



Arduino Based Automatic Door Lock Design Using Personal Identification Number Pin

Anton¹, Sri Mujiyono¹

¹Informatics, Ngudi Waluyo University

*Corresponding Author: Anton

Email: anton221198@gmail.com



Article Info

Article history:

Received 09 August 2024

Received in revised form 05
September 2024

Accepted 28 September 2024

Keywords:

Door Locks

Pins

Arduino IDE Development
Applications

Abstract

Current developments require more innovation in everyday life, one of which is home or office door security. Initially, home or office door security was only with ordinary padlocks or door keys found in most houses in Indonesia which had shortcomings in terms of security and effectiveness. In the current era of digitalization, almost every line of human activity is no exception, technology is currently continuously developing more rapidly. This can be observed through the many sophisticated equipment that utilizes technology so that the work system can run automatically. Of course, this makes it much easier for someone to carry out their activities and the work they do is also more efficient. This research aims to design a door lock system that is able to increase security, effectiveness and comfort in accessing rooms, both home and office. This system utilizes an Arduino microcontroller as the brain of the system, a keypad as input for entering the PIN code. Users are allowed to open the door simply by entering a predetermined PIN code. The main advantage of this system is its ease of use and a better level of security compared to conventional door locks. The results of this research are a pin-based door lock system using Arduino and keypad. This system uses the Arduino IDE development application for writing program code and Proteus for work simulation.

Introduction

Currently, there are many jobs that are done using computerization or automation. One example is the use of technology to open or close doors automatically. Often this is used for large doors to make it easier because it definitely requires more power when done manually. Therefore, based on this explanation, a tool will be created that is able to operate the door automatically, both opening and closing it. The use of automatic locks or digital keys for property owners is quite important (Lontoh et al., 2017). Because houses, buildings and various places that store many valuable assets certainly require extra security. Digital lock technology offers an automatic door lock system that provides multiple levels of security. Implementing a digital lock system is one of the best ways to secure valuable items from various unwanted possibilities (Adkins et al., 2020). Compared to conventional locks, of course this system will provide various benefits, one of which is practicality, which is often a drawback of conventional locks. By using an automatic door lock, there is no longer a need to carry a key and look after it while traveling, because the security system uses advanced technology (Setiawan et al., 2022)

Automatic door mode that can only move if automatic mode is activated on Android, for Android phones or active control mode if automatic mode is disabled (Saputro, 2023). The working system in this tool is based on commands from Android, if the PIR sensor is off and

the door is closed then the locking process can be carried out (Tajadod, 2021; Mostakim et al., 2020). The maximum distance for door and Bluetooth controls is 1-50 meters in open spaces, but with obstacles, the maximum control distance is 45 meters. However, this research still has shortcomings, namely not being able to use a motor with a voltage of 12 V so that the driver on the motor does not heat up quickly and not using a DC motor to make the work process easier, with these shortcomings the results of this research are not good (Setiawan et al., 2022)

Making tools with door control systems and electrical automatic equipment with PIR sensors and SMS gateways as keys to systems executed with SMS commands. Meanwhile, the pir sensor detects the presence of someone at the door (Samsuddin et al., 2020). The way this system works is that when the user opens the main door, the user will enter a command via SMS and it will be sent to the microcontroller to be processed as an input command, then the door will open if moved with a servo motor and the door will be locked using a solenoid. However, in this research there are still shortcomings, namely that the door can only be opened using SMS, which nowadays only a small number of people still use SMS (Adella et al., 2020; Purnama, 2013; Rahajoeningroem, 2013).

The door security system with pins using Arduino and keypad has several advantages which are the objectives and benefits obtained in its application, including increasing security (Sayeduzzaman et al., 2024), ease of use because there is no need for a key and the pins used can be adjusted according to needs. This system is designed using an Arduino microcontroller UNO is the controller and reads all input given on the iPhone keypad which is displayed on the LCD and is indicated by a red light for the door is locked and green means the door is open. In designing this system, software and hardware are needed. Software design is focused on developing Arduino programs by utilizing the Arduino IDE development application to write program code. Meanwhile, to simulate using the Proteus application. Based on the above, the author intends to continue further research by adopting the case above as a project entitled. "Design And Design Of An Arduino Based Automatic Door Lock Using Pin (Personal Identification Number)".

