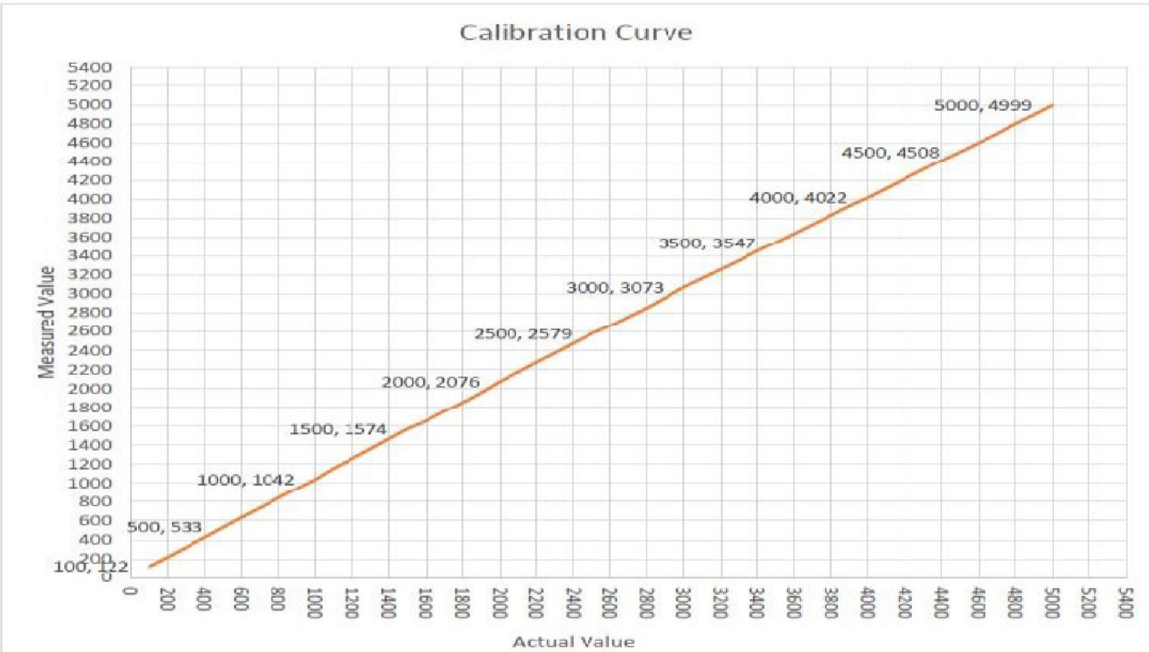


Fig. 2. Calibration Curve

Object Detection Using YOLOv2We are using YOLOv2 for object detection shown in Fig. 3.YOLOv2 partitions the image into several grids and predicts0780the bounding box for interested object in each grid. First, inorder to facilitate object detection in our system, Tensorflow and keras libraries were installed. YOLO is implemented using darknet.

The statements of Tensorflow library are used for implementing darknet. For implementing object detection using YOLO, certain software packages have been installed. First, Microsoft visual studio package was installed in the


DOI: 10.48175/IJARSCT-9290

system. Then, CUDA and CuDNN by Nvidia were installed. Packages like matplotlib for creating 2D graphs and plots, Cython for implementing darknet in python, scikit-learn for machine learning, pillow for python imaging library, pandas for providing fast, flexible, and expressive data structures designed to make working with structured and time series data, beautifulsoup4

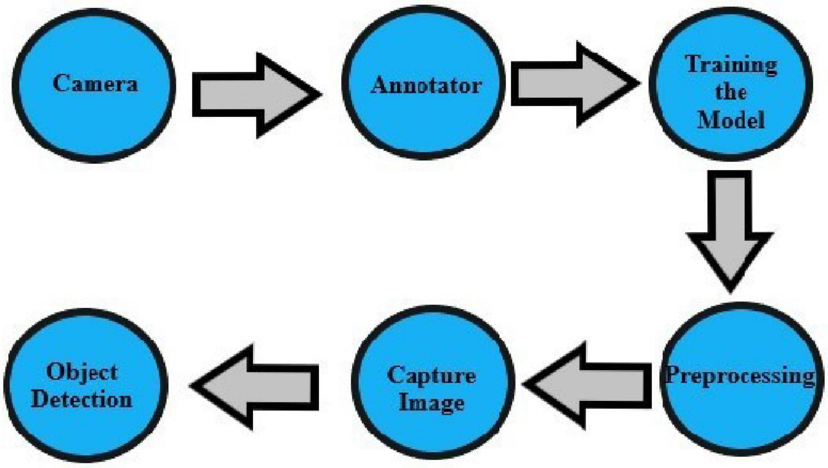


Fig. 3. Working of YOLOv2

The datasets are taken in high resolution in order to obtain accurate results. The datasets taken are used to train the system that had to be used to detect objects. In order to train our system, the datasets are converted to XML files which were JPG files previously.

