

A Novel Approach Machine Learning and Gesture, Pose Estimation Based Industrial Automation

Jagdish Kumar¹

Computer Programmer

KVK Reasi, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu ,jagdishkkvk@gmail.com

Manjunatha²

NITTE (Deemed to be University), Department of Information Science and Engineering, NMAM Institute of Technology
manjunatha.msh@gmail.com

Ankitha Shetty³

NITTE (Deemed to be University), Department of Artificial Intelligence and Data Science, NMAM Institute of Technology,
ankishetty91@gmail.com

Assistant Professor Shivangi dheer⁴, JECRC University, Shivangidheer999@gmail.com

Ashish Dibouliya⁵,

MD Data Architect, ashish.dibouliya@gmail.com

Er. Gaurav Kumar Sain⁶, Researcher in IoT and Embedded System, Gauravsain266@gmail.com

Abstract

In recent years, there has been a growing interest in leveraging machine learning techniques and gesture/pose estimation algorithms for industrial automation. This novel approach holds the potential to revolutionize the way industrial processes are performed by enabling intuitive human-machine interactions and improving overall system efficiency. This research paper presents a comprehensive study on the integration of machine learning and gesture/pose estimation techniques for industrial automation applications. The objective is to develop a robust and reliable system that can accurately interpret human gestures and poses, allowing operators to control machines and perform complex tasks in a more intuitive and efficient manner. The proposed approach utilizes recognizing and interpreting human gestures and poses. These algorithms analyze input data from cameras or depth sensors to accurately estimate the position and orientation of human body parts or the overall body pose. The estimated gestures and poses are then mapped to specific commands or actions within the industrial automation system. To evaluate the effectiveness of the proposed approach, several experiments are conducted using a simulated industrial environment. The experiments involve different tasks, such as machine control, object manipulation, and assembly operations, which are performed by operators using gesture-based interaction. The performance of the system is measured in terms of accuracy, response time, and overall system efficiency. The results of the experiments demonstrate the feasibility and potential benefits of the novel approach. The integrated system effectively recognizes a wide range of gestures and poses, enabling operators to control machines and perform tasks with high precision and efficiency. The real-time gesture and pose estimation algorithms exhibit robustness and accuracy, even in dynamic industrial environments with varying lighting conditions and occlusions. In this paper, we show motor speed control using hand gestures for industrial use, same as this method can also use for switching or other automation task. Overall, this research contributes to the advancement of industrial automation by proposing a novel approach that combines machine learning and gesture/pose estimation techniques. The developed system has the potential to enhance human-machine interactions, improve productivity, and reduce the learning curve associated with operating complex industrial systems.

Keywords— Gesture Automation, OpenCV, Pose Industrial Automation

1. Introduction

Gesture-based home automation refers to the use of gestures, typically captured through a camera, to control and automate various functions and devices within a home environment. OpenCV (Open Source Computer Vision

Library) is a popular open-source computer vision and image processing library that provides a framework for developing gesture recognition systems.

The concept behind gesture-based home automation is to enable users to interact with their home environment

through simple hand or body movements, without the need for physical switches or touch-based interfaces. By leveraging computer vision techniques, OpenCV can analyze video input from cameras and detect specific gestures or movements performed by users.

The process typically involves several steps. First, a camera captures the video feed of the user's movements. This video feed is then processed using various computer vision algorithms provided by OpenCV. These machine learning algorithms can include hand detection, tracking, and gesture recognition.

Hand detection algorithms are used to identify and track the position and shape of the user's hand within the video feed. Once the hand is detected, tracking algorithms can track its movement over time, allowing the system to follow the hand's path.

Gesture recognition algorithms analyze the tracked hand's movements and classify them as specific gestures or commands. These gestures can be predefined, such as a swipe motion to turn on/off lights, a circular motion to control the volume, or a hand gesture to open/close doors.

Once the gestures are recognized, the automation system triggers the corresponding actions, such as adjusting the lighting, controlling appliances, activating security systems, or any other home automation function. These actions can be integrated with existing smart home technologies or custom-built systems.

