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ROBOTIC PLC-BASED PICK AND PLACE INDUSTRIAL PNEUMATIC TRAINER: AN AUTO-ELECTRO STIMULUS

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Abstract

This Project-Based Research & Development (PBRD) Programmable Logic Controller (PLC) - based Pick and Place Industrial Pneumatic Trainer is a miniature model of industrial equipment which mimics and prototypes the actual operations in an industrial setting. Creating, designing, developing, and evaluating the function of the pick and place robotic powered pneumatics PLC, in a linear formation of the actuator. Thus, the systematic & theoretical analysis on the PBRD was tested and the infinite cycle cannot sustain due to the insufficient power source needed to capacitate the voltage. And, the overall results were 4.75 which indicates the very high acceptability of the PBRD however, in operating the system individual regulator on solenoid valves was needed so that the voltage on the power supply won't dropdown. So that, the continuous environmental stimulus will always be sensitive to the needed environment reactor that imitates its sensitivity.

Keywords: Robotic PLC, Auto-Electro-Pneumatic Trainer

INTRODUCTION

Common Industrial facility for automation in pneumatic power controlled Programmable Logic Controller (PLC) is the language on the high-tech and sensitive workplace. It is an industrial digital computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, in a robotic device, or any activity that requires high consistency and reliability control and ease of programming and process fault diagnosis in an auto-electro robotic logarithm to provide flexible, ruggedized and easily programmable controllers to replace hard-wired relays and timers. Since then, they have been widely adopted as high-consistency and reliability auto-electro controllers suitable for harsh environments. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited "time and space" in the workplace otherwise unintended operation will result. Pneumatic systems used in industry are commonly powered by compressed air or compressed inert gases. A centrally automated and electrically powered compressor powers cylinders, air motors, and other pneumatic devices. A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternative to electric motors and actuators. It is designed and developed by the researcher in the PBRD to help the community counterpart partners of Tagoloan Community College to be self-sufficient partners making the workplace free from hazards and promoting life to the fullest.

Conceptual Framework

The Input-Thruput-Output of the *PBRD* shows how a PLC-based pick and place industrial pneumatic trainers being processed. The input box describes what knowledge are required before the process of module development takes place. The thruput box gives the idea as to step to be undertaken in the process of the module development leading to the completion of the project showing the project output as illustrated in the third box. After the module has been developed, an evaluation process by projected end-users will follow for its applicability and/or acceptability of the PBRD output. Thus, the process to wit:

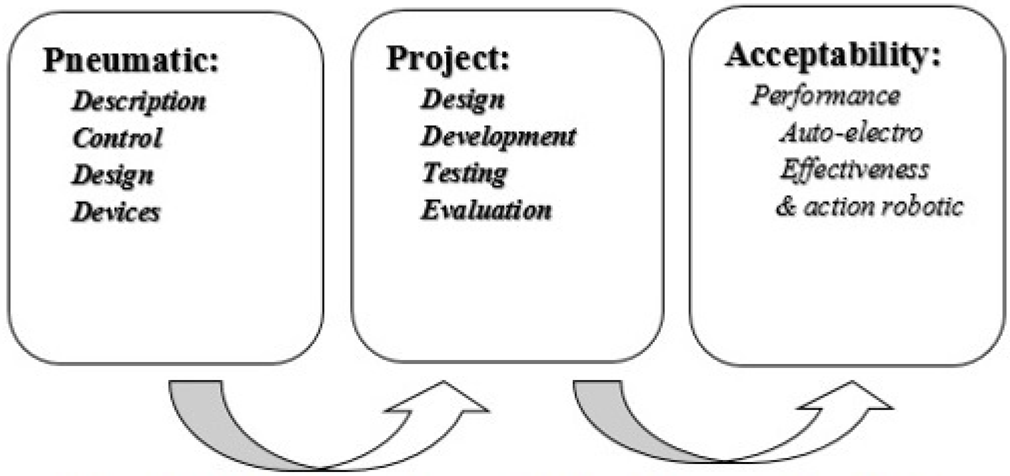


Figure No. 1. The Input - Thruput & Output Process of the PBRD

Objective of the PBRD

The general objective of the PBRD is to develop a PLC-based pick and place industrial pneumatic trainer prototype in a robotic auto-electro powered machine. The specific objectives are the following: to design a PLC-based pick and place industrial pneumatic trainer; to develop and simulate a learning material for a PLC-based pick and place industrial pneumatic trainer that mimics real industry application and evaluate the PLC-based pick and place industrial pneumatic trainer based on its acceptability in terms of their clarity, physical Appearance, academic Impact, accuracy, safety and effectiveness as prototype robotic partner in the workplace.

Significant of the PBRD

PLC-based pick and place industrial pneumatic trainer was chosen in this PBRD because it is important in the community counterpart partners of Tagoloan Community College in the community sectors, businesses, company and industries to give knowledge to everyone on the importance of having PLC-based pick and place controlled powered pneumatic robotic. It will contribute further to defray the working personnel free from hazardous challenges and situation in the workplace.