The XML files that are converted are called annotation files. These files contain the coordinates of the bounding boxes for the image and the labels of those images. This conversion is carried out using a software created called Label-Img. For example, if we want our system to detect carrot, then the dataset containing the image of carrot is taken and edited using the Label-Img. Bounding box surrounding the image of our desired object is drawn and then labelled as carrot and saved. A XML file will be created after saving.

When we open the XML file, we can see the coordinates and the label that was given by us. After XML file is created for all datasets, the program is run using cfg and weight files. The configuration (cfg) file contains the layers of the neural network and the weights file is used for updating weights after training of the given dataset. Once the training is done, checkpoint files are created, which contains the modified weights. These checkpoint files are accessed before the object detection algorithm is run on the testing dataset. The completion of training is indicated by the creation of checkpoint files.

## V. WORKING OF THE SYSTEM

The system's major components are the Camera, Arduino, Load cell, LCD display. The system here is designed in such a way that object of one kind is detected. That is one sort of a vegetable is placed in front of the camera.

The vegetable is detected using the Object detection technique we are using that is YOLO. After detecting the object's class a signal is sent to the Arduino with the serial communication techniques, and all the items of that same kind are placed in the cart. After the Arduino receives the signal about the class of the object, it has load-cell connected to it which measures the weight of the total items present in the cart. Now the rate of each vegetable is predefined by the user, which means thateach class of objects have a particular rate. After the load-cell measures weight the Arduino computes the total cost according to the rates defined by the user.

We have provided 3 buttons for the user:

- Reset
- Next
- Finish

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 7.301
Volume 3, Issue 4, April 2023

These buttons are provided for the user to have a hassle free experience. The RESET button is used for clearing all the items in the cart if there is any mistake in the bill. The NEXT button is used to detect the next object, that is when one kind of vegetable's rate is computed, then we need to provide the system with the next object. The FINISH button is used whenall the items the customer wants to buy are evaluated by the cost. The block diagram of the cart is shown in Fig. 4. Connections given in the circuis, Load cell is connected to the Vcc, Ground, Pin 4 – Data (OUT), Pin-5Clock.

