A Project Report on

Industry 4.0 Based On IOT & M-2-M Communication

(In collaboration with Mechanical department as multidisciplinary project)

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BACHELOR OF ENGINEERING

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Under the Guidance of

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M. H. Saboo Siddik College of Engineering,

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Anjuman-I-Islam's

M. H. Saboo Siddik College of Engineering

CERTIFICATE

This is to certify that **Yesh Damania, Gautam Sahu, Aman Shaikh** are the bonafide students of M. H. Saboo Siddik College of Engineering, Mumbai. They have successfully carried out the project titled *"**Industrial 4.0 Mini factory based on IOT and M2M**"* in partial fulfillment of the requirement of B.E. Degree in Electronics and Telecommunication Engineering of Mumbai University during the academic year 2021-2022. The work has not been presented elsewhere for the award of any other degree or diploma prior to this.

Er. Abdul Sayeed	**Er. Nayana Chaskar**
(Project Guide)	**(Project Incharge)**
Er. Abdul Sayeed	**Dr. Ganesh Kame**
(EXTC HOD)	**(Principal)**

Project Report Approval for B.E.

This project entitled ***'Industrial 4.0 Mini factory based on IOT and M2M communication'*** by **Yesh Damania, Gautam Sahu, and Aman Shaikh** is approved for the degree of Bachelor of Engineering in Electronics and Telecommunication from University of Mumbai.

Examiners

1. - - - - - - - - - - - - - - - - - -

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Date:

Place:

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Signatures of all the students in the group

(Yesh Damania)

(Gautam Sahu)

(Aman Shaikh)

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included; we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in this submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Signatures of all the students in the group

(Yesh Damania)

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Abstract

The fourth industrial revolution (Industry 4.0) aims at transforming traditional industries into intelligent ones by incorporating innovative technologies. Industry 4.0 enables physical assets to be integrated into intertwined digital and physical processes thus creating smart factories and intelligent manufacturing environments. Internet of Things (IoT) is a rapidly growing technology that has drastically contributed to the Industry 4.0 realization. IoT pursues to pervade our everyday environment and its objects, linking the physical to the digital world and allowing people and “things” to be connected anytime, anywhere, with anything and anyone ideally using any network and service. IoT is regarded as a dynamic and global network of interconnected “things” uniquely addressable, based on standard and interoperable communication protocols and with self-configuring capabilities. Despite still being at an early development, adoption and implementation stage, Industry 4.0 and IoT can provide a multitude of contemporary solutions, applications and services. Hence, they can improve life quality and yield significant personal, professional and economic opportunities and benefits in the near future. This study scrutinizes IoT in the Industry 4.0 context. More specifically, it presents related studies, describes the IoT concept and explores some of the numerous IoT application domains. Moreover, it presents and analyzes the concept of Industry 4.0 and the benefits it offers as well as the relevant key technologies (e.g. industrial internet of things (IIoT), Internet of things (IOT), Advanced Robotics, and Augmented Reality).

Keywords: Internet of things, Industry 4.0, IOT Applications, Industrial internet of things, Augmented Reality, Advanced Robotic

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List of Abbreviations

IIOT	Industrial Internet of Thing
IOT	Internet of Thing
AR	Argument Reality
IoS	Internet of Services
M2M	Machine to Machine
DOF	Degree of Freedom

Chapter 1
Introduction

The Industrial 4.0 Mini factory is a new concept of manufacturing that is based on the Internet of Things (IoT) and Machine to Machine (M2M) communication. The idea behind this concept is to create an environment where machines are connected to each other and can communicate with each other without human intervention. This will allow for more efficient production, better quality control, and reduced costs for manufacturers. The Industrial 4.0 Mini factory has been developed by Siemens AG in collaboration with Bosch, Cisco Systems Inc., General Electric Co., Huawei Technologies Co., IBM Corp., Microsoft Corp., Oracle Corp., SAP SE, Schneider Electric SE, and ZTE Corp.