Input, Thruput and Output Roadmap

In this phase, Automation, PLC Control, Robotic, Auto-Electro-Pneumatic Action, Pneumatic Applications, Synthesis of the PBRD, Programmable Logic Controllers in Control Systems Education, Recent Advancements in Actuator Technology, Robotic System

Automation. Automation is the application of machines to tasks once performed by human beings to tasks that would otherwise be impossible. Automation generally, implies the integration of machines into a self-governing system. The term automation was coined in the automobile industry in about 1946 it describes the increased use of automatic devices and controls in mechanized production. One of the most important application areas for automation technology is manufacturing and fabricating. To many people, automation means manufacturing automation. Three types of automation in production can be distinguished, Fixed Automation, Programmable Automation, and Flexible Automation. The social merits of automation have been argued by labor leaders, business executives, government officials, and college professors. The biggest controversy has focused on how automation affects employment. There are other important aspects of automation, including its effect on productivity, economic competition, education, and quality of life. (Groover, 2013)

PLC Control. A Programmable Logic Controller (PLC) is a digital computer used for the automation of industrial processes, like controlling machinery or factory assembly lines. PLCs have multiple inputs and outputs, operate under extended temperature ranges, have immunity to electrical noise, and have resistance to vibration and impact. Programs to control machine operation are usually stored in non-volatile memory. PLCs operate in industrial environments and have multiple input/output (I/O) terminals. I/O terminals connect the PLC to sensors and actuators where it can read the stimulus of the given environment of the workplace. PLCs output operates electric motors, pneumatic or hydraulic cylinder relays or solenoids, and analog outputs. Inputs/Outputs are built into micro PLCs, and on modular PLCs external I/O modules area attached to a base or chassis. A single PLC can be programmed to replace thousands of relays. Programmable controllers were initially adopted by the automotive manufacturing industry, where software revision replaced the re-wiring of hard-wired control panels when production models changed. The functionality of the PLC has evolved over the years to include sequentially relay control, motion control, process control, distributed control systems, and networking. Therefore, virtual or remote multimedia infrastructure intervention has something to do with the network logarithm.

Auto-Electro-Pneumatic Action. The electro-pneumatic action is a control system for pipe organs, whereby air pressure, controlled by an electric current and operated by the keys of an organ console, opens and closes valves within windchests, allowing the pipes to speak. This system also allows the console to be physically detached from the organ itself. The only connection was via an electrical cable from the console to the relay, with some early organ consoles utilizing a separate wind supply to operate combination pistons. Although early experiments with Barker lever, tubular-pneumatic and electro-pneumatic actions date back to the 1850s, credit for a feasible design is generally given to the English organist and inventor, Robert Hope-Jones. He overcame the difficulties inherent in earlier designs by including a rotating centrifugal air blower and replacing banks of batteries with a DC generator, which provided electrical power to the organ. This allowed the construction of new pipe organs without any physical linkages whatsoever. Previous organs used tracker action, which requires a mechanical linkage between the console and the organ wind-chest, or tubular-pneumatic action, which linked the console and wind-chest with a large bundle of lead tubing. However, in modern times this can be operated through the intervention on the multimedia infrastructure through computer software.

Pneumatic Applications. Factory automation is the largest sector for pneumatics technology, which is widely used for manipulating products in manufacturing, processing, and packaging operations. Pneumatics is also widely used in medical and food processing facilities. Pneumatics is typically thought of as pick-and-place technology, where pneumatic components work in concert to perform the same repetitive operation thousands of times per day. But pneumatics is much more because compressed air can have a cushioning effect; it is often called on to provide a gentler touch than what hydraulics or electromechanical drives can usually provide. In many applications, pneumatics is used more for its ability to provide controlled pressing or squeezing than it is for fast and repetitive motion. Moreover, auto-electronic controls can give pneumatic systems positioning accuracy comparable to that of hydraulic and electromechanical technologies. Pneumatics is also widely used in chemical plants and refineries to actuate large valves. It's used on mobile equipment for transmitting power where hydraulics or auto-electromechanical drives are less practical or not as convenient and in on-highway trucking for various vehicle functions. And of course, vacuum is used for lifting and moving workpieces and products. In fact, combining multiple vacuum cups into a single assembly allows lifting large and heavy objects. Again, in modern times this can be facilitated through the intervention on the multimedia infrastructure.

Synthesis of the PBRD. *Many RRLS* give information that substantiates the technical content of this PBRD. It gives the information which is required to fortify this PBRD. It provides valuable information that supports the conduct of this PBRD. The work of Groover (2013) gives more valuable information about automation. He stated that "The biggest controversy has focused on how automation affects employment." That is why the PBRD researchers would prove that this PBRD is important because it can perform dangerous tasks to humans as stated by Greenemeier (2007). The work of Mars (2007) about a robotic gives compelling truth that a robotic can be used on any dangerous mission and work that need not necessarily be operated by humans and even to the extent of sending "robot" in another planet and allowing the robot to go to war. Just like what Greenemeier said in his article "Robots can be found in the manufacturing industry, the military and space exploration, transportation, and medical applications." The work of Barker explains that not only solid materials like gears, belts, or other had the force to move objects. But also those things that are pressurized like air and liquid. It says, there that those pressurize air (pneumatic) do things more without adding more things to perform another function. That's why many of production companies and industries had used this thing for the automation movement of their actuator.

