THE EMPLOYEE ATTENDANCE SYSTEM DESIGN USING RFID AND FACE RECOGNITION AT PT. METRO PERMATA RAYA

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ABSTRACT

Attendance is one form of employee discipline that also helps to increase motivation in every activity of the company and is one of the professional benchmarks of employees. The purpose of this research is to avoid fraud committed by employees in attendance, avoiding lost or damaged presence data, and facilitating the HRD to process attendance data to avoid mistakes in calculating the amount of Attendance and processing of employee attendance data in charge of three running housing projects. The research method used in this research is descriptive. The method of software development used is a method of the prototype with the communication process, quick plan, modeling quick design, construction of prototype and development delivery and feedback. From the results of the tests that have been done, the system can prevent the occurrence of cheating in the employee attendance process because the attendance process can be done only by the employee itself using the own RFID and facial recognition based on Nip. The employee attendance system can also help the HRD to minimize the error in the recapitulation of the attendance report. The results of attendance testing showed that RFID card S50 and RFID Reader RC-522 with a frequency of 13.56 MHz can be detected with a maximum distance of 2cm, and testing the accuracy of facial recognition using three face training data has a level Highest accuracy rate of 90.2%.

Keywords: Attendance, Employee, Face Recognition, Eigenface

1. INTRODUCTION

Attendance is one form of employee discipline that also helps to increase motivation in every activity of the company, Attendance is also one of the professional benchmarks of employees [1]. The company uses attendance to calculate the list of present employees of the company.

At PT Metro Permata Raya still, use an attendance system in the form of attendance check-lock and attendance card. The obstacles experienced in using this tool is not able to detect the cheating of employees in attendance process using absent to his friend, this will certainly give the data that is not suitable to the company and employees can come and Not at the designated hour [2]. At PT Metro Permata Raya There are 1 to 5 employees who are cheating in the attendance process, and for a month there is an average of 10% of the attendance process that is done by entrusting the friend. PT Metro Permata Raya which suffered damage or loss of attendance card between 1 to 10 pieces in a year or there is 3% of the number of attendance cards for a year lost or damaged, therefore the company must reconfirm to the Employee to complete the damaged or missing attendance data. The process of calculating employee attendance data that is done manually has many shortcomings, such as mistakes in entering employee attendance data and lack of efficiency and effectiveness in the processing of attendance data. Processing attendance data of employees of PT Metro Permata Raya who served in 3 different project offices require management at the head office to ask for employee attendance data in each project, it causes lack of Time efficiency in processing attendance data.

To avoid the occurrence of mistakes or fraud collection of employee attendance, on the final task is made an attendance system by utilizing RFID technology as input data employee attendance and use facial recognition to force Employees who conduct fraud in order to act honestly in the absence of attendance, so that the attendance data will correspond with the actual admission hours and hours of the employee. Data collection is done automatically by using Raspberry-Pi that is connected to the WiFi modem so that the data can be integrated online with a database on the Web server, so when employees do attendance process, the data will go to Databases and data can be processed on the web to facilitate the recapitulation of employee attendance data.

The objectives that will be achieved in this study include:

1. Avoid cheating by employees in the attendance process.
2. Avoiding lost or damaged employee attendance data
3. Facilitate the HRD in the processing of employee attendance data to avoid mistakes in calculating

the number of employee attendance and processing of attendance data of employees in charge of 3 housing projects in progress.

2. FOUNDATION THEORY

2.1 Internet of Things

The Internet of Things (IoT) is a technology that allows the control, communication, and collaboration between various types of hardware over the Internet, IoT emerged as a form of change and development of information and network technologies. IoT is not only about the remote control, but IoT is also related to how processes for data sharing, virtualizing everything on the Internet and other forms [3].

2.2 Raspberry Pi

Raspberry Pi is a small computer and has 2 models namely Model A and Model B. The main function of Raspberry Pi is as a computer that allows browsing, create Lapran, presentation, play games, or just listen Music and watching movies. Raspberry Pi uses Python as its official programming language [4]. Raspberry Pi does not require large electrical energy to operate. We can power the electrical power with a computer in the house that needs electrical power starting from 200 watts [5]. Images from the Raspberry Pi board can be viewed in Figure 1. Raspberry Pi 3 Model B.

Figure 1. Raspberry Pi 3 Model B

2.3 RFID

RFID (Radio Frequency Identification) is a digital technology in the form of tag and reader based on the wireless network (Radio wave) for the data transfer process, object identification and other electronic information [6]. The RFID system consists of four components, such as can be seen in Figure 2. RFID system[7].