Industrial 4.0 is a manufacturing concept that emerged in the early 2010s and is a framework for sustainable manufacturing. It is a response to the challenges of global competition, demographic change, and environmental protection. Industrial 4.0 will be characterized by automation, intelligence, and connectivity as well as distributed production that will be coordinated by cloud computing and mobile communications. In this section we will discuss about Industrial 4.0 Mini factory based on IOT and M2M communication' which falls under Industrial 4.0 framework for sustainable manufacturing with automation, intelligence, connectivity and distributed production coordinated by cloud computing and mobile communications in which there are two main components: Internet of Things (IoT) devices such as sensors or actuators connected to the internet; machine-to-machine (M2M) communication among devices such as industrial robots or factory machines without human intervention needed.

Before Industry 4.0, there were three prior industrial revolutions that have led to changes of paradigm in the domain of manufacturing: mechanization through water and steam power, mass production in assembly lines and automation using information technology. Industry 4.0 is being presented as an overall change by digitalization and automation of every part of the company, as well as the manufacturing process. Big international companies that use concepts of continuous improvement and have high standards for research and development will accept the concept of Industry 4.0 and make themselves even more competitive in the market. This becomes possible by introducing self-optimization, self-cognition, and self-customization into the industry. The manufacturers will be able to communicate with computers rather than operate them.

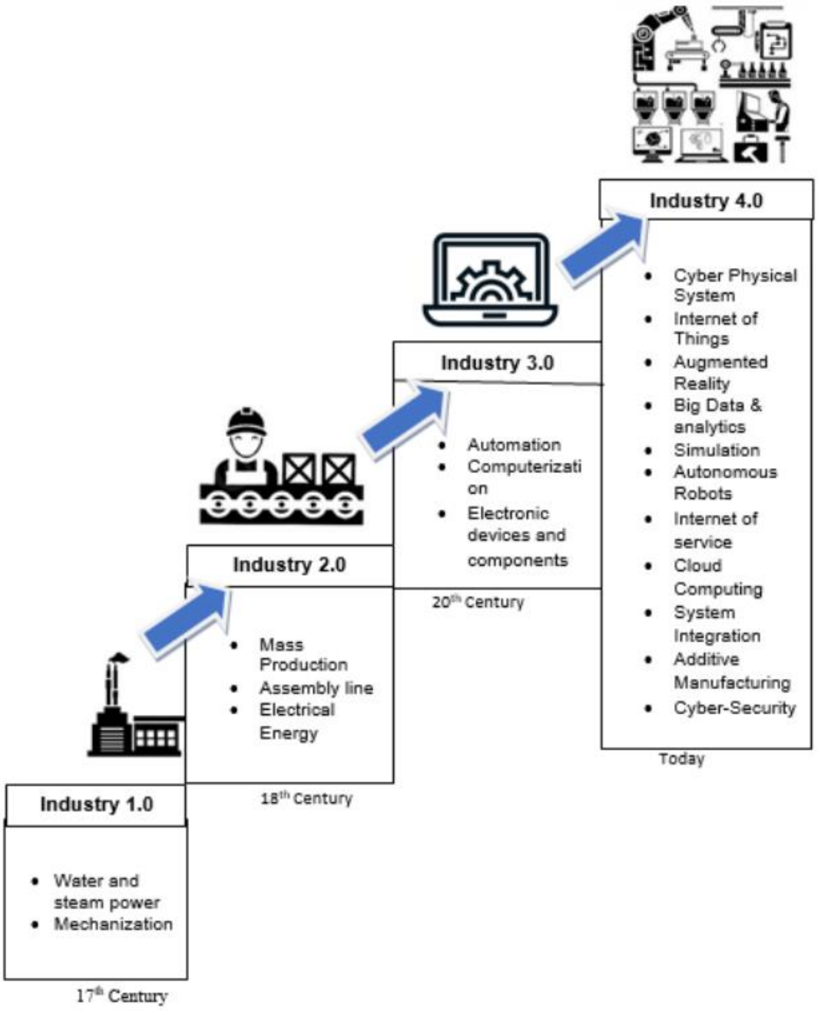

Fig 1.1: The Industrial Revolution

The schematic diagram of overview for the industrial revolutions is illustrated in Figure 1.1.