Programmable Logic Controllers in Control Systems Education. Foster, Hammerquist, and Melendy (2010) stated in their paper that a Programmable Logic Controller (PLC) is a standard industrial control device that common control mechanism used by manufacturing businesses of all sizes to provide a simple, yet robust, method of controlling manufacturing and dynamic processes. As a result, of their low cost, adaptability, and reliability, PLCs are by far the most environment control, food processing, motion control, and automated test facility. Yet, even though PLCs are heavily used by industry, their use in teaching control theory concepts is uncommon for mechanical engineering programs. Traditional, control systems engineering courses focus on the theory and mathematics of continuous-based control systems and rarely involve the use of PLCs, which provide an excellent platform to teach feedback control. Only a few programs have included a specific focus on non-continuous (on/off) control commonly used in industrial environments. In addition, learning ladder logic, a programming language for PLCs, can be difficult and seem unnecessary for those with a traditional programming background, such as C++. Recognizing the appropriate ways of how and when to use PLCs is a key factor in applying control theory effectively in an industrial or even a research environment.

Recent Advancements in Actuator Technology. Robinson et.al, (2013) suggests that the implementation of reliable, high power-to-weight ratio pneumatic actuation systems is now possible for robotic platforms. Existing robotic manipulators for casualty extraction and patient placement uses hydraulic actuation, whereas related robotic prosthetic devices typically use heavy actuator motors. We have developed an alternative solution that employs pneumatic artificial muscles (PAMs). The goal of this PBRD is to identify requirements for a lightweight, high-force robotic manipulator, design the system for heavy lifting capability, and assemble a prototype facility. Following characterization and comparison of different-sized PAM actuators, a proof-of-concept manipulator was constructed. A quasi-static model for the PAM actuators was applied to the system, which includes the Gaylord force, as well as non-linear elastic energy storage. Experimental testing was performed to measure the joint torque and dynamic response of the manipulator and to validate the model.

Robotics. Robots can be found in the manufacturing industry, the military and space exploration, transportation, and medical applications. Typical industrial robots do jobs that are difficult, dangerous, or dull. They lift heavy objects, paint, handle toxic chemicals, and perform assembly work. They perform the same job hour after hour, day after day with precision. They don't get tired and they don't make errors associated with fatigue and so are ideally suited to performing repetitive tasks. According to the polar coordinate robot which is flexible and can hold different kinds of objects around it. It rotates on by a turntable base and the elbow joint is the second degree and moves the forearm up and down. Its inner forearm has the job of bringing the gripper close or away from the robot. (Greenemeier, 2007)

The primary purpose of the Phoenix Lander Robotic Arm (RA) and associated Icy Soil Acquisition Device (ISAD) is to acquire samples of Martian dry and icy soil (DIS) by digging, scraping, and rasping, and delivering them to the Thermal Evolved Gas Analyzer and the Microscopy, Electrochemistry, and Conductivity Analyzer. The RA will also position the Thermal and Electrical Conductivity Probe (TECP) in the DIS; the TECP at various heights above the surface for relative humidity measurements, and the Robotic Arm Camera to take images of the surface, trench, DIS samples within the ISAD scoop, magnetic targets, and other objects of scientific interest within its workspace. The RA/ISAD will also be used to generate DIS piles for monitoring; conduct DIS scraping, penetration, rasping, and chopping experiments; perform compaction tests, and conduct trench cave-in experiments. Data from the soil mechanics experiments will yield information on Martian DIS properties such as angle of repose, cohesion, bearing strength, and grain size distribution. (Mars, 2007)

Low-Cost Robotic Arm and Controller System. Rogers (2009) said in his paper that a low-cost robotic arm and controller system is a desktop model of the robotic arm with the same degrees of freedom whose joints are equipped with sensors. A robotic arm system can save lives by enabling humans to do dangerous tasks at safe distances. Tele-operative systems have been used in a range of applications. In earth-space systems, the communication time delay is a significant consideration. This robotic arm system has two components; a robotic arm and a controller that serves as an operator interface. The controller functions as a desktop model of the robotic arm with the same degrees of freedom.

Pick and Place Robot. Patel Charmin Rajendrakumar et.al (2015) state in their piece that mankind has always strived to give life-like qualities to its artifacts in an attempt to find substitutes for himself to carry out his orders and also to work in a hostile environment. The popular concept of a robot is of a machine that looks and works like a human being. The industry is moving from the current state of automation to Robotization, to increase productivity and to deliver uniform quality. The industrial robots of today may not look the least bit like human beings although all the research is directed to provide more and more anthropomorphic and humanlike features and super-human capabilities in these. One type of robot commonly used in industry is a robotic manipulator or simply a robotic arm. It is an open or closed kinematic chain of rigid links interconnected by movable joints. In some configurations, links can be considered to correspond to human anatomy as waist, upper arm, and forearm with a joint at shoulder and elbow. At end of the arm, a wrist joint connects an end effector which may be a tool and its fixture or a gripper or any other device to work.