OpenCV provides a comprehensive set of functions and algorithms for image and video processing, making it an ideal tool for developing gesture-based home automation systems. Its open-source nature allows developers to customize and extend the library to meet their specific requirements. Gesture-based home automation using OpenCV offers a hands-free and intuitive way to control and automate various aspects of a home environment. By leveraging computer vision techniques, it enables users to interact with their automation through simple gestures, providing convenience and enhancing the overall user experience.

2. Literature Review

Md Akram Ahmad et. All (2014) Authors have compared a fuzzy logic controller's performance to that of numerous other types of controllers. The Fuzzy Logic Controller has shown superior performance in simulations compared to the PID and IMC controllers. This supports the conclusion that the proposed Fuzzy Logic Controller improves DC motor control and features improved performance characteristics. In this investigation, Authors use Matlab's simulation programme to examine how a Fuzzy Logic controller, in addition to the more common PID and IMC, may be used to control the speed of a DC shunt motor. [1]

Mohammed Alhanjouri (2017) In terms of performance and response time (null steady state), the results show that NARMA-L2 controller is superior than PI. This controller model displays optimum step responses over a broad range of parameters, with a wide range of loads and speeds acting as references. In this study, Authors aim to improve the efficiency of a separately stimulated DC motor (SEDM) by using artificial neural networks (ANNs), one of the most significant current techniques utilised in control applications, to predict speed and control it. The DC motor's rotor speed may be guided along any desired route. The objective is to achieve exact speed control over the trajectory, despite the fact that the specifications of the motor and the load are often unknown. [2]

Ali A. Hassan et. All (2018) Theoretical and experimental data shows that the Modified Ziegler-Nichols Tuning technique offers the most sensitive and robust response to load disturbance while keeping overshoot in the PMDC motor target system within acceptable bounds. Authors utilised Matlab for the modelling phase, and an Atmega328 microcontroller with an IBT-2 driver for the actual hardware implementation. The tuning approaches produce results that are in agreement with those obtained in simulation. Commonly employed in industry, Proportional-Integral-Differential (PID) tuning techniques are compared and contrasted. [3]

Ashwini et. All (2020) This research shows how the Internet of Things has gone from an obscure concept to a mainstream enterprise with explosive growth. The Internet of Things is crucial in the modern day. The world's billions of objects will need to be able to communicate with one another and with the cloud at some point. As sensors have become more affordable and more widely available, IoT has rapidly expanded into many new areas, such as industry, homes, cars, farms, hospitals, and more. The parameters for condition monitoring using the Internet of Things (IoT) and PWM methods for controlling motor speed are demonstrated. Examine and monitor voltage, current, speed, and temperature using an LCD display. [4]

Cosmas Tatenda Katsambe et. All(2017) The team developed a PWM-based motor speed controller. The effect of the duty cycle on the converter's output voltage has been analysed. As the pulse width grows, the average voltage at the motor terminals rises. This causes an increase in magnetic flux within the armature windings. As a result, the motor's rotational speed will increase. The microprocessor enables fine-grained control of the speed by, for example, adjusting the duty cycle of the PWM pulse. Pulse width modulation (PWM) has been shown to have an effect on the motor's voltage and rotational frequency. [5]

Jeen Ann Abraham et. All(2018) MATLAB was used to create a PID controller and a neural network controller for controlling the DC motor model. Both controllers'

performances were compared, and the effect of a change in rotor inertia on the controller output was analysed, in order to verify the usefulness of machine learning in control systems. The simulation findings demonstrate that NNPC is less precise than PID controller. The PID controller fails to keep the motor under control when the rotor's moment of inertia grows by 10%, whereas the NNPC does so with only a minor delay. This indicates that the controller's output is independent of the equipment's functioning. [6]

Aykut Çubukçu et. Al(2015) In this design, the speed of a motor is determined using a combination of a stationary camera and image processing techniques. OPC-server is used to enable communication between PLCs and computers due to the broad range of devices in use. The driver can monitor the other engine's speed and keep it within safe limits thanks to data sent from the computer to the PLC through OPC at predefined intervals. In this context, the camera will serve as an encoder. Disruption to this study comes from variations in light intensity, a common issue in scientific research. The line on the wheel will be unclear or nonexistent if there is insufficient illumination. Therefore, the estimation of speed and the angle between them may be inaccurate. Finding a resolution to this disruption will need research to be carried out in a brightly lit atmosphere at all times. [7]