Methods

System Planning

System design is carried out when the supporting theory on which this final assignment is based is sufficient. This planning is carried out in line with the supporting theory that is owned and will be applied in the design and manufacture of tools whose aim is to match the desired results. In this case, the design includes hardware in the form of designing electrical, mechanical circuits, and also software from programs that have been created. The initial stage in the hardware design process is making a prototype of the house door that will be installed with grendel and servo motors. The next step is to connect all the components such as the Arduino Uno, servo motor, LCD, and 4x4 type membrane keypad using jumper cables. This hardware design was carried out seriously and really took into account the placement of each component so that it looked neat.

System Design

System design is the planning and development of system specifications to meet specified goals and needs. This involves identifying required components, selecting specifications, and thinking about how those components will work together to meet the end goal. System design involves analysis, conceptual thinking, and determining system specifications to ensure that the resulting system will be efficient, effective, and easy to use. (Martani & Arfiani, 2022)

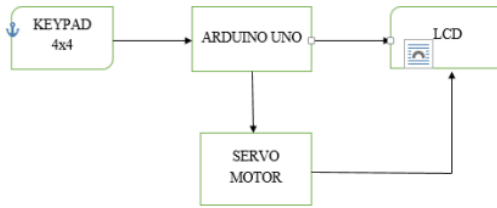


Figure 1. System Design Scheme

The flow diagram block related to system design is explained through pictures. The diagram is a visual representation of a particular process, system or workflow using several symbols or blocks to represent an individual element of the system. The goal is to make interaction in each part easier.

Use Case Diagram

Case Diagram One type of UML (Unified Modeling Language) diagram is a use case diagram which is used to provide an overview of the interaction between users (actors) and the system.

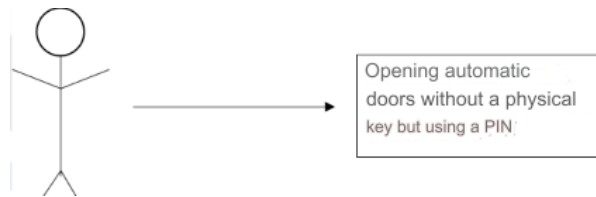


Figure 2. Use Case Diagram

Flowchart

A flowchart can be understood as a flow diagram that shows an overview of performance or processes in visual form using several standard symbols. The workflow or process of planning, analyzing and improving the system is depicted through a flowchart. Flowcharts can also help in visualizing how a system works, showing the relationships between steps and making it easier to identify problems or deficiencies in the process. The following is a flowchart display of the research system design carried out.

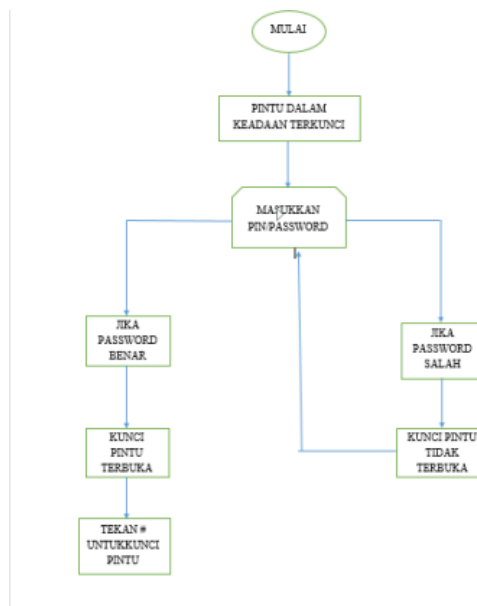


Figure 3. System Design Flowchart

Hardware Design Scheme

The design circuit framework in this study can show the manufacture of hardware in the form of an automatic lock system and various interrelated components. The following is a schematic image of the circuit created:

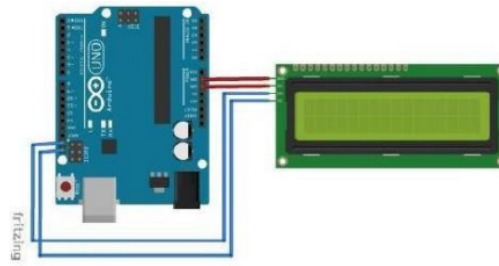


Figure 4. LCD network

The LCD circuit is connected to the Arduino UNO so that the LCD can light up when it has been programmed using LiquidCrystal which functions to determine the pins used and commands to write characters on the LCD.