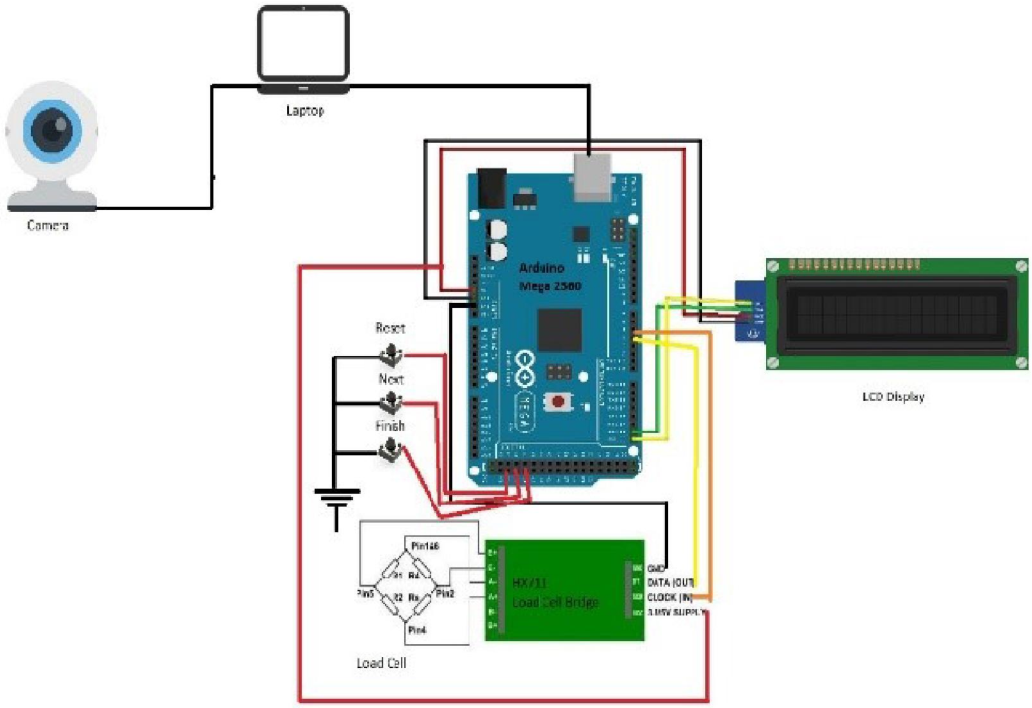


Fig. 4. Block Diagram for the Cart

## VI. CONCLUSION

The system that we have designed can detect only 3 objects namely, Potato, Tomato and Carrot. The accuracy of the object detection is 70%. In this paper, we proposed a new, hassle-free shopping experience. The system has been mainly designed for edible objects like fruits and vegetables. The RFID tags that are being used nowadays, can't be stuck to edible objects like fruits and vegetables. In case if that is to be done, the weights of the objects must be predefined. The customers doesn't have a choice to buy according to their requirement. Also, in India, Barcodes and barcode readers arethe widely used method for shopping. Practically, Barcodes cannot be given to each and every vegetable and fruits that the customer wants to buy. Like RFID tags, these Barcodes doesn't give the user choice to buy according to their requirement. Thus, using object detection for this purpose, gives the customer a freedom to buy and pay for exactly what they want

## REFERENCES

**[1].** Sowmya V., P., S. K., and Deepika, J., "Image Classification Usin Convolutional Neural Networks", International Journal of Scientific & Engineering Research , vol. 5, no. 6, p. 06/2014, 2014.

**[2].** E. K. Jose and Veni, S., "YOLO classification with multiple object tracking for vacant parking lot detection", Journal of Advanced Research in Dynamical and Control Systems, vol. 10, pp. 683-689, 2018.

**[3].** Redmon and A. Farhadi, "YOLO9000: Better, Faster, Stronger," 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 6517-6525.

**[4].** R. Li, T. Song, N. Capurso, J. Yu, J. Couture and X. Cheng, "IoT Applications on Secure Smart Shopping System," in IEEE Internet ofThings Journal, vol. 4, no. 6, pp. 1945-1954, Dec. 2017.

**[5].** C. Phanikrishna and A. V. N. Reddy, "Contour tracking based knowledgeextraction and object recognition using deep learning neural networks,"2016 2nd International Conference on Next cpp. 352-354.

**[6].** Y. Sakai, T. Oda, M. Ikeda and L. Barolli, "A Vegetable Category Recognition System Using Deep Neural Network," 2016 10th

**[7].** International Conference on Innovative Mobile and Internet Services inUbiquitous Computing (IMIS), Fukuoka, 2016, pp. 189-192.

**[8].** V. G. Nandanwar, M. K. M. and R. S. Ankushe, "Portable WeightMeasuring Instrument," 2017 International Conference on Recent Trends in Electrical, Electronics and Computing Technologies (ICRTEECT),Warangal, 2017, pp. 44-48.

**[9].** W. Xibao, B Xu etc., ‘’Visual Target Detection Based on YOLO Network Structure’’BoletínTécnico, Vol.55, Issue 9, pp.06-13.2017.

**[10].** Esteban, P. G., Baxter, P., Belpaeme, T., Billing, E., Cai, H., Cao, H. L., ... & Fang, Y. (2017). How to build a supervised autonomous system forrobot-enhanced therapy for children with autism spectrum disorder. Paladyn, Journal of Behavioral Robotics,8(1), 18-38.

**[11].** Kumar, R., Gopalakrishna, K., & Ramesha, K. (2013). Intelligent shopping cart. International Journal of Engineering Science and Innovative Technology, 2(4), 499-507.

**[12].** Halli U M, “Nanotechnology in IoT Security”, Journal of Nanoscience, Nanoengineering & Applications, 2022, Vol 12, issue 3, pp. 11 – 16

**[13].** Wale Anjali D., Rokade Dipali, et al, “Smart Agriculture System using IoT”, International Journal of Innovative Research In Technology, 2019, Vol 5, Issue 10, pp.493 - 497.