Y Sudha et. Al(2020) In this paper, Authors show how to use an Arduino Uno board to change the rotational frequency of an induction motor to adjust its speed. Using code written in the Arduino Uno programming language, the approach displays smooth speed control by changing the frequency at which the board's output is created. Because of the following, this technique is effective: Setting a defined duration for each speed makes the code easy modifiable to acquire the required speeds for different purposes. Since Arduino can run on a single 9V battery, it saves energy and can be readily programmed to achieve the required speeds in a variety of contexts. [8]

Mr.Burali Y. N. et. Al(2012) In order to control the rotational speed of an AC motor remotely, this project will employ a DTMF decoder. There is a wide range of applications for DTMF signalling. As a low-cost and highly reliable signalling technology, DTMF is simple to install. This signalling technique has found widespread use in both control and data communications systems. Wireless Handle Administrative Matters Remotely, The motor may be turned on and off with the touch of a button on a smartphone. Human error rates have gone down. The speed of the motor may be changed with the push of a button on a portable controller. Give the audience an update on the present state of the operation. Reduce how much upkeep is required. [9]

Rima Idris et. Al(2022) In most cases, when motion is detected by the PIR motion sensor connected to the raspberry Pi, the associated identification and detection

algorithms are activated. Automatically unlocks upon user recognition and activation of the default mode of operation. However, if the second option is used, the system will track the user's internal temperature to make sure it stays within the acceptable range. If the visitor is unfamiliar, the system will initiate an IP video conversation with the user, who may then decide whether or not to let the person in, as well as take their temperature, using an Android app. The research in this paper culminates in the creation of an efficient and inexpensive intruder detection and door lock automation system. Face detection has a 100% success rate, but recognition only has a 20% success rate. [10]

Diponkar Kundu et. Al(2020) The present method has been successfully used to several home automation and security applications. Authors solution is innovative and improves upon conventional practises in terms of cost, security, and sustainability. Every 3 seconds, Authors proposed system would update with new information, allowing for immediate response to any danger. Because it can be operated in so many different ways (through voice control software, Smart-phone, internet, World Wide Web, and electrical switch), our system is accessible to a wide range of individuals, including those with physical disabilities. Users of our system may rest easy knowing that they are protected by the interconnectedness of all things. [11]

Swati Tiwari et. Al (2016) The readings illustrated the far-reaching effects of the Internet on contemporary society. Consequently, IoT is the core topic of this paper, and Authors also compared and contrasted several home automation approaches. There is a lot of space for innovation in IoT home automation. Several issues with the currently available options are readily apparent. The use of IoT to create a state-of-the-art, energy-efficient, self-learning home automation system is the focus of this piece. [12]

3. Methodology

3.1 Main Circuit Diagram

Optocoupler MCT2E (IC5) is wired as a zero-crossing detector that supplies trigger pulses to monostable multivibrator IC3 during zero crossing. Opto-isolator MOC3021 (IC4) drives triac BT136. Resistor R13 (47-ohm) and capacitor C7 (0.01 μ F) combination is used as snubber network for triac1 (BT136). As the width of the pulse decreases, firing angle of the triac increases and speed of the fan also increases. Thus the speed of the fan increases when we press any button on the remote control.

Assemble the circuit on a general-purpose PCB and house it in a small case such that the infrared sensor can easily receive the signal from the remote transmitter.