1.1 Objectives

- Establishing precise control of Robotic arms & Sorting System.
- Implementation of IoT technology and interconnectivity of Robotic Arm, Inventory & server.

1.2 Problem Statement

In this project, we are attempting to implement interconnectivity, automation, machine learning and inventory management in an assembly line model that will demonstrate Industry 4.0 technology.

1.3 Methodology

The modules that we are working on in the project are

1. Advanced Robotics:

The most common type of pick and place robots are the four DOF robotic arms, used for most standard applications, like moving objects along a single plane.

2. Inventory Management:

Industry 4.0 is also having a significant impact on inventory management. With the right combination of technology, managers can improve tracking, create more effective demand-planning algorithms and adopt robots that help optimize warehouse operations.

3. IOT:

IoT is a key part of the industry 4.0 strategy which works to create flexible and connected digital factories where communication is facilitated between all parts of the system. The best aspect of today's technologies like IoT, AI, and Big Data is their range of applications.

4. Augmented Reality:

Augmented reality is a technology that gives the real world an additional dimension by overlaying information such as text, images and sound onto the world as we see it.

1.4 Organization of Project Report

This project report is organized as follows:

Chapter 1 gives a brief introduction of the project covered. It contains the basics of a Belt Conveyor Monitoring and Robotic arm control and the other tools and components used for completion of this project.

Chapter 2 presents the literature survey on the existing techniques

Chapter 3 provides a brief explanation on design methodology.

Chapter 4 is dedicated to the experimental results.

Chapter 5 presents the conclusions and future scope for this project.

Chapter 2

Literature Review

Industry 4.0 refers to a new phase in the Industrial Revolution that focuses heavily on interconnectivity, automation, machine learning, and real-time data. Different Modules of Industry 4.0 are Cyber-Physical Systems, Internet of Things (IOT), Internet of Services (IOS), Interoperability, Virtualization, Decentralization, etc.

In this paper, the integration of Cloud and IoT along with the Industrial Internet of things at Industry 4.0. They concentrated on the Evolution of the Industrial Revolution and Technologies that support Industry 4.0 and the role of cloud computing in combination with the Internet of Things. The Experimental Analysis is done in a variety of cloud, IoT modules, and sensors. The result analysis is shown in the form of graphs [1]. The paper represents the smart hardware for smart factories, which has more advanced features like communication without interruption, security of data, easy communication between human and machine, connectivity between hardware and software, and easy accessibility. The paper presents, benefits with limitations and challenges with the objectives of IIOT 4.0 for smart hardware development under industry 4.0 [2]. This paper presents a reference architecture for IoT-based smart factories and defines the main characteristics of such factories with a focus on sustainability perspectives. And then it proposes an approach for energy management in smart factories based on the IoT paradigm [3]. The paper represents automatic material handling system. It coordinates the movement of robotic arm pick the items moving on the conveyor belts. It aims in organizing the coloured objects which are approaching on the conveyor by picking and placing the objects in its separate located place. There by reducing the tedious work done by human, accomplishing accuracy and rapidity in the work. The project includes colour sensors that senses the items color and lead the signal to the controller. The microcontroller guides signal to the motor driving circuit which drives the different motors of the robotic arm to grasp the object and place it in the correct location. Depending upon the colour sensed the robotic arm go’s to the correct location to releases the object and comes back to the normal potion [4]. In this research, a sensor is utilized to identify the color of the item and a microcontroller is utilized to control the arrangement and the primary disfavour is-that can't perceive the thickness of the object [5].

Chapter 3

Theoretical Background/DesignMethodology

Industry 4.0 is the era of automation, of the digitalized factory and digitalized products – the fourth phase of industrial revolution, or Industry 4.0. Nevertheless, the academics field is still unable to define the approach as the industry 4.0 is the basic term referring to the fourth industrial revolution.