**[14].** Kazi K. S., “Significance And Usage Of Face Recognition System”, Scholarly Journal For Humanity Science and English Language, 2017, Vol 4, Issue 20, pp. 4764 - 4772.

**[15].** Miss. A. J. Dixit, et al, “Iris Recognition by Daugman’s Method”, International Journal of Latest Technology in Engineering, Management & Applied Science, 2015, Vol 4, Issue 6, pp 90 - 93.

**[16].** Kazi K S L, “Significance of Projection and Rotation of Image in Color Matching for High-Quality Panoramic Images used for Aquatic study”, International Journal of Aquatic Science, 2018, Vol 09, Issue 02, pp. 130 – 145.

**[17].** Halli U.M., “Nanotechnology in E-Vehicle Batteries”, International Journal of Nanomaterials and Nanostructures. 2022; Vol 8, Issue 2, pp. 22–27

**[18].** Pankaj R Hotkar, Vishal Kulkarni, et al, “Implementation of Low Power and area efficient carry select Adder”, International Journal of Research in Engineering, Science and Management, 2019, Vol 2, Issue 4, pp. 183 - 184.

**[19].** Kazi K S, “ Detection of Malicious Nodes in IoT Networks based on Throughput and ML”, Journal of Electrical and Power System Engineering, 2023, Volume-9, Issue 1, pp. 22- 29.

**[20].** Karale Nikita, Jadhav Supriya, et al, “Design of Vehicle system using CAN Protocol”, International Journal of Research in Applied science and Engineering Technology, 2020, Vol 8, issue V, pp. 1978 - 1983, http://doi.org/10.22214/ijraset.2020.5321.

**[21].** K. Kazi, “Lassar Methodology for Network Intrusion Detection”, Scholarly Research Journal for Humanity science and English Language, 2017, Vol 4, Issue 24, pp.6853 - 6861.

**[22].** Miss Argonda U A, “Review paper for design and simulation of a Patch antenna by using HFSS”, International Journal of Trends in Scientific Research and Development, 2018, Vol 2, issue-2, pp. 158 - 160.

**[23].** Kazi K., “ Hybrid optimum model development to determine the Break”, Journal of Multimedia Technology & Recent Advancements, 2022, vol 9, issue 2, pp. 24 - 32

**[24].** Ms. Yogita Shirdale, et al, “Analysis and design of Capacitive coupled wideband Microstrip antenna in C and X band: A Survey”, Journal GSD-International society for green, Sustainable Engineering and Management, 2014, Vol 1, issue 15, pp. 1 - 7.

**[25].** Ms. Shweta Nagare, et al., “Different Segmentation Techniques for brain tumor detection: A Survey”, MM-International society for green, Sustainable Engineering and Management, 2014, Vol 1, issue 14, pp.29 - 35.

**[26].** Kazi K., "Reverse Engineering's Neural Network Approach to human brain", Journal of Communication Engineering & Systems, 2022, vol 12, issue 2, pp. 17 – 24.

**[27].** Miss. A. J. Dixit, et al, "A Review paper on Iris Recognition", Journal GSD International society for green, Sustainable Engineering and Management, 2014, Vol 1, issue 14, pp. 71 - 81.

**[28].** Ms. Shweta Nagare, et al., "An Efficient Algorithm brain tumor detection based on Segmentation and Thresholding", Journal of Management in Manufacturing and services, 2015, Vol 2, issue 17, pp.19 - 27.

**[29].** Kazi K., "Model for Agricultural Information system to improve crop yield using IoT", Journal of open Source development, 2022, vol 9, issue 2, pp. 16 – 24.

**[30].** Miss. A. J. Dixit, et al, "Iris Recognition by Daugman's Algorithm – an Efficient Approach", Journal of applied Research and Social Sciences, 2015, Vol 2, issue 14, pp. 1 - 4.

**[31].** Shirgan S S, " Face Recognition based on Principal Component Analysis and Feed Forward Neural Network", National Conference on Emerging trends in Engineering, Technology, Architecture, 2010, pp. 250 - 253.

**[32].** Ms. Yogita Shirdale, et al., "Coplanar capacitive coupled probe fed micro strip antenna for C and X band", International Journal of Advanced Research in Computer and Communication Engineering, 2016, Vol 5, Issue 4, pp. 661 - 663.