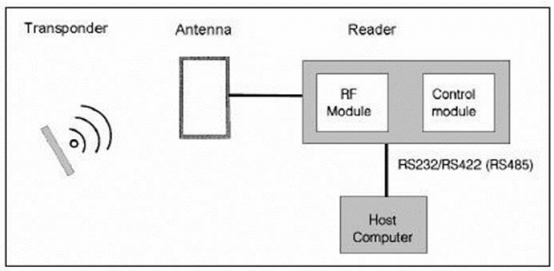

Figure 2. RFID system

2.4 Face recognition

Face recognition is a computer or mobile application where the app runs automatically to identify or verify someone from a digital image sourced from a video. Facial recognition is divided into 2 types, namely the future based system and image-based system. In a future based system use the extracted features of the face components (eyes, nose, mouth, etc.) which are then connected and modeled geometrically. While the image-based system uses raw information from the image pixels represented in certain methods, such as the principal component analysis (PCA), the wavelet transform is then used for the classification of imagery [8].

2.5 Eigenface Algorithm

Eigenface is a collection of eigenvector used for computer vision on human face recognition, taken from statistical analyses of many facial images. Eigenface is one of the facial recognition algorithms based on the Principal Component Analysis (PCA) developed at MIT. Overall the algorithm is quite simple, the training image is represented in a vector combination merged into a single matrix [8].

The eigenface algorithm starts with a column matrix of the face that is included in the database. The average vector image (mean) of a column matrix is calculated by dividing the number of images stored in the database. To generate the Eigenface value a set of digital imagery from a human face is taken at the same lighting condition and then normalized and processed at the same resolution e.g. (M x N).

3. RESEARCH METHODS

The research method used in this research is descriptive. A descriptive research method is a method aimed at making descriptions or representations in researching an object, a set of conditions, a system of thought, or a class of events at present [9].

1.1 Metode Prototype

The method used in the development of this software is a method of the prototype because in the creation of the attendance system is very high user engagement so that the system can comply with the needs of users [10]. The following processes are as follows:

a. Communication

In the Communication phase, we analyze the needs of the system by collecting the data by conducting interviews with PT Metro Permata Raya, as well as collecting additional data on both journals and books.

b. Quick Plan

This stage is the advanced stage of the Communication Process. At this stage generated data relating to the user's wishes in the development of the system, namely an attendance system using RFID that can avoid the cheating by employees, and can process

attendance data from All branches of the project online.

c. Modeling Quick Design

At this stage of modeling began to conduct a system design according to the needs of PT Metro Permata Raya which can be estimated before the coding process. The modeling process is done by designing data structures, software architecture, interface representation, and unified Modeling Language (UML).

d. Construction of prototype

After the modeling stage, next is the Construction stage. At this stage start coding the Web build according to the design at the modeling stage, coding the Raspberry pi to set the function on the RFID Reader as a tool for the attendance process, inserting a facial recognition algorithm By using the camera, as well as connecting the Raspberry pi to the Internet so that data can be integrated online with a Web server. After the encoding is completed, testing of the system that has been built. The purpose of testing is to find errors against the system to be repaired.

e. Deployment Delivery & Feedback

This stage can be said to be final in making a system. After conducting analysis, design, and coding, the finished system will be used by the user. Then the system that has been built maintenance periodically.

The prototype model depiction can be seen in Figure 3. Prototype Model.

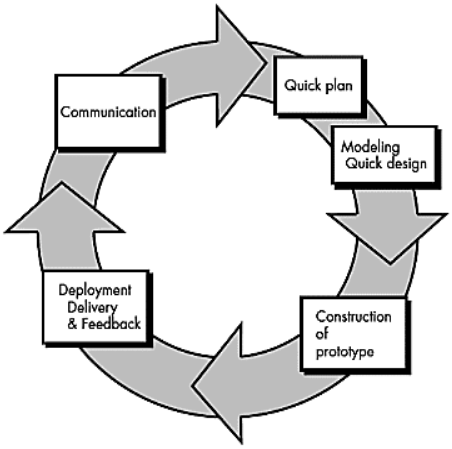

Figure 3. Prototype Model

4. ANALYSIS AND PLANNING

4.1 Problem analysis

The attendance process at PT Metro Permata Raya is currently still using the attendance system in the form of check-lock attendance and attendance card. The obstacles experienced in using this tool are as follows:

1. The attendance check-lock tool can not detect the cheating of employees in the attendance process using absent from his friend. At PT Metro Permata Raya There are 1 to 5 employees who are cheating in attendance process, and for a month there is an average of 10% of attendance process performed by employees by entrusting his friend.
2. Attendance cards are used to perform a sheet of paper that allows tears or damage if exposed to water, even lost. At PT Metro Permata Raya, the damage or loss of attendance card between 1 to 10 pieces in a year, or as much as 3% of the number of attendance cards for a year lost or damaged, therefore the company must re-confirm to the employee to complete the damaged or missing attendance data.
3. Lack of time efficiency in processing attendance data because the process of calculating employee attendance data is done manually by calculating attendance data on the attendance cards, then the presence data is typed on the computer. In addition, the head office should ask for employee attendance data in 3 ongoing projects.