Figure 5. Picture of the Keypad network

The Keypad circuit is connected to the Arduino UNO so that the Keypad can be used when it has been programmed using Keypad.h which functions to determine the pins used and commands to write characters on the LCD.

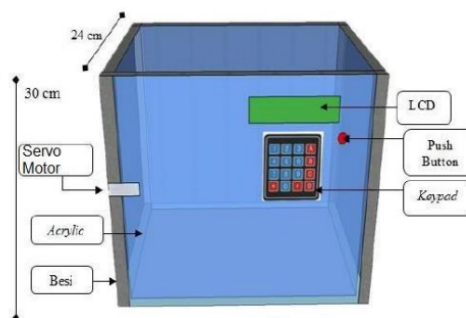


Figure 6. Hardware Network

The Hardware series functions as a place to install the components used to make automatic door locks.

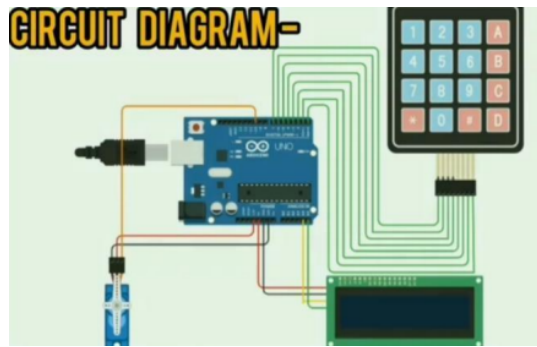


Figure 7. System Network

The image above explains a system circuit consisting of several hardware components where the aim is to carry out an automatic lock scheme using a PIN.

Results and Discussion

Implementation

Implementation is defined as a stage in a design, namely when a plan or design that has been created is changed into a system so that it can be used. Generally, implementation will involve several activities such as development, configuration, testing and maintenance aimed at ensuring that the final result conforms to the initial objectives, specifications and established standards. So that the design of an automatic door locking system using a PIN can be used well by users and can provide input to the writer who made the design so that they can make improvements so that in the future it can be used even better. (Gultom & Susanto, 2020)

Tool Implementation

This hardware design is carried out by making mechanical and electrical designs. Apart from that, the aim of this design is to provide a clear picture regarding the circuit design and the various components needed in it.



Figure 8. Automatic Door Lock Prototype

Software Implementation

The program preparation was carried out using Arduino Software (IDE). IDE is a piece of software that is useful in developing microcontroller applications. IDE functions include writing source programs, compiling, uploading compilation results, and testing.

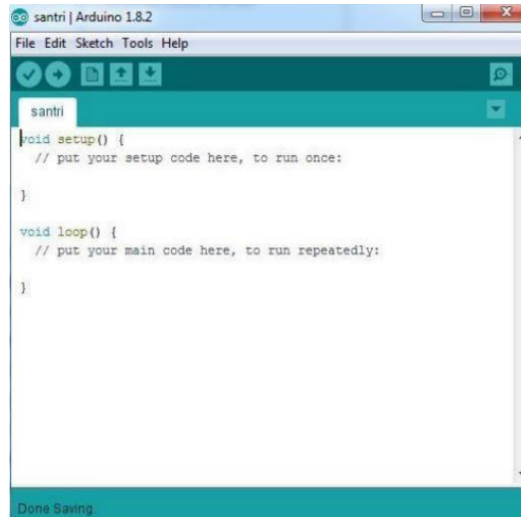


Figure 9. Arduino software

The checklist image as a verify menu symbol has a function to check whether the program is written correctly or incorrectly or if an error is possible. The arrow image to the right for the upload menu functions to send the program that has been created in the Arduino software to the Arduino hardware. The image that looks like a piece of paper is the New menu with the function of creating a new page in programming. The image of the arrow pointing up is the Open icon, its function is to open a program that has been saved or created by the Arduino software manufacturer. The downward arrow image for the save menu functions in saving programs that have been created or modified. The serial monitor menu is symbolized by the image of a magnifying glass. The function of this menu is to display or send serial communication data when sent from the Arduino hardware.