Robotic Arm Pick and Place System. Mabanta et.al, (2014) said that their study aimed to create a proto-type robotic pick and place system that utilized pneumatic components to drive an arm, with an air compressor as a source of power, sensors as a feedback device, and a programmable logic controller (PLC). The robotic pick and place system consists of a loading station, testing station, processing station, and sorting station. The process involved the sorting of plastics and metallic materials into different slots. The piece Hammerquist et.al (2010) states that the PLC (Programmable Logic Controller) is a common mechanism in the manufacturing business, with this piece, we concluded that our study is important because after we graduate, we would eventually work in a factory. Maybe they use PLC. That is why it is necessary for us to study the PLC. The composition of Rogers (2009) states that you can make a low-cost robotic arm; this solidifies the said study because it proves that we can actually make a mockup of a robotic arm. The works of Robinson et.al (2013) said that they made a high-efficiency robotic arm which we can use to strengthen our study as well. Mabanta et.al (2014) stated in their composition that created a prototype of a pick and place robotic arm. With their work, we are motivated and excited to develop our own PLC-based Electronic Arm.

METHODS

Research Design. Technical Developmental research is decision-oriented research involving the application of the steps of the scientific method in response to an immediate need to improve existing practices. This type of research also refers to Research and Design programs that deal with developing the materials for instruction since the present study was concerned with the development of learning material on a basic PLC-based pick and place industrial pneumatic trainer that mimics real industrial application utilizing the Automation studio software as the simulation tool in conveying technical knowledge in PLC programming and control. The Research addresses the school community-based that offered technology-based programs who does not have sufficient physical equipment to supplement theoretical matters in industrial automation. Technical developmental research was the most appreciated research method used.

The setting of the Study. This PBRD took place at Tagoloan Community College (TCC). The subject participants are the fourth-year student who took the degree of Bachelor of Science in Engineering Technology (BSET) – major in Electronic and automotive of which another subject of the PBRD are the internal recipient the faculty. Likewise, the external recipient is the community counterpart partners of Tagoloan Community College. The objectives of the PBRD are to develop and acceptability of PLC-based Pick and Place Industrial Pneumatic Trainer. Source of Data. We gathered the data from the multimedia infrastructure, Books, journals, and relevant thereto. Phase Procedure of the PBRD. The phasing procedure of the study shows the flow of how the study had made. Project Design. The project design shows us how the project will work. It is illustrated on the block diagram of the project that is shown in the Figures and it illustrates the classification of raw materials and their specifications. The power supply 24VDC is the power source of the project; The PLC controller is the memory of the project it saves and sends data to control the actuators; The dc relays are a kind of voltage controller, it plays only in the open and close switch. The main purpose of relay the project is to control the actuator and other load components by the command of the PLC; The solenoid valve is the pneumatic controller through electricity it also plays an open and close switch; The cylinder arm is the actuator in the project it illustrates the movement of pick and places motion and other activities; Sensor it's an accessory in the project. It uses as a triggering component; These are the functions of the components in the figure above. It illustrates an arrow to designate how the PBRD process workflow.

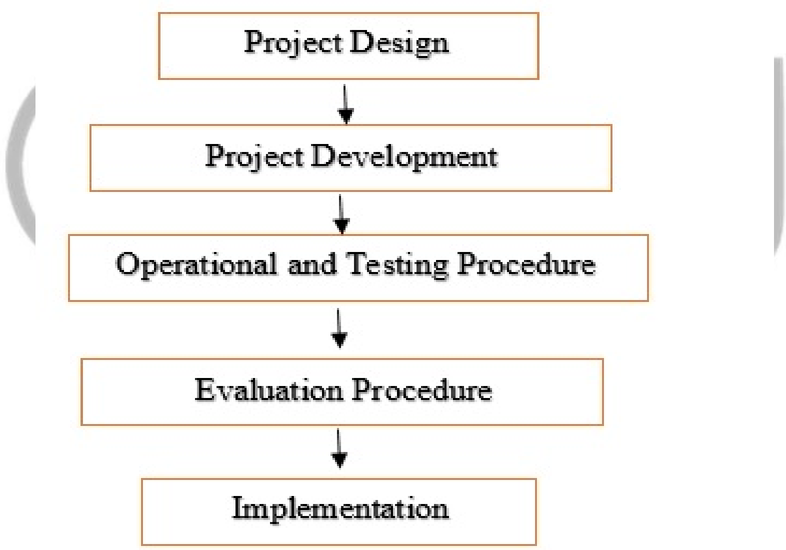


Figure No.2 Process Workflow

We saw in figure no. 2 the flow chart of the PBRD that explains the flow of how the study had been processed to be done as validated in the final output of PLC-based pick and place industrial pneumatic trainer. In the first object, it determined the preparation of the study where it explains the things that you must do first or in other words, gathering data to choose a PBRD questionnaire. The second object explained the validation of the study that was validated by the adviser instructor and another expert. The third object, explained the decision-making if the study will proceed to the next step or back in the previous and find another study. The fourth object, explains the preparation of material to assemble the design of the study. In the fifth object, it explained the continuation in making the design, it is adding a program so that it will run on what particular function it performs. The sixth object, explains the test run of the design if it will function on what is the perception the researcher to perform on that design. It indicates there the Yes and No, if yes it will proceed but if no it goes back in the previous stage. The seventh object, explains the analysis of the design by analyzing feedback data of the design that had been collected by the researcher. And, the last object is the final output of the study, which determines the trainer's total performance.