4.2 Analysis of ongoing procedures

Based on the results of observations and interviews with the HRD parties are obtained the following procedures:

1. Employee Attendance procedure

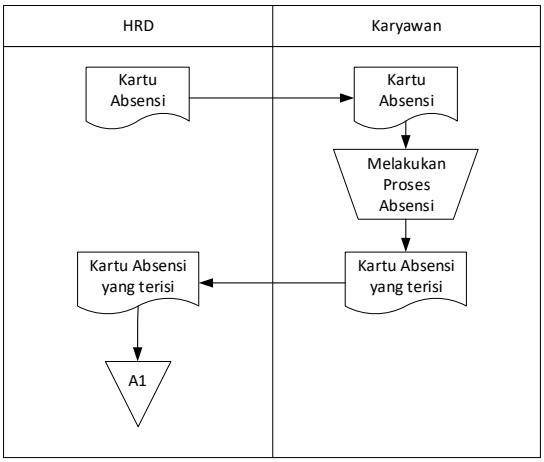

Figure 4. Employee Attendance procedure

4.3 Analysis of new procedures

1. New procedure Attendance Process

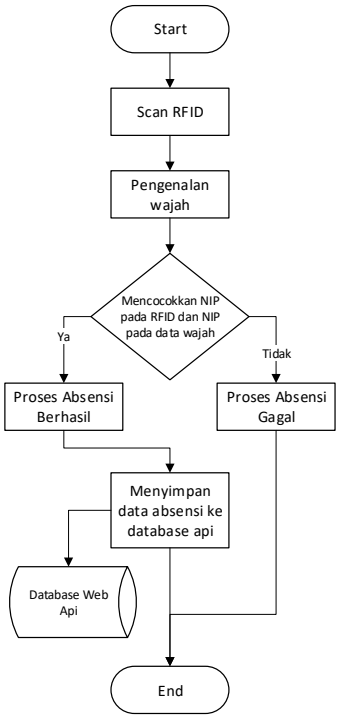

Figure 5. New procedure Attendance Process

4.4 Algorithm analysis

The algorithm of the attendance system to do the attendance process is as follows:

1. RFID Scan
2. RFID reader on Raspberry Pi will read the RFID and NIP Id
3. Facial recognition process, face recognition process will match the face of the Raspberry Pi video camera with the face training data that has been stored if the data found it will be obtained NIP according to the data face.
4. NIP of the results of facial recognition will be matched with NIP on the RFID, if NIP the same then the attendance process succeeded if the NIP is not the same then the process of attendance failed.
5. If the absence process succeeds, the system will create a TXT file containing the JSON code as a backup of attendance data of the new employee who did the attendance process.
6. The system calls the backup JSON file which contains the date and time attendance data based on the NIP to be sent to the server and stored into the database.

4.5 Facial recognition procedure

1. Convert RGB image to grayscale

The phase of transforming the RGB image into a grayscale image aims to simplify the image model. The three layers contained in the color image, Red, Green, and Blue are converted into one grayscale layer. To change the color image that has the values of the individual R, G, and B become grayscale image by dividing the number of the three layers, with the equation below:

$$f_0(x,y) = \frac{f_i^R(x,y) + f_i^G(x,y) + f_i^B(x,y)}{3} \qquad (1)$$

For example suppose we have a face image with a size of 30x30 pixels with RGB values can be seen in Figure 6. A 30x30 pixel RGB face image.