Test result

Every component that is interrelated with the door locking system is tested. The purpose of this test is to determine the suitability of the function carried out with the researcher's expectations. The implementation of testing is based on each supporting circuit as a whole. In testing this tool, all components that have been installed and the program become a miniature Automatic Door through the use of a PIN. The way to carry out the test is by entering the password on the 4x4 Matrix Keypad. The following is a picture when the Arduino is connected to the Arduino IDE application on the laptop.



Figure 10. Image of the connected Arduino

```

1 #include <Keypad.h>
2 #include <LiquidCrystal_I2C.h>
3 #include <Servo.h>
4 #include <LiquidCrystal_I2C.h> lcd(0x3F,20,4);
5 Servo servo;
6
7 #define Password_Length 5
8 int Position = 0;
9 char Particular[Password_Length];
10 char Specific[Password_Length] = "1111";
11 byte Particular_Count = 0, Specific_Count = 0;
12 char Key;
13 const byte ROWS = 4;
14 const byte COLS = 4;
15 char keys[ROWS][COLS] = {
16   {'1','2','3','A'},
17   {'4','5','6','B'},
18   {'7','8','9','C'},
19   {'*','0','#','D'}
20 };
21
22 bool SmartDoor = true; // the servo
23 // the pins to plug the keypad into
24 byte rowPins[ROWS] = {7, 6, 5, 4};
25 byte colPins[COLS] = {3, 2, 1, 0};
26 Keypad myKeypad( makeKeypad(keys), rowPins, colPins, ROWS, COLS);
27
28
29
30
31
32 byte locked[R] = [
33   001110,
34   010001,
35   010001,
36   011111,
37   011011,
38   011011,
39   011111,
40 ];

```

Figure 11. Arduino coding display when opened

If you enter some initial settings in the Arduino IDE application, the initial display will be as below. This initial setting is used to display text when the automatic door lock is started to be used.

```

41
42 byte locked[R] = {
43   001110,
44   010001,
45   010001,
46   011111,
47   011011,
48   011011,
49   011111,
50 };
51 // open character
52 byte opened[R] = {
53   000110,
54   000001,
55   000001,
56   011111,
57   011011,
58   011011,
59   011111,
60 };
61
62 void setup()
63 {
64   servo.attach(10);
65   servo.write(90);
66   lcd.begin(20,4);
67   lcd.print("Pintu Ricky");
68   lcd.setCursor(0,2);
69   lcd.print("Arduino lock!!!");
70   delay(4000);
71   lcd.clear();
72 }
73
74 void loop()

```

Figure 12. Arduino IDE display

The results of programming in the Arduino application will produce an initial display on the LCD screen when the door is opened, the initial door state is automatically locked and then writing will appear according to the settings in the Arduino IDE application.