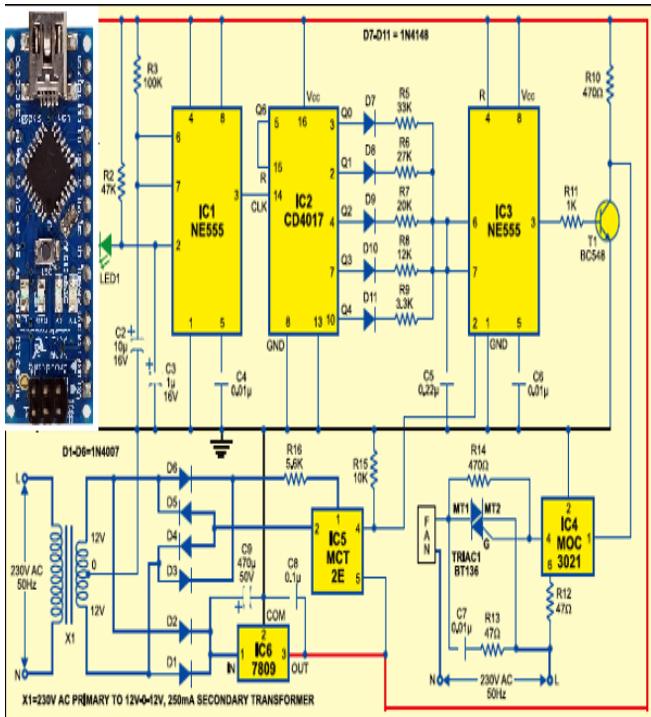
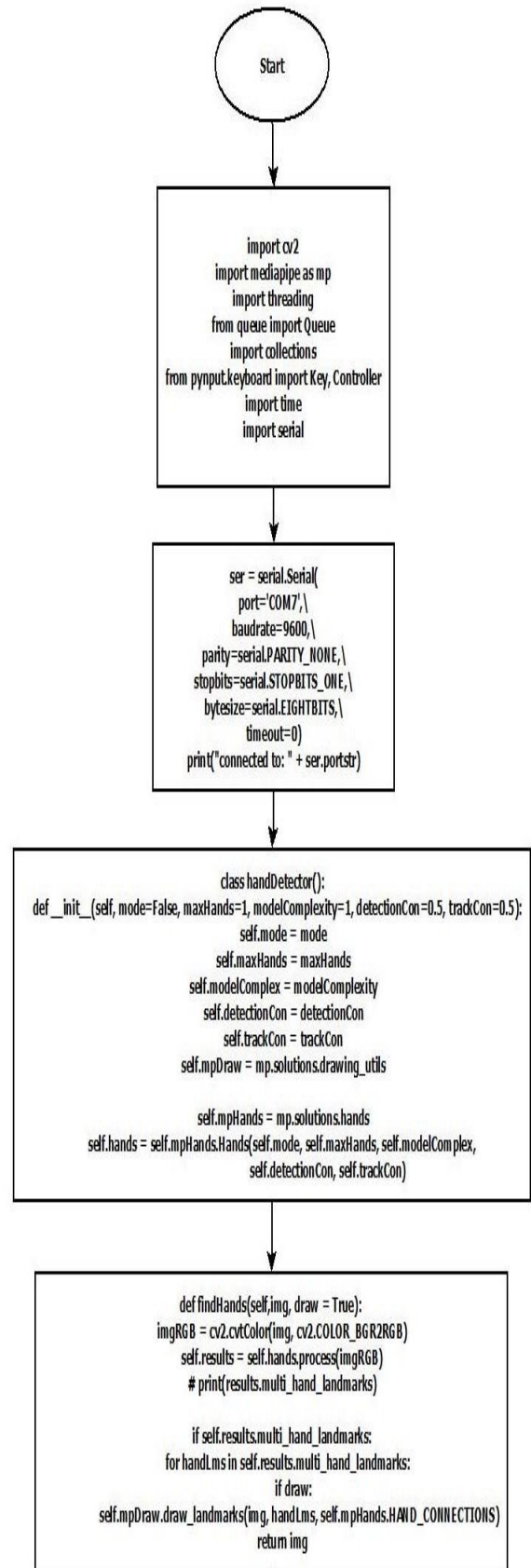