Figure 6. 30x30 pixel RGB face image

The matrix obtained from a 30x30 pixel RGB face image above is as follows :

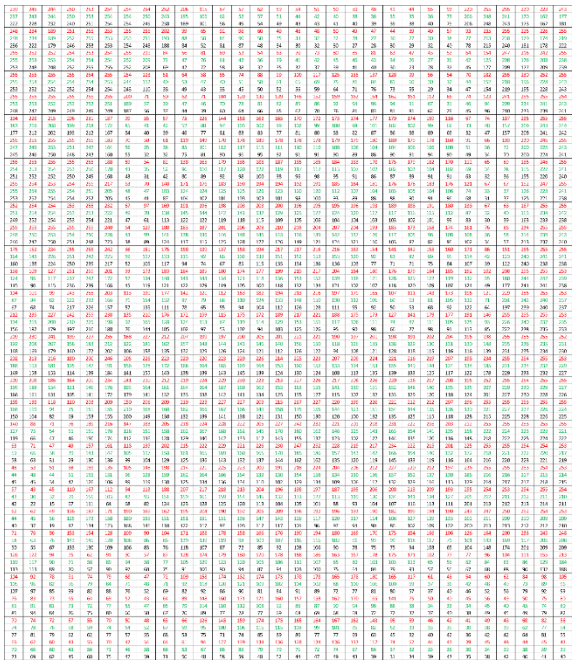

Figure 7. 30x30 pixel RGB face image matrix

For RGB color conversion above to grayscale using the following equation :

$$f_0(0,0) = \frac{239 + 237 + 222}{3} = 232{,}67$$

$$f_0(0,1) = \frac{245 + 243 + 228}{3} = 238{,}67$$

$$f_0(0,2) = \frac{244 + 244 + 232}{3} = 240$$

$$\downarrow$$

$$f_0(29,29) = \frac{43 + 39 + 40}{3} = 40{,}67$$

Calculate each RGB pixel with the equation above from the pixel (0.0) to the last pixel, then round the result of the calculation above if the result is decimal,

it will form the grayscale image and the grayscale image matrix as follows:

Figure 8. 30x30 pixel grayscale face image

And the matrix of grayscale face image above is as follows:

233	239	240	247	252	254	254	251	244	197	107	62	53	58	53	47	45	44	43	42	38	39	44	80	211	250	246	188	184	200
244	230	186	250	254	253	254	251	194	90	58	86	92	53	39	37	37	37	35	34	35	32	37	45	83	221	244	195	193	232
254	251	251	253	254	254	253	212	75	48	76	63	44	41	46	49	51	55	57	55	42	32	33	42	50	135	221	190	220	244
254	254	254	254	254	254	247	115	43	55	49	43	57	65	71	77	82	88	96	99	94	71	38	40	54	163	231	207	236	247
252	252	252	252	252	252	192	61	42	51	52	78	87	92	95	99	103	109	112	114	112	108	80	42	55	104	220	241	245	246
185	220	208	199	220	175	89	45	46	58	97	107	115	116	114	118	117	119	118	122	122	121	116	83	44	56	167	217	246	247
249	250	253	251	248	169	60	39	44	93	110	124	130	130	127	126	126	126	125	124	125	125	126	117	64	45	82	210	232	246
253	253	254	253	251	175	48	40	59	105	121	129	134	137	135	133	133	131	127	122	121	124	126	121	81	44	48	165	229	245
254	253	254	254	253	209	52	53	110	133	134	136	139	141	139	137	137	130	127	124	122	124	126	126	88	44	47	134	230	245
251	253	254	253	254	225	54	76	137	153	154	153	154	152	146	142	143	141	140	138	136	135	136	130	103	43	49	171	241	245
250	251	253	253	251	230	48	106	148	146	146	157	161	160	160	153	155	158	154	143	134	123	115	126	124	49	67	220	244	246
166	144	228	252	245	227	66	124	142	122	102	97	115	147	168	168	168	168	135	108	98	98	106	113	131	56	132	245	245	245
126	98	120	241	245	180	65	142	148	149	152	144	133	132	151	167	168	155	135	136	141	143	138	137	149	69	188	247	246	243
86	84	85	227	238	175	80	163	140	106	88	78	122	137	146	162	165	146	129	121	72	76	97	123	150	85	209	245	245	242
187	211	202	216	232	208	101	173	136	133	123	78	132	127	140	165	166	133	124	127	89	102	129	124	143	108	234	244	242	240
183	202	209	166	194	223	132	189	170	165	159	156	156	157	151	168	164	134	144	152	155	146	149	150	147	162	240	242	241	238
180	188	183	143	162	207	167	186	179	175	174	177	181	176	164	172	166	149	152	171	172	166	163	153	151	199	238	240	240	236
190	186	157	130	163	194	204	172	168	172	175	179	180	173	164	175	169	158	148	170	168	164	159	154	151	220	237	238	237	236
168	120	98	85	169	173	220	174	166	171	176	178	177	160	168	187	171	161	141	170	170	160	154	154	154	230	236	236	236	235
129	76	57	58	163	189	126	157	164	170	177	179	172	156	180	192	177	163	143	161	179	170	159	151	173	232	234	234	234	233
60	67	39	39	143	148	107	120	163	167	174	180	171	176	181	198	200	173	161	159	182	170	158	150	187	230	232	233	232	230
46	49	43	57	147	124	97	132	162	167	173	176	174	150	141	167	172	149	147	153	172	167	155	147	200	228	229	229	229	227
47	32	31	92	145	93	81	96	154	163	169	167	162	154	144	145	142	129	136	147	150	157	152	144	220	226	225	226	227	225
49	48	35	119	165	151	179	157	134	156	157	139	144	157	156	141	135	138	135	131	123	143	144	148	215	224	224	225	225	224
60	65	76	143	143	119	108	86	89	143	145	128	109	118	125	136	139	124	113	113	116	132	129	81	110	152	181	210	220	222
119	117	91	72	59	90	94	58	80	108	134	131	131	121	126	134	131	108	100	122	119	126	75	63	69	89	92	96	139	195
105	95	82	95	78	84	72	49	71	94	123	127	131	121	120	124	123	108	118	122	115	81	45	41	47	53	56	79	93	100
81	89	79	71	70	75	56	47	65	79	117	116	120	119	107	104	105	107	111	112	100	48	40	38	39	50	45	48	76	81
74	78	76	59	59	74	54	52	66	59	99	105	113	125	126	116	113	115	109	96	64	41	40	40	36	43	43	65	80	55
70	66	61	44	57	72	45	57	68	55	70	90	95	87	89	81	84	86	81	69	47	39	39	41	35	39	43	41	42	41