Figure 13. Initial LCD Display

Next, the LCD will display a command to enter the password that was previously created. Below is the program used to create this display.

```

projekickypintu.ino
104 servo.write(position);
105 delay(10);
106 }
107 }
108 }
109 }
110 }
111 }
112 }
113 }
114 }
115 }
116 }
117 }
118 }
119 }
120 }
121 }
122 }
123 }
124 }
125 }
126 }
127 }
128 }
129 }
130 }
131 }
132 }
133 }
134 }
135 }
136 }
137 }
138 }
139 }
140 }
141 }
142 }
143 }
144 }
145 }
146 }
147 }
148 }
149 }
150 }
151 }
152 }
153 }
154 }
155 }
156 }
157 }
158 }
159 }
160 }
161 }
162 }
163 }
164 }
165 }
166 }
167 }
168 }
169 }
170 }
171 }
172 }
173 }
174 }
175 }
176 }
177 }
178 }
179 }
180 }
181 }
182 }
183 }
184 }
185 }
186 }
187 }
188 }
189 }
190 }
191 }
192 }
193 }
194 }
195 }
196 }
197 }
198 }
199 }
200 }
201 }
202 }
203 }
204 }
205 }
206 }
207 }
208 }
209 }
210 }
211 }
212 }
213 }
214 }
215 }
216 }
217 }
218 }
219 }
220 }
221 }
222 }
223 }
224 }
225 }
226 }
227 }
228 }
229 }
230 }
231 }
232 }
233 }
234 }
235 }
236 }
237 }
238 }
239 }
240 }
241 }
242 }
243 }
244 }
245 }
246 }
247 }
248 }
249 }
250 }
251 }
252 }
253 }
254 }
255 }
256 }
257 }
258 }
259 }
260 }
261 }
262 }
263 }
264 }
265 }
266 }
267 }
268 }
269 }
270 }
271 }
272 }
273 }
274 }
275 }
276 }
277 }
278 }
279 }
280 }
281 }
282 }
283 }
284 }
285 }
286 }
287 }
288 }
289 }
290 }
291 }
292 }
293 }
294 }
295 }
296 }
297 }
298 }
299 }
300 }
301 }
302 }
303 }
304 }
305 }
306 }
307 }
308 }
309 }
310 }
311 }
312 }
313 }
314 }
315 }
316 }
317 }
318 }
319 }
320 }
321 }
322 }
323 }
324 }
325 }
326 }
327 }
328 }
329 }
330 }
331 }
332 }
333 }
334 }
335 }
336 }
337 }
338 }
339 }
340 }
341 }
342 }
343 }
344 }
345 }
346 }
347 }
348 }
349 }
350 }
351 }
352 }
353 }
354 }
355 }
356 }
357 }
358 }
359 }
360 }
361 }
362 }
363 }
364 }
365 }
366 }
367 }
368 }
369 }
370 }
371 }
372 }
373 }
374 }
375 }
376 }
377 }
378 }
379 }
380 }
381 }
382 }
383 }
384 }
385 }
386 }
387 }
388 }
389 }
390 }
391 }
392 }
393 }
394 }
395 }
396 }
397 }
398 }
399 }
400 }
401 }
402 }
403 }
404 }
405 }
406 }
407 }
408 }
409 }
410 }
411 }
412 }
413 }
414 }
415 }
416 }
417 }
418 }
419 }
420 }
421 }
422 }
423 }
424 }
425 }
426 }
427 }
428 }
429 }
430 }
431 }
432 }
433 }
434 }
435 }
436 }
437 }
438 }
439 }
440 }
441 }
442 }
443 }
444 }
445 }
446 }
447 }
448 }
449 }
450 }
451 }
452 }
453 }
454 }
455 }
456 }
457 }
458 }
459 }
460 }
461 }
462 }
463 }
464 }
465 }
466 }
467 }
468 }
469 }
470 }
471 }
472 }
473 }
474 }
475 }
476 }
477 }
478 }
479 }
480 }
481 }
482 }
483 }
484 }
485 }
486 }
487 }
488 }
489 }
490 }
491 }
492 }
493 }
494 }
495 }
496 }
497 }
498 }
499 }
500 }
501 }
502 }
503 }
504 }
505 }
506 }
507 }
508 }
509 }
510 }
511 }
512 }
513 }
514 }
515 }
516 }
517 }
518 }
519 }
520 }
521 }
522 }
523 }
524 }
525 }
526 }
527 }
528 }
529 }
530 }
531 }
532 }
533 }
534 }
535 }
536 }
537 }
538 }
539 }
540 }
541 }
542 }
543 }
544 }
545 }
546 }
547 }
548 }
549 }
550 }
551 }
552 }
553 }
554 }
555 }
556 }
557 }
558 }
559 }
560 }
561 }
562 }
563 }
564 }
565 }
566 }
567 }
568 }
569 }
570 }
571 }
572 }
573 }
574 }
575 }
576 }
577 }
578 }
579 }
580 }
581 }
582 }
583 }
584 }
585 }
586 }
587 }
588 }
589 }
590 }
591 }
592 }
593 }
594 }
595 }
596 }
597 }
598 }
599 }
600 }
601 }
602 }
603 }
604 }
605 }
606 }
607 }
608 }
609 }
610 }
611 }
612 }
