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Implementation of Professional Development Training for Industrial Employees on Artificial Intelligence of Things

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Abstract: Artificial Intelligence of Things (AIoT) is the most emerging era of a combination of Artificial Intelligence (AI) and the Internet of Things (IoT), which is exponentially gaining researchers' attention with every passing day because of its broad applicability in various sectors. Technology 4.0 in the industry focuses on effective object sorting of conveyors and energy saving. There is an increase in the need for industrial employee training. However, the new technology of conveyor systems to enhance performance has yet to be widespread. However, the new technology of conveyor systems to enhance performance has yet to be widespread. Owing to the learning material for training is expensive. It is also not possible to simulate the operation of a comprehensive system. Industrial employees need to understand the big picture, causing problems in learning and lacking practical skills. Especially new industrial employees may need more knowledge and experience when operating errors; they can have problem-solving skills to seek solutions. Therefore, we proposed the implementation of an object-sorting training kit based on AIoT technology. In the experiment, nineteen industrial employees from many industrial enterprises participated in three days of training activities. The results show increased employee performance with an AIoT training kit that can simulate object sorting with color and size and then offer a dashboard. They can understand how to save energy in manufacturing. Mainly, they have practical skills and positive perceptions toward this study.

Keywords: AIoT, professional development, learning tool, engineering education

1. Background and Motivation

Artificial Intelligence of Things (AIoT) is the most emerging era of a combination of Artificial Intelligence (AI) and the Internet of Things (IoT), which is exponentially gaining researchers' attention with every passing day because of its broad applicability in various sectors (Ishengoma et al. 2022). Especially in the industrial sector many researchers' effort to present new technologies based on AIoT (Matin et al., 2023; Xian et al., 2023; Wang et al., 2022). For example, Nishimura et al. (2021) presented AIoT industrial controllers programming of an industrial automation controller, which features capabilities, virtualization, and open-source software integration while creating the possibility to integrate machine learning models into the automation process. Cheng et al. (2021) proposed an AIoT module that uses AI algorithms to identify objects, calculate locations for items in automated production, and then send the information to the controller in the automation process. Technology 4.0 in the industry focuses on effective object sorting of conveyors and energy saving. There is an increase in the need for professional training for industrial employees (Chookaew & Howimanporn, 2022). However, the new technology of conveyor systems to enhance performance has yet to be widespread. Owing to the learning material for training is expensive. It is also not possible to simulate the operation of a comprehensive system. Industrial employees need to understand the big picture, causing problems in learning and lacking practical skills. Especially new

industrial employees may need more knowledge and experience when operating errors; they can have problem-solving skills to seek solutions. In addition,

Therefore, we proposed the implementation of professional development training for industrial employees with an object-sorting training kit based on an AIoT platform. The significant contributions of the research studies are as follows:

- To develop an AIoT platform for proper AIoT training in the industrial sector.
- To evaluate industrial employee performance after participating in AIoT training.
- To investigate industrial employees' perception toward AIoT training.

2. Development of Artificial Intelligence of Things platform

2.1 AIoT platform

Initially, we designed the prototype of the AIoT platform for use in training activities based on the architecture of AIoT, which is composed of the following four layers:

- Laver 1: The device layer includes various hardware for input and output devices such as load cell, photoelectric sensor, encoder, and DC motor.
- Laver 2: The connectivity layer includes hardware and software that links cloud storage to controllers and sensors such as Omron PLC: NX1P2 that can connect the network via TCT/IP.
- Laver 3: The cloud layer includes data storage and access via Node-Red, an application programming interface (API).
- Laver 4: The user communication layer includes web portals on the monitor and mobile applications.