Project Design and Development

The project Design and Development on PBRD as shown in figure no.3 & 4 below:

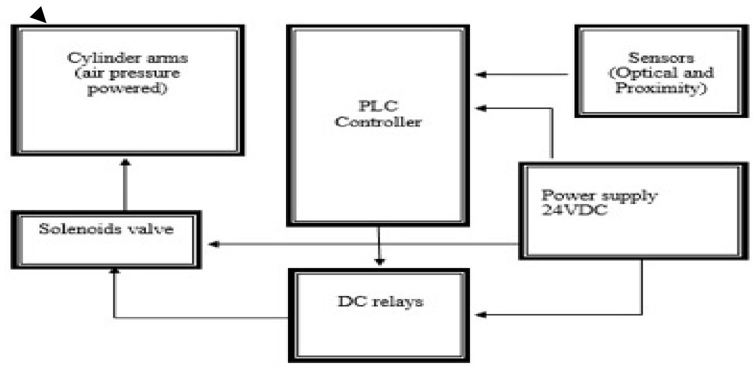


Figure No.3. Block Diagram of the PLC-based pick and place industrial pneumatic trainer in PBRD Design on Logarithmic Robotic Sensor

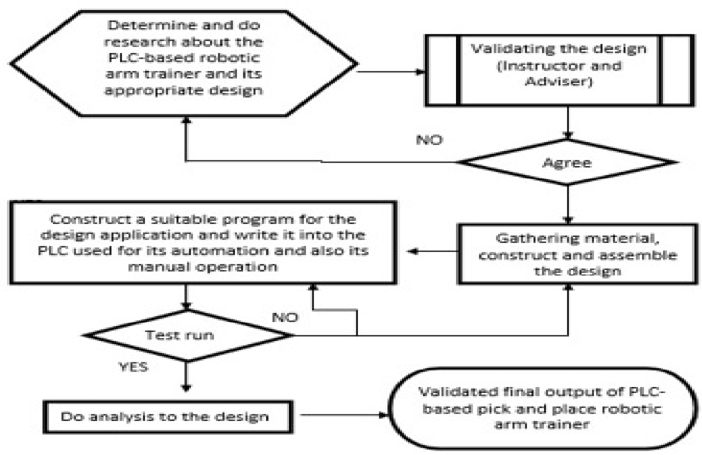


Figure No.4. The PBRD Development

Operational testing and procedure

In this stage testing and retesting are done. Here, problems met were addressed and revisions were made until the project has acceptable performance. The project is all about the PLC-based Pick and Place Industrial Pneumatic Trainer. The following are the necessary instructions in operating the said instrument. ***Hardwiring Phase***. First, before you do anything else use Personal Protective Equipment (PPE) for your safety. Second check the voltages source of each terminal using the multitester. Third check the polarity of each terminal to its designated component. Forth do it safely and with care. ***Pneumatic Phase***. First, check air pressure if it's in the working pressure of your components. Double-check if needed. Second, check your pressure hose if the connection of each hose has followed what is on the diagram. Third, do it safely and with care. ***Test Run Phase***. Before you do anything else use Personal Protective Equipment (PPE) for your safety. Prepare all the materials needed. And arrange it for safety purposes. Connect the input terminals to the designated input pin of the PLC. And also to the output. Construct a suitable program for the design application and write it into the PLC used for its automation. Also, it's a manual operation. Before the PLC will going to run mode, check all the terminals and wire connectors if there's no wire short. Then, activate the run mode. Observe the performance of the trainer if it follows what is on the program.

Evaluation Phase. This PLC-based pick and place industrial pneumatic trainer has passed through the testing procedure, in this phase the Pneumatic trainer will be evaluated by using the statistical instrument PBRD questionnaire specifying the Five-point rating scale (1- not acceptable at all; 2- fairly acceptable; 3- acceptable; 4-much acceptable and 5- very much acceptable) in which the participants are the students of BSET- 4 major in electronics – BSAT-4 major in automotive and Faculty. Likewise, the external recipients are also involved such as communities, businesses, companies, and industries. The assessment and evaluation according to its: **Clarity-** evaluation of the pick and place trainer in terms of its being understandable or being a friendly user. **Accuracy-** Evaluation of the robotic arm trainer in terms of being exact/accurate to its required function focusing on Pick and Place. **Safety-** Evaluation of the robotic arm trainer which is perfectly passed through the testing procedure that qualifies for safety use. **Cost-Effectiveness-** Evaluation of the robotic trainer in comparison to the manual picking and placing which is more time-consuming. As overall Impression in terms of its academic usefulness and compatibility to the 4th year Electronics and automotive Technology students and to their partners the faculty.