Figure: 1 Main Circuit Figure

3.2 Algorithm Flow Diagram



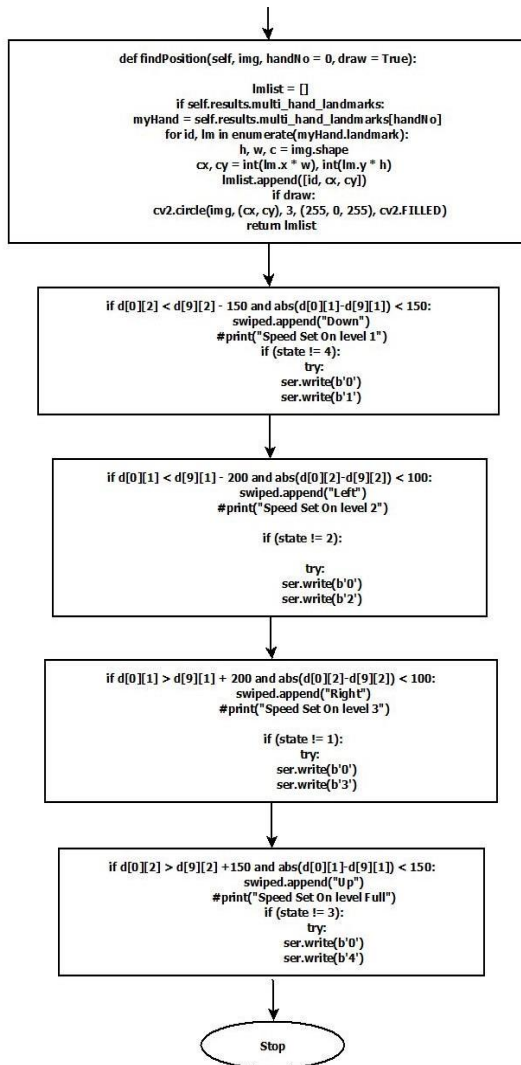


Figure: 2 Main Python Algorithm Flow Chart

In this flow chart we can see 1st algorithm is start then import some important libraries like cv2, mediapipe, threading, serial etc. then set serial communication at the baud rate of 9600 for serial communication with computer and our proposed circuit. then a class is made for detection of hand movement like up, down, left and right, one, two, three, four, five, for the each movement algorithm send different value for set speed of motor in the form of digit like for speed 1- "1", speed 2- "2", speed-3 "3" and for speed-4 "4". for hand detection camera will be initialize and convert image in to rgb image and also print his landmark with the centroid of hand palm and also detect position of hand then if hand swipe down side then algorithm send value 1 and motor will run at the speed of 1, and for left swipe of hand it send value 2 mean on serial it mean motor will run at speed 2, for right swipe value 3 is send mean that time motor speed will be at level 3, and for up side value "4" is send mean motor will be top speed in this condition, we can also use one, tow, three, four, five sign for control speed of the motor, for demonstration of this proposed work we

used light bulb here we can see different brightness on different level.