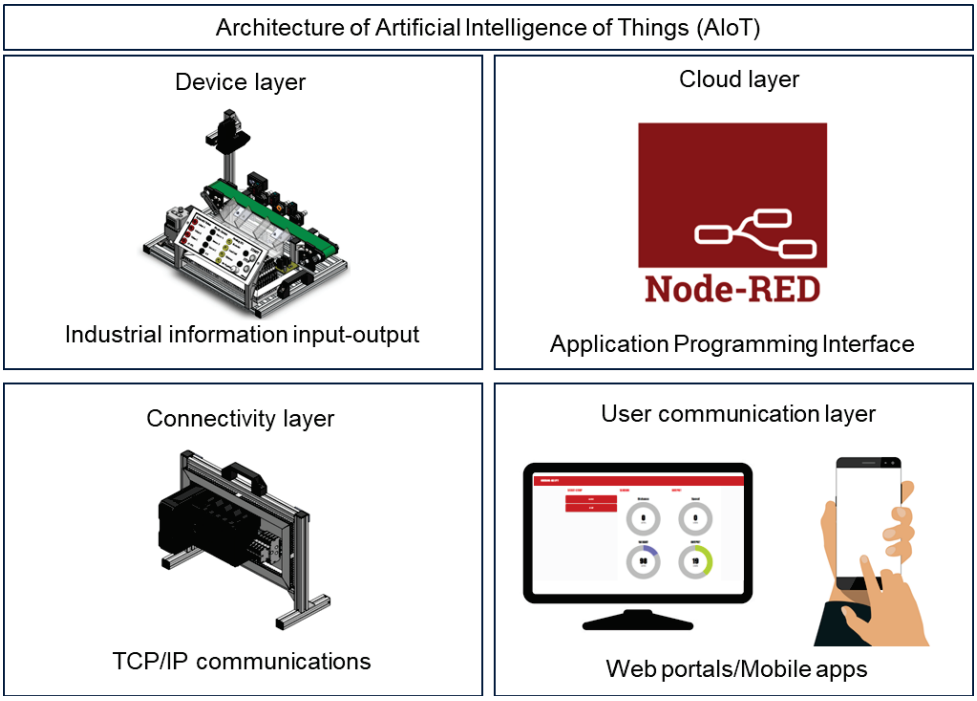


Figure 1. Architecture of AIoT

After, we developed the prototype of the AIoT training kit, as shown in Figure 2 (a), which is the part of the training kit, and Figure 2 (b) is the part of the PLC for the controller. In addition, fuzzy inference is used for energy efficiency experiments to make decisions on wind energy saving with MATLAB (Howimanporn et al.,2021), as shown in Figures 3 (a) and 3 (b).

In addition, the data for processing in this system are three inputs: speed, weight, and distance. We use all input data, the conditions obtained from the rules of data in the MATLAB program, to be written into the PLC device, as shown in Figure 4. (a-c).