Figure 9. 30x30 pixel grayscale face image matrix

2. Eigenface algorithm

Eigenface consists of an eigenvector set representing the characteristics of a saved face image. Eigenface was first developed by Mathew Turk and Alex Pentland from Vision and Modelling Group, The Media Laboratory, Massachusetts Institute of Technology.

Each face image is the same size as 112x92 pixel, then the resulting matrix set is 112x92. Thus acquired a set of facial imagery in the form of matrices.

Supposing there is a face image I = {I1, I2, I3... The Im} that every 3x3 face image is transformed into a 9x1 column vector of Γi.

Supposing there is a face image **I = {I_1, I_2, I_3... I_m}** that every 3x3 face image is transformed into a 9x1 column vector of $\mathbf{\Gamma}_i$.

The stages of the PCA method for calculating eigenface are as follows:

1. Prepare training data by creating a set of S consisting of all training data.

$$S = (\Gamma_1, \Gamma_2, \ldots, \Gamma_M) \qquad (2)$$

2. 2. Calculate the average face image of the training data.

$$\Psi = \frac{1}{M}\sum_{n=1}^{M} \Gamma_n \qquad (3)$$

The average facial image describes the characteristics of the same face, e.g. position of the nose and mouth eyes.

3. Calculate the difference of each face image is reduced by the average face image.

$$\phi_i = \Gamma_i - \Psi \qquad (4)$$

where i = 1,2,3,…,M. This process removes the same traits on each face image.

By removing the same characteristics of each face image, it will be obtained matrix with a large variety.

4. Calculate the Matrix Covariant

$$C = \frac{1}{M}\sum_{n=1}^{M} \phi_n \phi_n^T = AA^T \qquad (5)$$

The Covariant matrix is used to compare each face image with other imagery contained in the training data.

5. Calculate eigenvalue (λ) and eigenvector (v) of the matrix covariant (C)

$$C\, v_i = \lambda_i\, v_i \qquad (6)$$

6. After eigenvector (v) is obtained, then calculate Eigenface (μ)

$$\mu_i = \sum_{k=1}^{M} v_{ik}\, \phi_k \qquad (7)$$

Facial recognition Stage

Apply the way at the first stage on the Eigenface calculation to get the Eigen value from the new face image

$$\mu_{new} = v\,(\Gamma_{new} - \Psi) \qquad (8)$$

$$\Omega = [\mu_1, \mu_2, \mu_{3,\ldots}, \mu_M] \qquad (9)$$

Use the Euclidean distance method to find the shortest distance between the Eigen value of the training image data and the new face image.

$$\varepsilon_k = ||\Omega - \Omega_k|| \qquad (10)$$

4.6 System Architecture Analysis

Analysis of system architecture is a process to describe the physical system to be built, here is the architecture of employee attendance system:

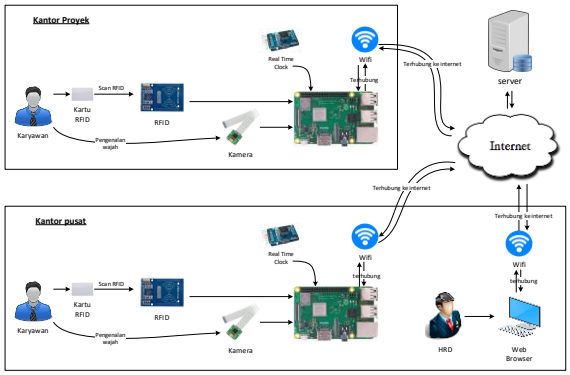

Figure 10. Employee Attendance System Architecture

4.7 Data Communication Analysis

Data communication is a very important part, if not using data communication, then the attendance system is not able to run according to the needs. Data communication used in this attendance system is using TCP/IP with data packet transmitted using the POST method, while data request using the GET method. Data communication that occurs consists of the transmission of RFID data, request for employee ID and delivery of employee attendance data.

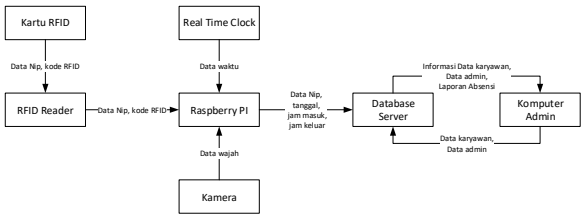

Figure 11. Data communication flows

4.8 UseCase diagram

UseCase diagram is modeling to define the functional and operational needs of the system by defining the use scenario of the system to be built. From the results of the analysis of existing applications, UseCase diagram for employee attendance system is divided into two, namely UseCase on Web API and UseCase on the employee attendance tool as follows :

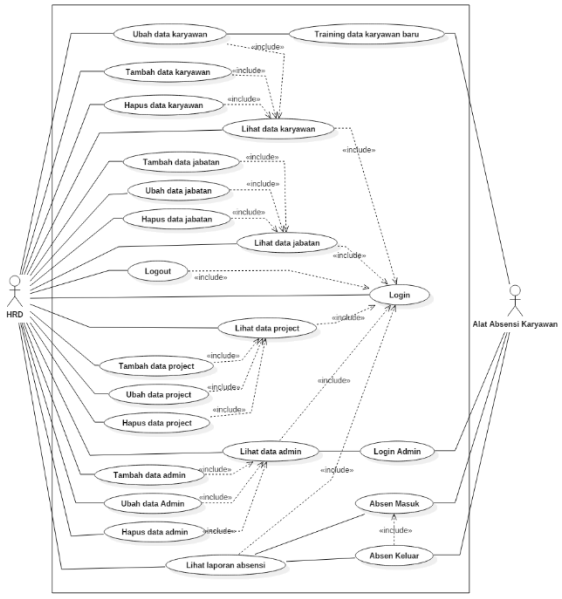

Figure 12. UseCase Web API diagram

On the Web API, HRD login to log in to the application, after the HRD has successfully logged in, HRD can see attendance data, processing employee data such as adding new employee data, changing employee data and deleting employee data and processing admin data. HRD can also print employee attendance data reports.

Before employees can perform the attendance process, HRD add employee data and fill the RFID number with RFID training of employees as well as employees conducting employee face training on attendance device.

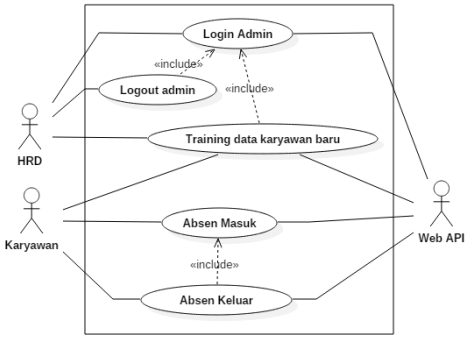

Figure 13. UseCase the Employee Attendance tool diagram

4.10 Relationship schemes

The relationship scheme is an overview of the relationships between the data, its meaning, and its boundaries are explained by rows and columns. Here is the relationship scheme for employee attendance system:

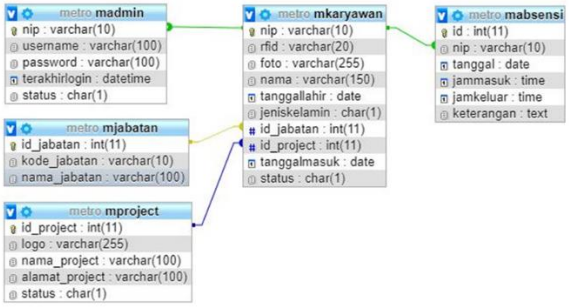

Figure 14. Employee Attendance System Relationship Scheme

5. RESULTS AND DISCUSSION

5.1 RFID Scan Distance Testing

Here are the results of the testing distance of RFID scan with RFID type S50 and RFID reader RC-522 with a frequency of 13.56 MHz.