Implementation Phase. The implementation of a monitoring and control system for the PLC-based Pick and Place Robotic Arm technology is described. Also, the implementation of the system and control panel and protection obtained from the result of tests on PLC-based pick and place industrial pneumatic trainer performance is provided. The PLC correlates the operational parameter to the movement requested by the user and monitors the system during normal operation and under trip conditions. Test of the Pick and Place robotic arm trainer controlled by PLC prove a higher accuracy in movement performance. The efficiency of PLC control increased into high quality for the synchronization movement of cylinder and robotic arm. Thus, PLC-based pick and place industrial pneumatic trainers prove themselves as a very versatile and effective tool mimicking real industry.

RESULTS AND DISCUSSION

Project Description. The pneumatic industrial trainer can perform numerous tasks such as pick and place simulation and other different PLC exercises. It also represents a miniature process in a food processing or power plant. It has two major functions, manually and automated wherein if it is operated in manual the terminals must be supplied one by one to work. But, if it's automated it only depends on what the PLC program or exercise is about to be executed. *Features:* It is more reliable in power usage because of its transformer. It can be moved easily into other locations because of its luggage. Easy to use, tools and connectors are provided. It can be easily connected to another compressor because of its standards fittings. It can be easily fixed because the parts are exposed and are easily disassembled. It has a secondary power switching and It has a standby mode.

Project Structure and Specification. The industrial pneumatic trainer looks like a rectangular prism with a slight curve on its back. Its whole body is made of fiberglass and its sidings are covered with metal angles to make it sturdier. *Dimensions are shown in figure no.5 to wit:*

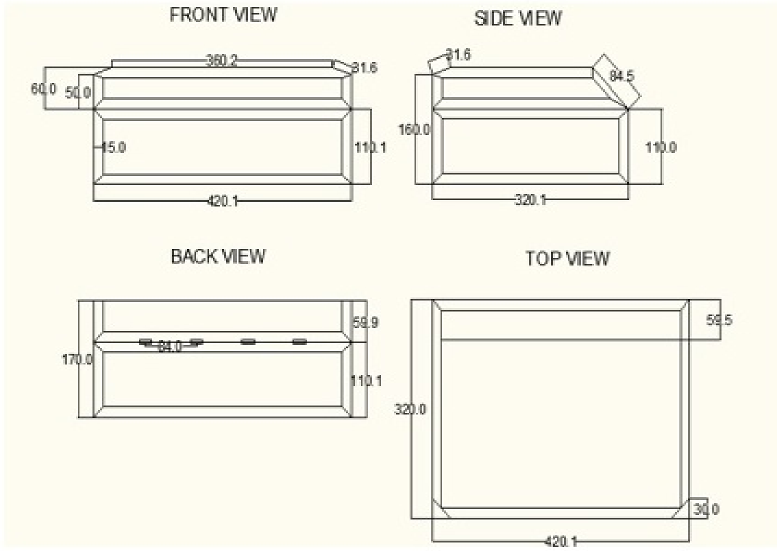


Figure No 5. Dimension of the prototype trainer

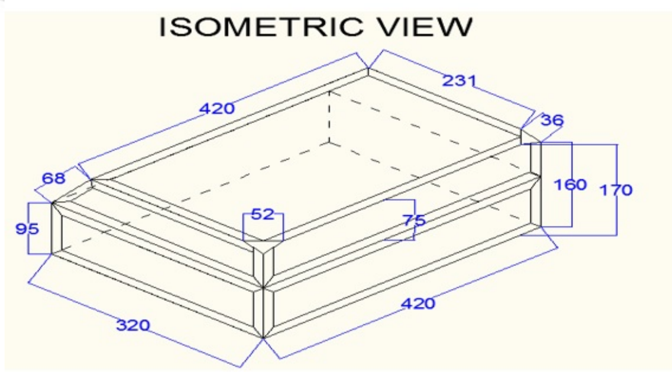


Figure No. 6. Isometric view of the Trainer

Stroke: 0.9843inch(25mm)
Force: 66.2lbs
Operating Pressure: 14.5 to 145psi

5/3 way valve
Double solenoid
Operating Pressure: 3-8 bar
Standard nominal flow rate: 750l/min
Media: Compressed Air

Figure No. 8. Cylinder and Solenoid Valve

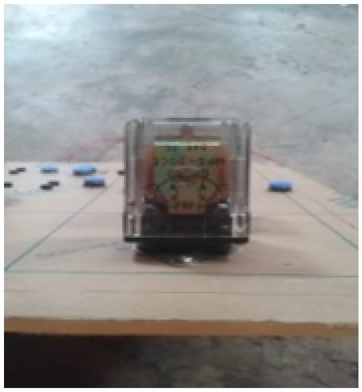
Black and Red color

Figure No.9. Terminal Binding Post

Housing: Cylindrical Thread design
Sensing Range: 8mm
Safe Sensing Range: 6.48
Switching Frequency: 1000 Hz

Sensing range max: 0m – 4m
Type of Light: Visible red light
Light Source: Pinpoint LED
Wavelength: 660nm
Adjustment: Single tech-in button

Figure No.10. Proximity and Retro-Reflective Sensor



Contact voltage: 0 – 220vac
Controlled voltage: 24vdc
2paired auxiliary contact

Coil voltage: 24vdc
Coil resistance: 39.8ohms
Coil Current: 37.7mA
Switching voltage:
250VAC, 125VDC

Figure No.11. Relays

Project Capabilities and Limitations

This phase discusses the capabilities of the whole system as well as the various components in the industrial pneumatic trainer.