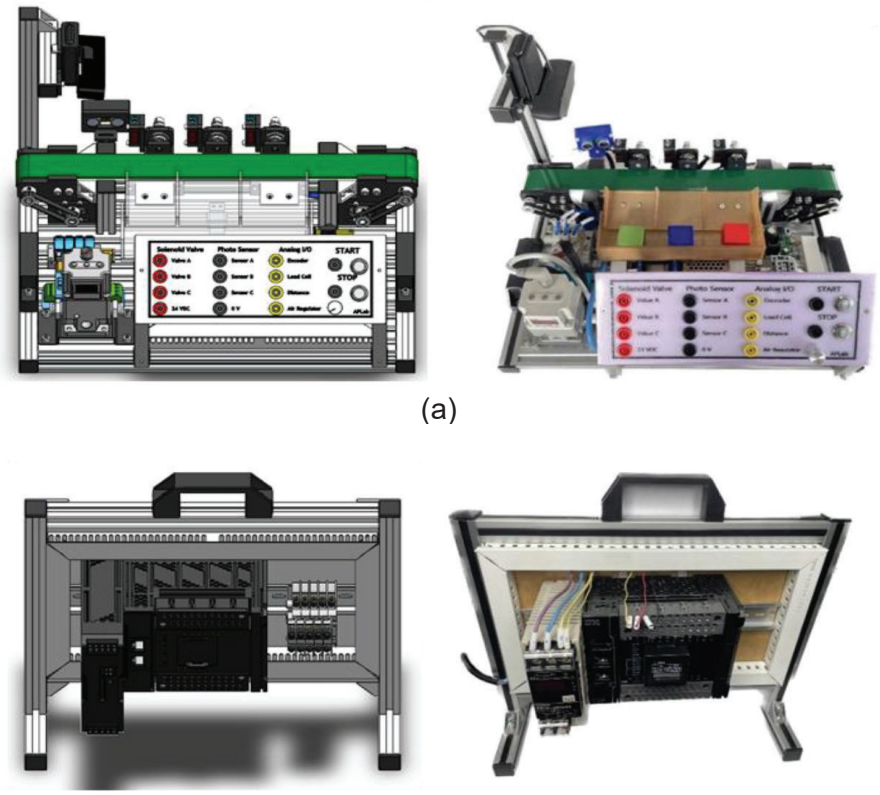
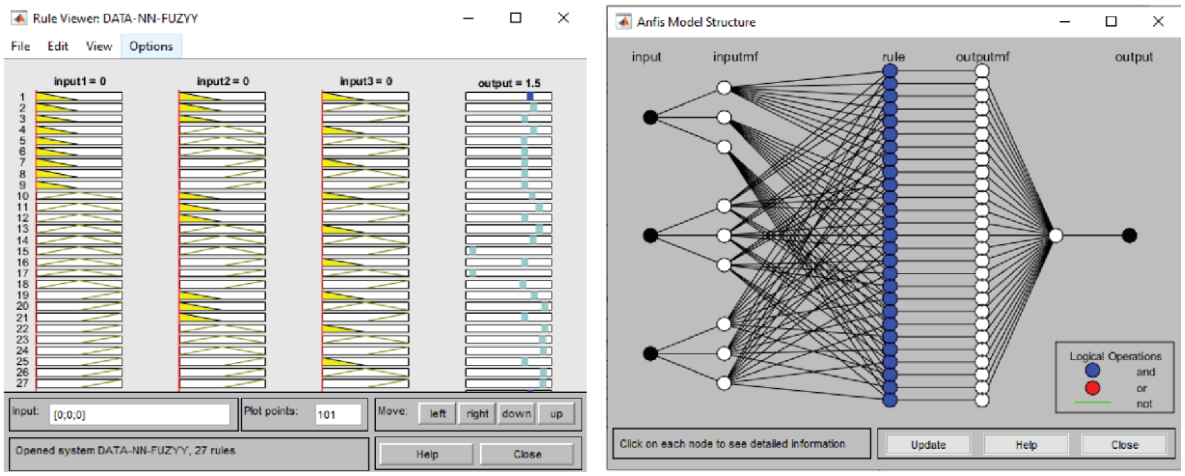


Figure 2. (a) structure of AIoT training kit (b) PLC kit



(a) (b)

Figure 3. (a) and (b) the screenshots of *MATLAB*

```
MF_Speed1:= 0;
MF_Speed2:= 0;
MF_Speed3:= 0;

//MF_Speed1
IF Speed <= 0 THEN
    MF_Speed1:=1;
END_IF;
IF Speed > 0 AND Speed <= 1.6 THEN
    MF_Speed1:=(-0.625*Speed)+1;
END_IF;

//MF_Speed2
IF Speed > 0 AND Speed <= 1.6 THEN
    MF_Speed2:=(0.625*Speed);
END_IF;
IF Speed> 1.6 AND Speed <= 3.2 THEN
    MF_Speed2:=(-0.625*Speed)+2;
END_IF;

//MF_Speed3
IF Speed > 1.6 AND Speed <= 3.2 THEN
    MF_Speed3:= (0.625*Speed)-1;
END_IF;
IF Speed >= 3.2 THEN
    MF_Speed3:=1;
END_IF;
```