Table 1. RFID Scan Distance Test results

No	Id RFID	Distance	Result
1	920026325140	0 cm	Detected
2	920026325140	0,5 cm	Detected
3	920026325140	1 cm	Detected
4	920026325140	1,5 cm	Detected
5	920026325140	2 cm	Detected
6	920026325140	2,5 cm	Undetectable

Based on the results of the test of the RFID scan distance in the Table 4.16 indicates that the RFID S50 type card can be detected on the RFID reader RC-522 at a maximum distance of 2 cm.

4.2 Facial recognition Accuracy Testing

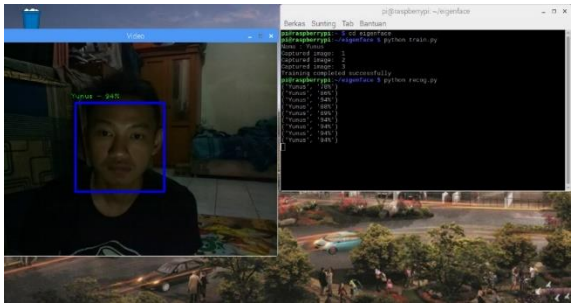

Figure 15. Testing facial recognition accuracy with 3 data training

Table 2. Results of face recognition accuracy test with 3 data training

No	Test iterations	Status	Accuracy percentage
1	1st Iteration	Detected	78%
2	2nd Iteration	Detected	86%
3	3rd Iteration	Detected	94%
4	4th Iteration	Detected	88%
5	5th Iteration	Detected	89%
6	6th Iteration	Detected	94%
7	7th Iteration	Detected	94%
8	8th Iteration	Detected	94%
9	9th Iteration	Detected	94%
10	10th Iteration	Detected	91%
Average percentage			90,2%

Figure 16. Testing facial recognition accuracy with 5 data training

Table 3. Results of face recognition accuracy test with 5 data training

No	Test iterations	Status	Accuracy percentage
1	1st Iteration	Detected	88%
2	2nd Iteration	Detected	90%
3	3rd Iteration	Detected	93%
4	4th Iteration	Detected	91%
5	5th Iteration	Detected	93%
6	6th Iteration	Detected	90%
7	7th Iteration	Detected	89%
8	8th Iteration	Detected	85%
9	9th Iteration	Detected	85%
10	10th Iteration	Detected	90%
Average percentage			89,4%

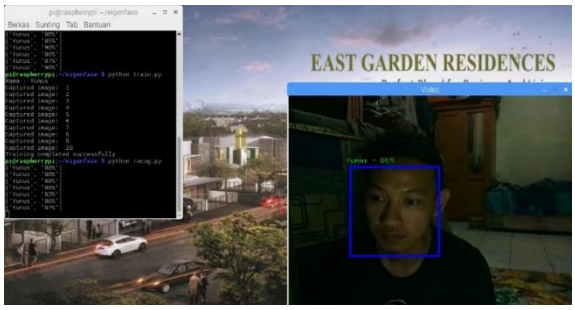

Figure 17. Testing facial recognition accuracy with 10 data training

Table 4. Results of face recognition accuracy test with 10 data training

No	Test iterations	Status	Accuracy percentage
1	1st Iteration	Detected	88%
2	2nd Iteration	Detected	88%
3	3rd Iteration	Detected	88%
4	4th Iteration	Detected	88%
5	5th Iteration	Detected	83%
6	6th Iteration	Detected	86%
7	7th Iteration	Detected	89%
8	8th Iteration	Detected	87%
9	9th Iteration	Detected	89%
10	10th Iteration	Detected	88%
Average percentage			87,4%

From the above accuracy testing showed that the average percentage for testing with 3 training data was 90.2%, testing with 5 training data was 89.4%, and testing with 10 training data was 87.4%. Based on the results of the test, the highest average accuracy is to use three data training of the face.