3.1 Characteristics of Industry 4.0

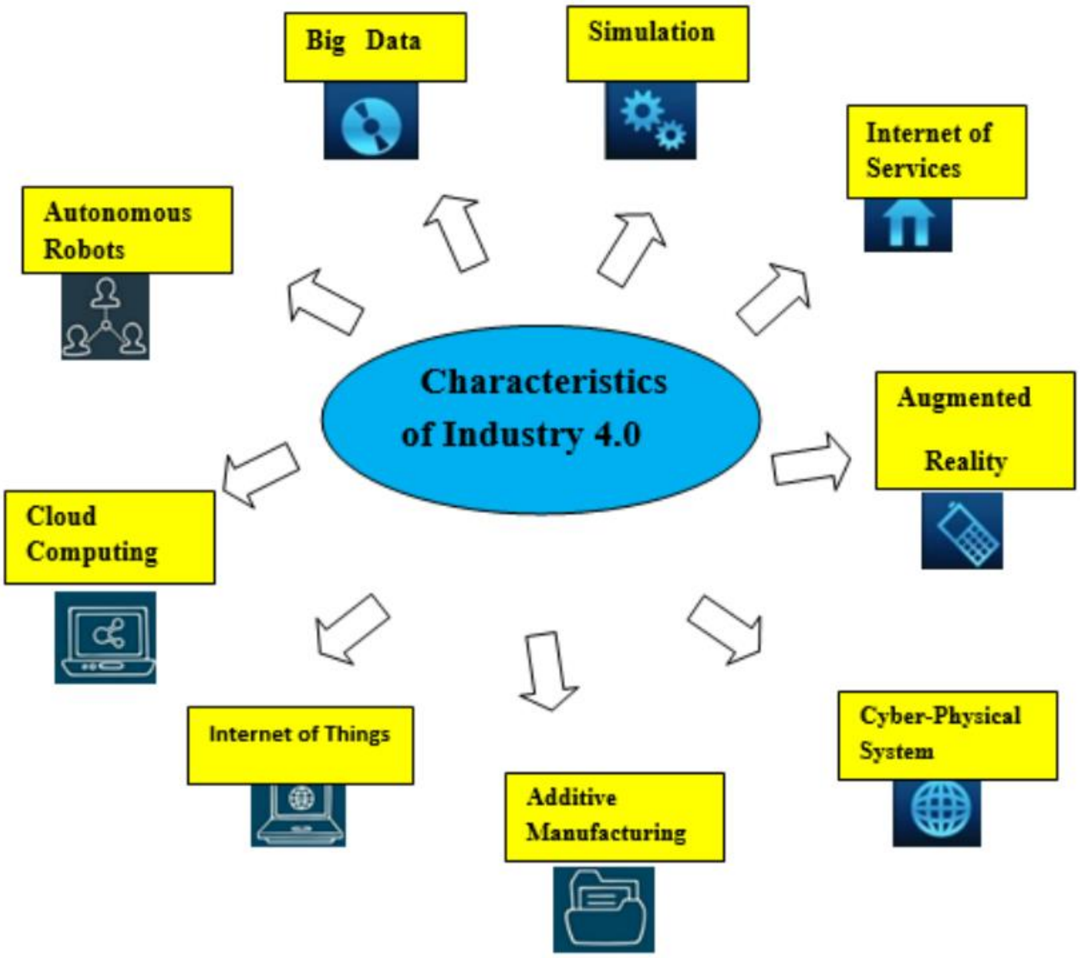

Fig 3.1: Characteristics of Industry 4.0

3.1.1 Internet of Things (IoT)

Industry 4.0 is the new phrase for the combination of the present Internet of Things (IoT) technology and the manufacturing industry. Industry 4.0 was initiated as a result of the combination of the Internet of Things (IoT) and the Internet of Services (IOS) in the manufacturing process (Kagermann, Wahlster & Johannes (2013). Generally, IoT can provide advanced connectivity of systems, services, physical objects, enables object-to-object communication and data sharing. IoT can be achieved through the control and automation of aspects like heating, lighting, machining and remote monitoring in various industries