(a) speed

```
MF_Weight1:= 0;
MF_Weight2:= 0;
MF_Weight3:= 0;

//MF_Speed1
IF Weight <= 0 THEN
    MF_Weight1:=1;
END_IF;
IF Weight > 0 AND Weight <= 300 THEN
    MF_Weight1:=(-0.003*Weight)+1;
END_IF;

//MF_Speed2
IF Weight > 0 AND Weight <= 300 THEN
    MF_Weight2:=(0.003*Weight);
END_IF;
IF Weight > 300 AND Weight <= 600 THEN
    MF_Weight2:=(-0.003*Weight)+2;
END_IF;

//MF_Speed3
IF Weight > 300 AND Weight <= 600 THEN
    MF_Weight3:= (0.003*Weight)-1;
END_IF;
IF Weight >= 600 THEN
    MF_Weight3:=1;
END_IF;
```

(b) weight

```
MF_Distance1:= 0;
MF_Distance2:= 0;
MF_Distance3:= 0;

//MF_Distance
IF Distance <= 0 THEN
    MF_Distance1:=1;
END_IF;
IF Distance > 0 AND Distance <= 300 THEN
    MF_Distance1:=(-0.003*Distance)+1;
END_IF;

//MF_Speed2
IF Distance > 0 AND Distance <= 300 THEN
    MF_Distance2:=(0.003*Distance);
END_IF;
IF Distance > 300 AND Distance <= 600 THEN
    MF_Distance2:=(-0.003*Distance)+2;
END_IF;

//MF_Speed3
IF Distance > 300 AND Distance <= 600 THEN
    MF_Distance3:= (0.003*Distance)-1;
END_IF;
IF Distance >= 600 THEN
    MF_Distance3:=1;
END_IF;
```

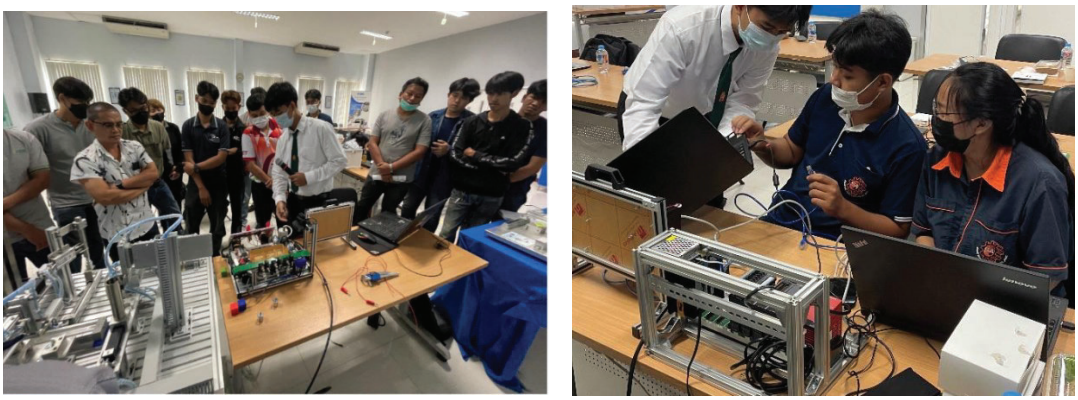
(c) distance

Figure 4. (a) - (c) The PLC algorithm programming based on input data

2.2 Training course

In this study, we have designed the learning activity in three days. These learning activities focus on hands-on learning processes that can support student development of learning outcomes (see Figure 5). We designed the learning outcomes based on four concepts in three days consisting of:

- Day 1: Able to use the computer to connect PLC and to program to control hardware and machine.
- Day 2: Able to display data on the dashboard.
- Day 3: Able to use AI technology for data decision-making to save energy.