**[33].** Salunke Nikita, et al, "Announcement system in Bus", Journal of Image Processing and Intelligent remote sensing, 2022, Vol 2, issue 6

**[34].** Madhupriya Sagar Kamuni, et al, "Fruit Quality Detection using Thermometer", Journal of Image Processing and Intelligent Remote Sensing, 2022, Vol 2, Issue 5.

**[35].** Shweta Kumtole, et al, " Automatic wall painting robot Automatic wall painting robot", Journal of Image Processing and Intelligent remote sensing, 2022, Vol 2, issue 6

**[36].** Kadam Akansha, et al, "Email Security", Journal of Image Processing and Intelligent remote sensing, 2022, Vol 2, issue 6

**[37].** K. Kazi, "Systematic Survey on Alzheimer (AD) Diseases Detection", 2022

**[38].** Mrunal M Kapse, et al, "Smart Grid Technology", International Journal of Information Technology and Computer Engineering, Vol 2, Issue 6

**[39].** Satpute Pratiskha Vaijnath, Mali Prajakta et al. "Smart safty Device for Women", International Journal of Aquatic Science, 2022, Vol 13, Issue 1, pp. 556 - 560

**[40].** Miss. Priyanka M Tadlagi, et al, "Depression Detection", Journal of Mental Health Issues and Behavior (JHMIB), 2022, Vol 2, Issue 6, pp. 1 - 7

**[41].** Waghmare Maithili, et al, "Smart watch system", International journal of information Technology and computer engineering (IJITC), 2022, Vol 2, issue 6, pp. 1 - 9.

**[42].** Divya Swami, et al, "Sending notification to someone missing you through smart watch", International journal of information Technology & computer engineering (IJITC), 2022, Vol 2, issue 8, pp. 19 - 24

**[43].** Shreya Kalmkar, Afrin, et al., " 3D E-Commers using AR", International Journal of Information Technology & Computer Engineering (IJITC), 2022, Vol 2, issue 6, pp. 18-27

**[44].** Kazi Kutubuddin S. L., "Predict the Severity of Diabetes cases, using K-Means and Decision Tree Approach", Journal of Advances in Shell Programming, 2022, Vol 9, Issue 2, pp. 24-31

**[45].** K. K. Sayyad Liyakat, "Nanotechnology Application in Neural Growth Support System", Nano Trends: A Journal of Nanotechnology and Its Applications, 2022, Vol 24, issue 2, pp. 47 - 55

**[46].** K. K., "Multiple object Detection and Classification using sparsity regularized Pruning on Low quality Image/ video with Kalman Filter Methodology (Literature review)", 2022

**[47].** K. Kazi, "Smart Grid energy saving technique using Machine Learning" Journal of Instrumentation Technology and Innovations, 2022, Vol 12, Issue 3, pp. 1 – 10.

**[48].** M Pradeepa, et al, "Student Health Detection using a Machine Learning Approach and IoT", 2022 IEEE 2nd Mysore sub section International Conference (MysuruCon), 2022.

**[49].** Waghmode D S , et al, "Voltage Sag mitigation in DVR based on Ultra capacitor", Lambart Publications. 2022, ISBN – 978-93-91265-41-0

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 7.301

Volume 3, Issue 4, April 2023

**[50].** Kazi Kutubuddin S. L., "Business Mode and Product Life Cycle to Improve Marketing in Healthcare Units", E-Commerce for future & Trends, 2022, vol 9, issue 3, pp. 1-9.

**[51].** Dr. A. O. Mulani, "Effect of Rotation and Projection on Real time Hand Gesture Recognition system for Human Computer Interaction", Journal of The Gujrat Research Society, 2019, Vol 21, issue 16, pp. 3710 - 3718

**[52].** Ms. Machha Babitha, C Sushma, et al, "Trends of Artificial Intelligence for online exams in education", International journal of Early Childhood special Education, 2022, Vol 14, Issue 01, pp. 2457-2463.

**[53].** Dr. J. Sirisha Devi, Mr. B. Sreedhar, et al, "A path towards child-centric Artificial Intelligence based Education", International Journal of Early Childhood special Education, 2022, Vol 14, Issue 03, pp. 9915-9922.