3.1.2 Internet of Services (IOS)

Internet of Services acts as important components in the automotive industry. Activities are triggered through data transfers in the information technology to make daily mobility safer, easier and pleasant. The Internet of Services (IoS) acts as “service vendors” to provide services through the internet according to the types of digitalization services. These services are available and on demand around business models, partners and any setup for services. The suppliers provide and aggregate the services into additional value services as communication among consumers can be received and accessed by them through various channels

3.1.3 Augmented Reality

Augmented Reality (AR) has begun to be considered as one of the most promising business that technological companies should heavily invest in. This technology can bring huge support for maintenance works in business due to reduced time needed for maintenance works and reduction of potential errors in maintenance works. It can predict with high accuracy and allows the frequency of maintenance to be kept at low numbers by utilizing predictive maintenance to prevent any unplanned reactive maintenance. This will reduce costs associated with doing too much preventive maintenance.

3.1.4 Autonomous Robots

Current robots have higher flexibility, advanced functions and are easier to operate in multitudes of fields. In the near future, robots will interact with each other and collaborate actively with humans under the guidance of handlers. These robots will be cheaper and more sophisticated in order to achieve better abilities compared to those currently used in the manufacturing field.

3.1.5 Simulation

Simulation modelling is a way of running a real or virtual process or a system to find out or guess the output of the modelled system or process. Simulations are done by using real-time data to represent the real world in a simulation model, which include humans, products and machines. Therefore, operators are able to optimize the machine settings in a virtual simulated situation before implementing in the physical world. This decreases machine setup times and improves quality.

3.2 Block diagram of sorting system:

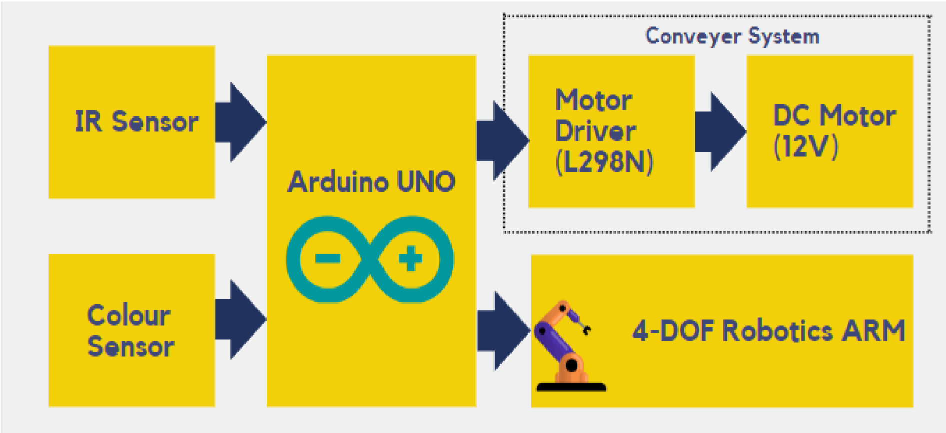

Fig 3.2: Block Diagram of Sorting System

3.2.1 Block Diagram Explanation: -

Figure 3.2 shows the block diagram of the sorting system in which the Color Sensor and IR sensors is used to detect Product in conveyor. The inputs are connected to Arduino are Color sensor to detect the Color (RGB) and air sensor to detect the product and the output of Arduino there is DC motor with H-bridge driver for conveyor and 4-DOF robotic arm for pick and place.

IR Sensor:- It is used as Obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver**.**

Colour Sensor:- A color sensor detects the color of the material. This sensor usually detects color in RBG scale. This sensor can categorize the color as red, blue or green. These sensors are also equipped with filters to reject the unwanted IR light and UV light.