4.3 Attendance testing at Attendance system

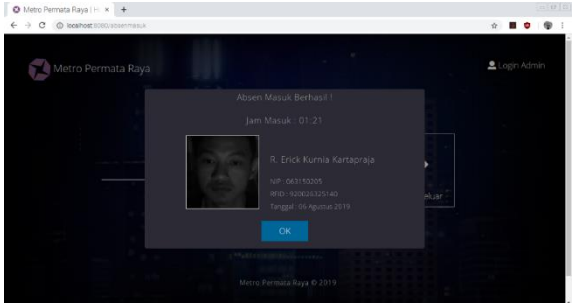

Figure 18. Testing absent entry

Table 5. Test results of the absent entry

No	Id RFID	NIP	Status
1	920026325140	063150205	Successful
2	920026325140	063150205	Successful
3	920026325140	063150205	Successful
4	920026325140	063150205	Successful
5	920026325140	063150205	Successful
6	920026325140	063150205	Successful
7	920026325140	063150205	Successful
8	920026325140	063150205	Successful

No	Id RFID	NIP	Status
9	920026325140	063150205	Successful
10	920026325140	063150205	Successful
Successful Percentage			100%

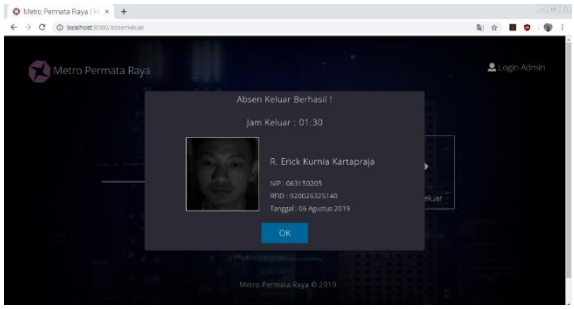

Figure 19. Testing absent out

Table 6. Test results off the absent out

No	Id RFID	NIP	Status
1	920026325140	063150205	Successful
2	920026325140	063150205	Successful
3	920026325140	063150205	Successful
4	920026325140	063150205	Successful
5	920026325140	063150205	Successful
6	920026325140	063150205	Successful
7	920026325140	063150205	Successful
8	920026325140	063150205	Successful
9	920026325140	063150205	Successful
10	920026325140	063150205	Successful
Persentasi Berhasil			100%

6. CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the research results and test results conducted in this final task can be concluded as follows:

1. The system can prevent the occurrence of fraud in the employee attendance process because the attendance process can be done only by the employee itself by using a proprietary RFID and facial recognition based on NIP. The employee attendance system can also help the HRD to minimize the error in the recapitulation of the attendance report.
2. The test results indicate that the RFID card S50 and RFID Reader RC-522 with a frequency of 13.56 MHz can be detected with a maximum distance of 2cm, and testing the accuracy of facial recognition using 3 data training face has an average level the highest accuracy of 90.2%.

5.2 Suggestion

An employee attendance system that built need development to improve and add features in performing attendance process, some advice that can be used for guidance in the development of the attendance system of this employee is as follows:

1. We recommend that this system is integrated with a personnel information system for attendance data that results from the employee attendance system can be authorized.
2. To improve the results of facial recognition accuracy better, we recommend using a camera with better quality and using the camera light.

BIBLIOGRAPHI

[1] U. Rahardja, O. Sholeh, and F. Nursetianingsih, "Penggunaan Dashboard Untuk Mengontrol Kinerja Profesionalisme Pegawai Pada Pt . Sinarmas Land Property," no. ISSN : 2302-3805, pp. 6–8, 2015.

[2] A. C. Karyawan *et al.*, "Aplikasi Data Mining Market Basket Analysis Pada Tabel Data Absensi Elektronik Untuk Mendeteksi Kecurangan," pp. 119–129.

[3] M. H. Asghar, A. Negi, and N. Mohammadzadeh, "Principle application and vision in Internet of Things (IoT)," in *International Conference on Computing, Communication and Automation, ICCCA 2015*, 2015.

[4] Rakhman, *Raspberry Pi Mikrokontroller Mungil yang Serba Bisa*. Yogyakarta: Andi, 2014.

[5] A. Dinata, *Physical Computing dengan Raspberry Pi*. Jakarta: Elex Media Komputindo, 2017.

[6] P. A. E. Pratama and S. Suakanto, *Wireless Sensor Network*. Bandung: Informatika Bandung, 2015.

[7] Aris, I. Mubarak, W. Yuliardi, A. Ramadhan, and A. Permana, "Desain Aplikasi Sistem Informasi Absensi Karyawan dengan Radio Frequency Identification (RFID) pada PT. Skyputra Pancasurya," in *Seminar Nasional Teknologi Informasi dan Multimedia 2015*, 2015.

[8] H. Al Fatta, *Rekayasa Sistem Pengenalan Wajah*. Yogyakarta: Andi, 2009.

[9] M. Nazir, *Metode Penelitian*. Bogor: Ghalia Indonesia, 2017.

[10] D. Hirawan and P. Sidik, "Prototype Emission Testing Tools for L3 Category Vehicle," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 407, no. 1, p. 012099, Sep. 2018.