**[54].** Mr. D. Sreenivasulu, Dr. J. Sirishadevi, et al, "Implementation of Latest machine learning approaches for students Grade Prediction", International Journal of Early Childhood special Education, 2022, Vol 14, Issue 03, pp. 9887-9894.

**[55].** Nilima S. Warhade, Rahul S. Pol, Hemlata M. Jadhav, Altaf O. Mulani, " Yarn Quality detection for Textile Industries using Image Processing", Journal Of Algebraic Statistics, 2022, Vol 13, Issue 3, pp. 3465-3472.

**[56].** Kazi K S L, "IoT-based weather Prototype using WeMos", Journal of Control and Instrumentation Engineering, 2023, Vol 9, Issue 1, pp. 10 - 22

**[57].** Kazi Kutubuddin, "IoT- Based Healthcare system for Home Quarantine People", Journal of Instrumentation and Innovation Sciences, 2023, Vol 8, issue 1, pp. 1 – 8.

**[58].** Ravi A. , et al, "Pattern Recognition- An Approach towards Machine Learning", Lambert Publications, 2022, ISBN- 978-93-91265-58-8

**[59].** Kazi Kutubuddin, " Healthcare system for Home Quarantine People using IoT", Recent trends in Sensor Research & Technology, 2022, Vol 9, Issue 3, pp. 26 – 32

**[60].** Kailash J. Karande and Sanjay N.Talbar ,"Face Recognition under Variation of Pose and Illumination using Independent Component Analysis", ICGST-GVIP, ISSN 1687-398X, Volume (8), Issue (IV), December 2008.

**[61].** Kailash J. Karande and Rajashree N Badage," Facial Feature Extraction using Independent Component Analysis", Annual Int'l Conference on Intelligent Computing, Computer Science & Information Systems (ICCSIS-16), pp-28-29, 2016.

**[62].** Avinash D. Harale , Kailash J. Karande, " Literature Review on Dynamic Hand Gesture Recognition", AIP Conference, October 2022.

**[63].** V. Waghmode and A. Harale, "Development of Alphanumeric Digital Fuel Gauge for Automotive Applications," 2019 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 2019, pp. 0762-0764, doi: 10.1109/ICCSP.2019.8697958.

**[64].** A.D. Harale, Amruta S. Bankar and K. J. Karande," Gestures Controlled Home Automation using Deep Learning: A Review", International Journal of Current Engineering and Technology, Vol.11, No.6, Oct 2021.

**[65].** Dheeraj Muttin, Avinash Harale, "IoT Based Personal Medical Assistant System", International Journal Of Innovative Research In Technology(IJIRT) , Volume 8 Issue 5 , ISSN: 2349-6002, October 2021.

**[66].** K Kutubuddin, "Detection of Malicious Nodes in IoT Networks based on packet loss using ML", Journal of Mobile Computing, Communication & mobile Networks, 2022, Vol 9, Issue 3, pp. 9 -16

**[67].** K Kutubuddin, "Big data and HR Analytics in Talent Management: A Study", Recent Trends in Parallel Computing, 2022, Vol 9, Issue 3, pp. 16-26.

**[68].** Kazi K S, "IoT-Based Healthcare Monitoring for COVID-19 Home Quarantined Patients", Recent Trends in Sensor Research & Technology, 2022, Vol 9, Issue 3. pp. 26 – 32

**[69].** Gouse Mohiuddin Kosgiker, "Machine Learning- Based System, Food Quality Inspection and Grading in Food industry", International Journal of Food and Nutritional Sciences, 2018, Vol 11, Issue 10, pp. 723- 730

**[70].** U M Halli, "Voltage Sag Mitigation Using DVR and Ultra Capacitor", Journal of Semiconductor Devices and Circuits. 2022; 9(3): 21–31p.

**[71].** Prof. Vinay S , et al, “Multiple object detection and classification based on Pruning using YOLO”, Lambart Publications, 2022, ISBN – 978-93-91265-44-1

**[72].** Kazi Kutubuddin, “A Study HR Analytics Big Data in Talent Management”, Research and Review: Human Resource and Labour Management, 2023, Volume-4, Issue-1, pp. 16-28

**[73].** Sayyad. Liyakat, "Detecting Malicious Nodes in IoT Networks Using Machine Learning and Artificial Neural Networks," 2023 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2023, pp. 1-5, doi: 10.1109/ESCI56872.2023.10099544.