System

The capability of this study is to illustrate the pick and place motion by the sequential movement of the actuator. It uses as a trainer for installing the parts and to visualizing the action of what had the PLC programmed. Its capable of illustrating a simulation process in food processing plants wherein cylinders and solenoid valves are used.

Components

- Cylinder- simulates the movement of the pick and place.
- Solenoid valves- is the pneumatic controller through electricity it plays only in open and close switch.
- Relay- a kind of voltage controller, it also plays an open and close switch. The main purpose of relay the project is controlling the actuator and other load component by the command of the PLC.
- Regulator- regulates the air pressure of the trainer.
- Filter- filtrate the moisture and other substance that can cause rusting.
- Sensor- it determine if our cylinder is extended or retracted.

Limitations

- Only for teaching purposes.
- It performed multiple cycle not in infinite.
- Only to perform the task in the program but to programmed.
- It does not use for production system.
- It illustrates a pick and place motion in linear form not in robotic form.

Distinct Parts

- Luggage
- 5/3 Way Directional valve
- Double Solenoid
- Sensors

Project Evaluation

Research design

The researchers designed the pneumatic trainer to have additional instructional material in the school that can be used by the instructor to have more visualization of the topic that we discussed. The trainer was implemented at the lab of Engineering Technology major in Electronics, in which trainer is more demanded because of hands-on activity in the school. It was composed of the following basic parts: Cylinder (actuator), solenoid valve, regulator and filter, relays, power supply, air supply, and terminals with this component it can be used as a normal trainer that can be found in the manufacturer of instructional material. But the researchers had an idea they modify it because we all know that a trainer is a huge one and it has been placed in one area only. So the researchers modified it into a small one that can be carried where ever you go. Also, it has an additional sensor to perform more activities.

Evaluation material

The instrument used by the PBRD researchers to evaluate the pneumatic trainer is Multi Meter. Through the help of these instruments, the PBRD researchers find out that the trainer had functioned well.

Figure No. 12. Multimeter

An electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a micrometer with a moving pointer to display the readings. Below is the physical instrument

Figure No. 13. Pressure Gauge

Instruments used to measure and display pressure in an integral unit. Below is the physical instrument

Results of using Multi Meter and Pressure Gauge Instrument

The ***PBRD*** researcher set the Multimeter in the 50V DC range to measure the power supply output, solenoid valves, relays, and all sensors power input. Table 1 shows the results of the operational testing and procedure of the hard wiring test.

Table 1. Results of Multi Meter

Parts to be Assessed & Evaluated	Results

Power supply output		24V DC
Relays triggering voltage		24V DC
Solenoid Valves triggering voltage		24V DC
Proximity sensor	Output voltage	24V DC
	Triggering voltage	24V DC
Retro-reflective sensor	output voltage	24V DC
	triggering voltage	24V DC

The ***PBRD*** researcher uses the pressure gauge to set the pressure of the air that fits the working pressure of the cylinder. Therefore, it is in the acceptable working condition of the parts. Likewise, Table 2 shows the result of the operational testing and procedure of the pneumatic test favorably likely operating working condition.

Table 2. Results of Pressure Gauge

Parts to be Assessed & Evaluated	Results
Working pressure of the cylinder	145 to 145 psi
Operating pressure of air filter	145 psi (max)
Operating pressure of air regulator	145 psi (max)

Statistical tool

The statistical tool as the language of this PBRD used to evaluate is the Pearson R and Linkert's scale. The PBRD questionnaire is the instrument used in collecting and gathering the statistical data and to be scaled on the five points rating scale. The behavioral data that are being known are also anecdotally and ethnographically recorded in support of the researcher-made instrument consisting of a series of questions (or other types of prompts) for the purpose of gathering legate information from the participants. However, it was standardized to elicit valid and reliable information. Questionnaires are also sharply limited by the fact that the participants must be able to read the questions and respond to them within the prescribed time allotted.

Measuring Scale on Results of the PBRD Questionnaire

The *PBRD* researchers used the *PBRD* questionnaire as the instrument of the research. Below one may see the result of the questionnaire. Table.3 shows the assessment and evaluation rating scale of the *PBRD*.