4. Results

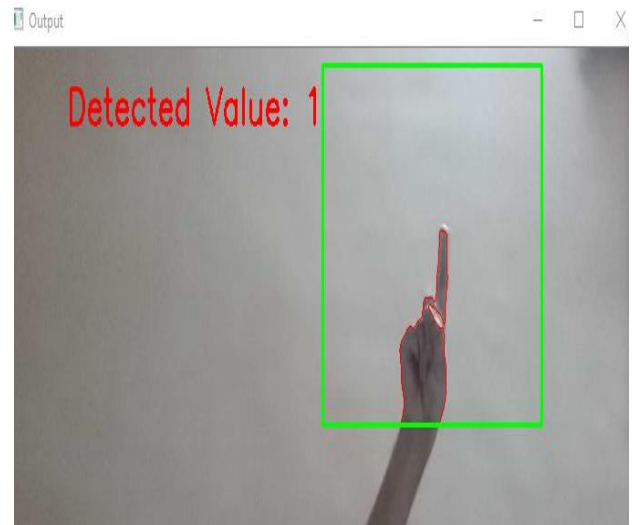


Figure: 3 Gesture Sign One

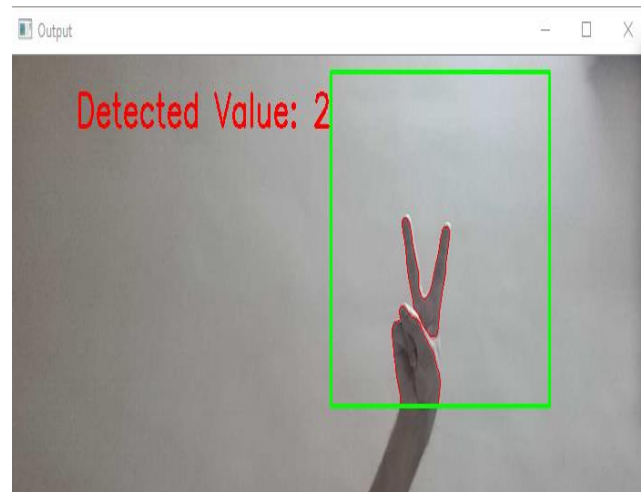


Figure: 4 Gesture Sign Two

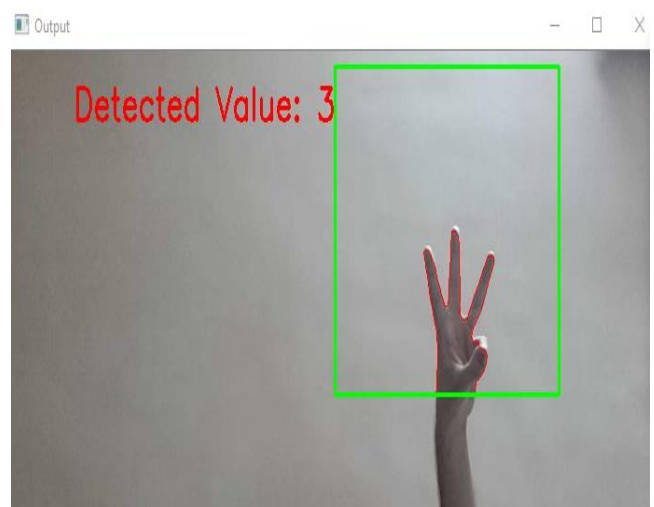


Figure: 5 Gesture Sign Three

Quality Control and Inspection: Gesture and pose estimation algorithms can be used to track and analyze hand movements during quality control processes. This can help identify defects, measure dimensions, and ensure compliance with standards. For instance, in automotive manufacturing, gesture-based inspection systems can detect deviations in component placement or assembly, improving overall product quality.

Training and Skill Development: Gesture and pose estimation technology can be utilized for training purposes, particularly in industries where complex operations are involved. Virtual reality (VR) or augmented reality (AR) systems can leverage gesture and pose estimation to provide real-time feedback and guidance to trainees, allowing them to practice tasks and acquire skills in a safe and controlled environment.

Worker Health Monitoring: Gesture and pose estimation systems can monitor and assess the physical well-being of workers. By analyzing body movements, these systems can detect signs of fatigue, stress, or repetitive strain, prompting the implementation of appropriate interventions such as rest breaks or task rotation. This can help improve overall worker health and prevent long-term injuries.

Process Automation and Efficiency: Integrating gesture and pose estimation with automation systems can enhance process efficiency and automation in industrial settings. By eliminating the need for physical buttons, switches, or touchscreens, workers can control machinery and equipment through simple gestures or poses, reducing human error and streamlining operations.

Customization and Adaptability: Gesture and pose estimation technology can enable customized and adaptive automation solutions. Workers can configure gestures or poses based on their preferences and needs, allowing for personalized control of machinery and equipment. This flexibility can improve worker satisfaction and productivity. Collaborative Robotics: Gesture and pose estimation can play a crucial role in collaborative robotics, where robots work alongside human workers. By accurately recognizing and interpreting gestures and poses, robots can understand human intentions and adjust their movements accordingly, facilitating safer and more efficient collaboration.

While gesture and pose estimation technology has made significant progress, there are still challenges to overcome, such as improving accuracy, robustness, and real-time processing capabilities. Additionally, addressing privacy concerns and ensuring the secure integration of these systems into industrial environments will be important for their widespread adoption.

Overall, gesture and pose estimation based industrial automation holds immense potential to revolutionize manufacturing processes, improve worker well-being, and drive efficiency and productivity in various industrial

sectors. Continued research and development in this field will pave the way for its successful implementation in the factories of the future.