Motor Driver (L298N):- It is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

3.3 Flow chart for sorting and robotic system:

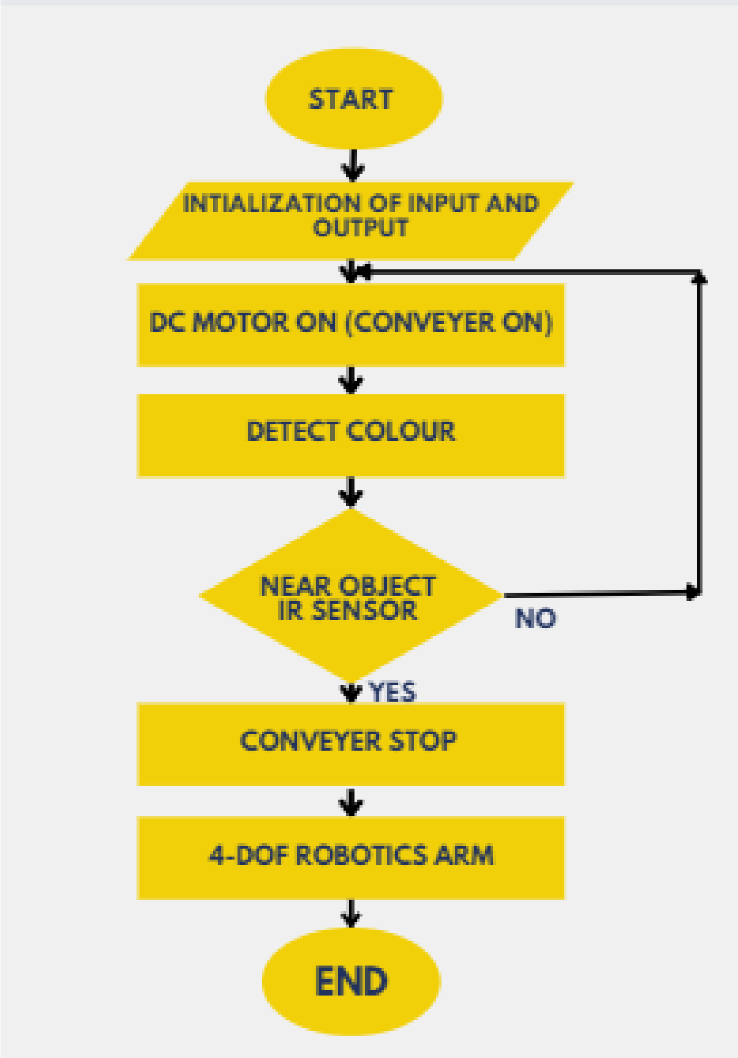

Fig 3.3: Flow Chart of Sorting System

3.3.1 Flow Chart Explanation: -

Figure 3.3 shows the flowchart of the sorting system in which it will initialize the input and output, the conveyor turns ON then it will detect the colour, IR sensor will detect the object, Conveyor stop and 4-DOF robotic arm will works accordingly.

3.4 Components used:

Sr.no	Instrument/Components	Specification	Qty
1	Arduino UNO	ATmega328P Analog Input Pins-6(A0-A5) Digital Input Pins-14(6-PWM) Operating Voltage-5V	1
2	Arduino Mega	ATmega2560 Analog Input Pins-16 Digital Input/output Pins-54(15-PWM output) Operating Voltage-5V	1
3	Node MCU	ESP8266 Digital I/O Pins (DIO): 16 Analog Input Pins (ADC): 1 Operating voltage-3.3v	1
4	IR Sensor	Operating voltage-5V DC I/O pins are 5V and 3.3V compliant Range: Up to 20cm 20mA supply current	1
5	Ultrasonic Sensor	Sensing range-40 cm to 300 cm Operating voltage-20VDC-30VDC Frequency-120KHZ (Sound waves) Resolution 1mm	1
6	Color Sensor	TCS3200 Module Supply Voltage- 2.7v-5.5v High-Resolution Conversion of Light Intensity to Frequency.	1

7	H-Bridge	Driver Model: L298N 2A Motor Supply Voltage (Max): 46V Motor Supply Current (Max): 2A Maximum Power (W): 25W	1
8	DC motor	Supply Voltage 12V	2
9	Servo Motor	Operating Voltage is +5V typically Torque: 2.5kg/cm Operating speed is 0.1s/60° Rotation: 0°-180°	As per Req.
10	Jumper wire	Male to Female	As per Req.
11	Power supply	5v and 12v	1
12	Breadboard	2 Distribution Strips, 200 tie-points Distortion Temperature:84°C (18 3° F) Insulation Resistance:500MΩ/DC500V Withstanding Voltage:1,000V AC/1min	As per Req

3.5 Software used:

1. **Arduino IDE:** Arduino is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers & microcontroller kits for building digital devices.