Table 3. The Evaluation Rating Scales

Adjectival rating	Rank	Numerical Scale Range
Not acceptable at all	1	1.49 – below
Fairly acceptable	2	1.50 – 2.49
Acceptable	3	2.50 – 3.49
Much acceptable	4	3.50 – 4.49
Very much acceptable	5	4.5 - above

Findings 1

In Table.3. shown the PBRD results of the clientele community partners, it states the rating in every question which the project should be evaluated in Table 4 as shown below:

Table 4 PBRD Results from the Community Counterpart Partners

No.1	QUESTIONS	SCALE RATING	ADJECTIVAL RATING
1.	What is your rating on the clarity of the PLC-based Pneumatic Trainer?		
	A	3.93	Much Acceptable
	B	3.96	Much Acceptable
	C	4.06	Much Acceptable
2.	What is your rating on the physical appearance of the PLC-based Pneumatic Trainer?		
	A	3.83	Much Acceptable
	B	4.06	Much Acceptable
3.	What is your rating on the academic impact of the PLC-based pneumatic trainer?		
	A	3.76	Much Acceptable
	B	3.83	Much Acceptable
	C	3.9	Much Acceptable
4.	What is your rating on the accuracy of the PLC-based Pneumatic Trainer?		
	A	3.83	Much Acceptable
	B	3.9	Much Acceptable
	C	4.06	Much Acceptable
5.	What is your rating on the safety measure of the PLC-based Pneumatic Trainer?		
	A	3.93	Much Acceptable
	B	3.93	Much Acceptable
6.	What is your rating on the cost effectiveness of the PLC-based Pneumatic Trainer?		
	A	3.96	Much Acceptable
	B	3.9	Much Acceptable
	What is your rating on the sensitiveness on the environmental stimulus sensor of the PLC-based Pneumatic Trainer		
	A	3.8	Much Acceptable
	B	3.8	Much Acceptable
TOTAL		**4.0**	**Much Acceptable**

So, Table.4. shown the assessment and evaluation on the community counterpart partners of the school were rated below as compared to the rating made by the faculty and students however, the overall rating about the PBRD research is much acceptable.

Findings 2

Table 5 shows the results rating made by the community counterpart partners in the PBRD acceptability Likewise, Table 5 shows the resulting rating made by the faculty and students regarding PBRD research shown Very Much Acceptability as to the clarity, physical appearance, academic impact, accuracy, safety measures, cost-effectiveness and lastly, sensitiveness on the environmental stimulus.

Table 5 PBRD Results from the students and the Faculty

No.	QUESTIONS	SCALE RATING	ADJECTIVAL RATING
1.	What is your rating on the clarity of the PLC-based Pneumatic Trainer?		
	A	4.5	Much Acceptable
	B	5	Very Much Acceptable
	C	4.75	Very Much Acceptable
2.	What is your rating on the physical appearance of the PLC-based Pneumatic Trainer?		
	A	5	Very Much Acceptable
	B	5	Very Much Acceptable
3.	What is your rating on the academic impact of the PLC-based pneumatic trainer?		
	A	4.75	Very Much Acceptable
	B	5	Very Much Acceptable
	C	5	Very Much Acceptable
4.	What is your rating on the accuracy of the PLC-based Pneumatic Trainer?		
	A	4.5	Much Acceptable
	B	4.75	Very Much Acceptable
	C	4.5	Much acceptable
5.	What is your rating on the safety measure of the PLC-based Pneumatic Trainer?		
	A	4.25	Much Acceptable
	B	5	Very Much Acceptable
6.	What is your rating on the cost effectiveness of the PLC-based Pneumatic Trainer?		
	A	5	Very Much Acceptable
	B	5	Very Much Acceptable
	What is your rating on the sensitiveness on the environmental stimulus sensor of the PLC-based Pneumatic Trainer?		
	A	5	Very Much Acceptable
	B	5	Very Much Acceptable
TOTAL		5	Very Much Acceptable

Based on the testing, assessment, and evaluation of the PBRD. The components are functioning properly and can perform various activities using the PLC. But in terms of performing an infinite cycle, the power source cannot keep up the necessary voltage and the results on the assessment and evaluation from the PBRD clientele community counterparts and the faculty and students where its adjectival rating is very much acceptable. Therefore, the Robotic Pneumatic Trainer is useful and acceptable in helping the working personnel in the workplace especially when the demand of work is hazardous.

CONCLUSION AND RECOMMENDATIONS

The PBRD is a miniature model of an industrial facility which mimics and prototypes the actual operations in an industrial setting. This PBRD was put into reality in the hopes of helping future

Engineering students to further broaden their learning in automotive and electronics. Thus in response to the needs of the community counterpart partner of Tagoloan Community College, the college of Engineering initiated this PBRD. It was used to demonstrate the function of the pick and place robotic that is powered by pneumatics and controlled Programmable Logic Controller (PLC) but in a linear formation of the actuator robotic. It performed the individual motion sensor of the actuator which explains the pick and place motion, and since it is a trainer it requires a well-elaborated instruction to be operated optimally through the auto-electro robotic environment stimulus. The trainer's overall performance is very much acceptable. It can perform various activities, and it is accurate in terms of performing the given task. Even though the trainer cannot perform the infinite cycle due to the insufficient power supply, therefore, provide an individual regulator on solenoid valves so that the voltage on the power supply won't dropdown. Provide its own compressor for comfortable usage. Install its own PLC for full usage of the trainer. Provide its own start and stop push button so that it can be independent of the PLC and lastly, bigger luggage and box are to be used for more systematized components and wirings free from auto-electro shock-wave.

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