References

- [1.] Md Akram Ahmad , Kamal Kishor , Pankaj Rai “Speed control of a DC motor using Controllers” Automation, Control and Intelligent Systems 2014.
- [2.] Mohammed Alhanjouri “Speed Control of DC Motor Using Artificial Neural Network” International Journal of Science and Research (IJSR) 2017.
- [3.] Ali A. Hassan , Nabil K. Al-Shamaa, Kasim K. Abdalla “Comparative Study for DC Motor Speed Control Using PID Controller” International Journal of Engineering and Technology (IJET) 2018.
- [4.] Ashwini B.KauleMrs.M.R.Bachawad “IoT Based Monitoring and Speed Control of an Induction Motor” International Journal of Engineering Research and Applications 2020.
- [5.] Cosmas Tatenda Katsambe, Vinukumar Luckose, Nurul Shahrizan Shahabuddin “EFFECT OF PULSE WIDTH MODULATION ON DC MOTOR SPEED” International Journal of Students’ Research In Technology & Management 2017.
- [6.] Jeen Ann Abraham, Sanjeev Shrivastava “DC Motor Speed Control Using Machine Learning Algorithm” International Journal of Engineering Research & Technology (IJERT) 2018.
- [7.] Aykut Çubukçu, Sıtkı Öztürk, Melih Kuncan, Kaplan Kaplan and Fatma Kuncan “The Implementation of DC Motor Speed Control Using Image Processing and OPC Interface in the S7-1200” ISITES2015.
- [8.] Y Sudha, P Pooja, K Rama, P Shweta “Speed Control of AC Motor” International Journal of Innovative Technology and Exploring Engineering (IJITEE) 2020.
- [9.] Mr.Burali Y. N. , Assistant Prof. Patil R. T. “Speed Control and Monitoring of an AC Motor by Wireless Communication Using DTMF Decoder Technique” International Journal of Engineering and Science 2012.
- [10.] Rima Idris, Aysha Alkooheji, Ahmed J. Jameel “Image Processing Based Smart Home Automation using Raspberry Pi and Python” Researchgate 2022.
- [11.] Diponkar Kundu, Md. Ebrahim Khallil, Tushar Kumar Das, Abdullah Al Mamun, Ahmmad Musha “Smart Home Automation System Using on IoT” International Journal of Scientific & Engineering Research, Volume 11, Issue 6, June-2020.
- [12.] Swati Tiwari , Rahul Gedam “A Review Paper on Home Automation System Based on Internet of Things Technology” International Research Journal of Engineering and Technology (IRJET) 2016.
- [13.] Shashank Kotyan, Nishant Kumar, Pankaj Kumar Sahu, and Venkanna U. “HAUAR: HOME AUTOMATION

USING ACTION RECOGNITION” PROCEEDINGS OF IEEE CONFERENCE ON INFORMATION AND COMMUNICATION TECHNOLOGY (CICT-2018).

[14.] Satish Palaniappan, Naveen Hariharan, Naren T Kesh, Vidhyalakshimi S, Angel Deborah S “Home Automation Systems - A Study” International Journal of Computer Applications (0975 – 8887) 2015.

[15.] Anup Dongre, M.N. Kakatkar “Home Automation Using Wi-Fi and Security System” International Engineering Research Journal 2014.

[16.] Yash Inaniya, Naresh Kumari and Urvashi Luthra “Home Automation System Using Capacitive Touchscreen” Yash Inaniya et al Int. Journal of Engineering Research and Applications 2014.

[17.] Juan Antonio Nazabal, Peio Lopez Iturri, Leire Azpilicueta, Francisco Falcone, and Carlos Fernandez-Valdivielso “Performance Analysis of IEEE 802.15.4 Compliant Wireless Devices for Heterogeneous Indoor Home Automation Environments” International Journal of Antennas and Propagation 2012.

[18.] Shrikant Subhash Warghade, Manu Vyas, Mani Kunnathettu Rajee, Prof Alex Noel Joseph Raj “Image Processing using FPGA” International Journal of Scientific & Engineering Research, Volume 7, Issue 10, October-2016.

[19.] Rajashree Chatterjee , Arijit Sarkar , Shalabh Agarwal , Asoke Nath “Design and Implementation of a Home Automation System Based on Wi-Fi” International Journal of Research Studies in Computer Science and Engineering (IJRSCSE) Volume 3, Issue 3, 2016.

[20.] Rozita Teymourzadeh, Salah Addin Ahmed, Kok Wai Chan, and Mok Vee Hoong “Smart GSM Based Home Automation System” IJSER 2015.

[21.] K.Y.Durga Prasad , S.Alekhya , A.Naresh , K.V.N Rajesh “Voice Recognition Based Home Automation using Raspberry Pi” International Journal of Innovative Science and Research Technology 7, July – 2018.