2. **Unity:** A framework purpose-built for AR development allows you to develop your app once, then deploy it across multiple mobile and wearable AR devices. It includes core features from each platform, as well as unique Unity features that include photorealistic rendering, physics, device optimizations, and more

Chapter 4

Experimental Results

Tested the various components such as IR Sensor, Robotic Arm and Conveyor Belt using Arduino UNO.

4.1 Testing of Robotic Arm

Fig 4.1: Testing of Robotic Arm

Figure 4.1 shows the testing of robotic arm which will pick the product and place it in the container.

4.2 Testing of Colour Sensor

Fig 4.2: Testing of Colour Sensor

Figure 4.2 shows the TSC33200 Colour Sensor interface with Arduino and testing of the colour sensor which will detect the colour & Robotic Arm will perform accordingly.

4.3 Testing of Sorting System

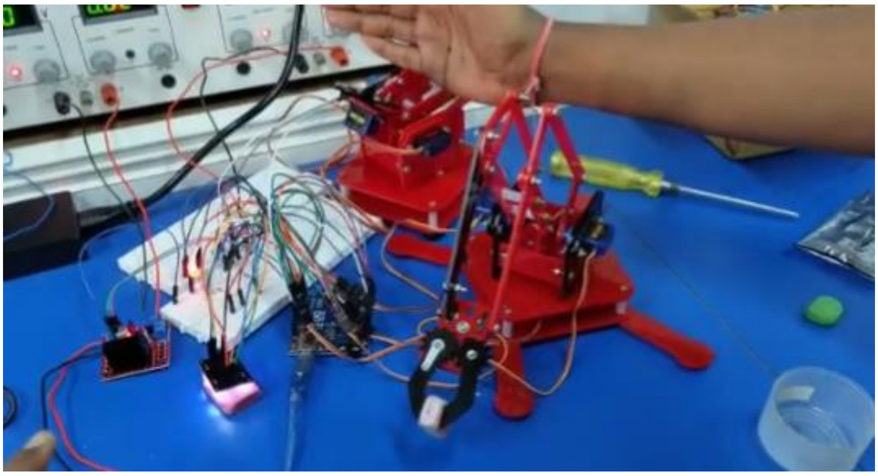

Fig 4.3: Testing of Sorting System

Figure 4.3 shows the testing of sorting system in which IR sensor will detect the object, Colour Sensor will detect the colour, robotic arm will perform accordingly and after the operation of robotic arm the conveyor starts & this process gets repeated.

Chapter 5

Conclusion

5.1 Conclusion

Industry 4.0 is the future of global manufacturing that combines existing ideas with new value. a chain that plays a crucial role in transforming all value chains in the life cycle of goods while developing innovative services and products in the manufacturing industry. implies the connection between systems and things that create self-organized and dynamic control in an organization. In this semester we designed the 4 modules which are Advanced robotics, Inventory management, IOT and AR and in next semester we will implement these modules.

5.2 Future Scope

Industry 5.0 makes a great change of perspective; the core of Society 5.0 focuses on people as fundamental axis of the production sector. Both production and marketing fields agree that beyond the focus of Industry 5.0 is the Society 5.0. In Society 5.0, the products or services offered will be customized to the customer needs. The intention is to reach a fusion between technological development and human beings, with the main objective of people and machines complimenting their activities, and not people being replaced by machines. The use of cobots and robots is a fundamental change for collaboration of repetitive, danger, and unsafe tasks. Furthermore, the humans work will be intellectual production, which means it will be necessary to be qualified to be proactive in this society model

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Appendix-I: Copies of the Reference Paper