(a) (b)

Figure 5. (a) and (b) the AIoT hands-on learning activities for industrial employees.

3. Results

3.1 Results of industrial employees' performance after participating in AIoT training.

Figure 6 shows the results of industrial employees' performance scores after the training experiment. We found that industrial employees have high performance (HP) of more than 80 percent (42 %), middle performance (MP) between 79-60 percent (42%), and low performance (LP) between 69-40 percent (16%). We found that the industrial employees who are low performance need a background in AI concepts, so that is a barrier for them in application.

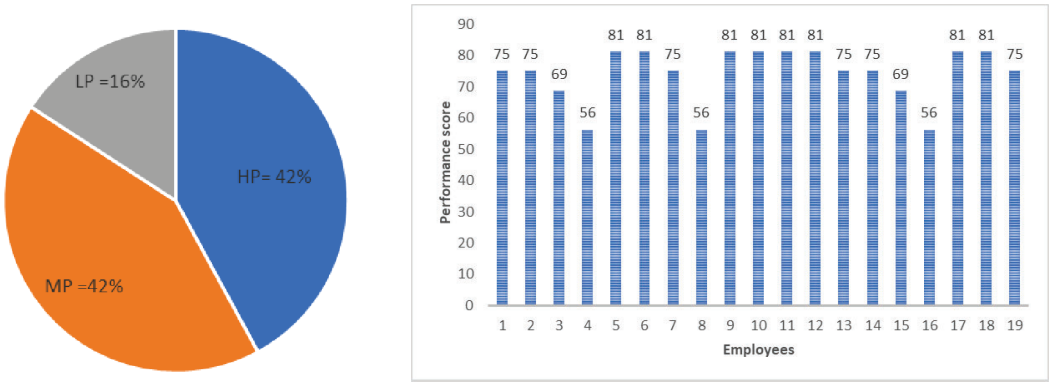


Figure 6. The performance score of industrial employees.

3.2 Results of industrial employees' perception toward AIoT training.

Table 1 shows the results of industrial employees' perception of AIoT training, which shows three dimensions of satisfaction at high levels. In addition, Table 2 showed a positive response to activity. Most employees mention that they like participating in training activities through learning opportunities in new technology for their industrial development.

Table 1. *The industrial employees' satisfaction*

Satisfactions	Mean	SD	Level
Training process	3.88	0.89	High
Training activities	3.67	1.12	High
Training usefulness	3.94	1.04	High

Note: 1.00-1.50 = very low, 1.51-2.00 = low, 2.51-3.50 = moderate, 3.51-4.50 = high, 4.51-5.00 = very high.

Table 2. *The industrial employees' response*

Employees	Responses
No.1	"I wish I had more time to train in new technology. Because I want to have the ability to do my work more, I would like to attend the training again if there is an opportunity."
No.2	"The training kit is very good and can be used for real experiments. Able to apply knowledge to practical use in industrial plants."
No.3	"This training is a new experience that can be applied, and beneficial to work admire the speaker and a good team paying attention to operators."
No.4	"The training set is interesting because it is something new in the industry to reduce energy consumption and use appropriate energy."
No.5	"The training set is diverse and interested in further application of shadows. It is a way to learn more."
No.6	"It is interested in bringing the learning package to develop industrial workers that improve the country's industry further is great."

4. Conclusion

The overview of the proposed professional development training for industrial employees on AIoT is essential to motivate them to improve technology skills it has achieved implementation. The training course proposed an object-sorting training kit based on AIoT technology to promote industrial employees' understanding and practical skills. After training, their improved performance, and positive responses. Thus, this course can be deployed to guideline professional training in the industrial sector. Nevertheless, the limitation of this study is that we explored the industrial employees' performance levels of AIoT and their perception of 19 employees in a few industrial enterprises. This finding may not be generalized to other contexts. Thus, future studies should aim to expand the sample size and include employees from various industrial enterprises.

Acknowledgements

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