613 }
614 }
615 }
616 }
617 }
618 }
619 }
620 }
621 }
622 }
623 }
624 }
625 }
626 }
627 }
628 }
629 }
630 }
631 }
632 }
633 }
634 }
635 }
636 }
637 }
638 }
639 }
640 }
641 }
642 }
643 }
644 }
645 }
646 }
647 }
648 }
649 }
650 }
651 }
652 }
653 }
654 }
655 }
656 }
657 }
658 }
659 }
660 }
661 }
662 }
663 }
664 }
665 }
666 }
667 }
668 }
669 }
670 }
671 }
672 }
673 }
674 }
675 }
676 }
677 }
678 }
679 }
680 }
681 }
682 }
683 }
684 }
685 }
686 }
687 }
688 }
689 }
690 }
691 }
692 }
693 }
694 }
695 }
696 }
697 }
698 }
699 }
700 }
701 }
702 }
703 }
704 }
705 }
706 }
707 }
708 }
709 }
710 }
711 }
712 }
713 }
714 }
715 }
716 }
717 }
718 }
719 }
720 }
721 }
722 }
723 }
724 }
725 }
726 }
727 }
728 }
729 }
730 }
731 }
732 }
733 }
734 }
735 }
736 }
737 }
738 }
739 }
740 }
741 }
742 }
743 }
744 }
745 }
746 }
747 }
748 }
749 }
750 }
751 }
752 }
753 }
754 }
755 }
756 }
757 }
758 }
759 }
760 }
761 }
762 }
763 }
764 }
765 }
766 }
767 }
768 }
769 }
770 }
771 }
772 }
773 }
774 }
775 }
776 }
777 }
778 }
779 }
780 }
781 }
782 }
783 }
784 }
785 }
786 }
787 }
788 }
789 }
790 }
791 }
792 }
793 }
794 }
795 }
796 }
797 }
798 }
799 }
800 }
801 }
802 }
803 }
804 }
805 }
806 }
807 }
808 }
809 }
810 }
811 }
812 }
813 }
814 }
815 }
816 }
817 }
818 }
819 }
820 }
821 }
822 }
823 }
824 }
825 }
826 }
827 }
828 }
829 }
830 }
831 }
832 }
833 }
834 }
835 }
836 }
837 }
838 }
839 }
840 }
841 }
842 }
843 }
844 }
845 }
846 }
847 }
848 }
849 }
850 }
851 }
852 }
853 }
854 }
855 }
856 }
857 }
858 }
859 }
860 }
861 }
862 }
863 }
864 }
865 }
866 }
867 }
868 }
869 }
870 }
871 }
872 }
873 }
874 }
875 }
876 }
877 }
878 }
879 }
880 }
881 }
882 }
883 }
884 }
885 }
886 }
887 }
888 }
889 }
890 }
891 }
892 }
893 }
894 }
895 }
896 }
897 }
898 }
899 }
900 }
901 }
902 }
903 }
904 }
905 }
906 }
907 }
908 }
909 }
910 }
911 }
912 }
913 }
914 }
915 }
916 }
917 }
918 }
919 }
920 }
921 }
922 }
923 }
924 }
925 }
926 }
927 }
928 }
929 }
930 }
931 }
932 }
933 }
934 }
935 }
936 }
937 }
938 }
939 }
940 }
941 }
942 }
943 }
944 }
945 }
946 }
947 }
948 }
949 }
950 }
951 }
952 }
953 }
954 }
955 }
956 }
957 }
958 }
959 }
960 }
961 }
962 }
963 }
964 }
965 }
966 }
967 }
968 }
969 }
970 }
971 }
972 }
973 }
974 }
975 }
976 }
977 }
978 }
979 }
980 }
981 }
982 }
983 }
984 }
985 }
986 }
987 }
988 }
989 }
990 }
991 }
992 }
993 }
994 }
995 }
996 }
997 }
998 }
999 }
1000 }

```

Figure 14. Program for Entering Password Display. The program above produces a display for entering password on the LCD



Figure 15. LCD screen displaying enter password

The program displays "enter password" as shown in the image above. Next, the password that has been entered will be checked via the microcontroller. If you enter the wrong password, there will be a notification display on the LCD. Meanwhile, if you have entered the correct password, the display will be different. Part of the program is as shown in the image below.

```

projekickypintu.ino
330 lcd.print("Pintu Terbuka");
331 lcd.setCursor(1,0);
332 lcd.write(1);
333 lcd.setCursor(0,1);
334 lcd.print("Tekan Tombol Untuk Menutup");
335 SmartDoor = 0;
336 }
337 else
338 {
339 lcd.clear();
340 lcd.setCursor(0,0);
341 lcd.print("Password Salah!!!");
342 lcd.setCursor(0,1);
343 lcd.print("Ulangi Password");
344 lcd.setCursor(1,1);
345 lcd.print("10");
346 delay(1000);
347 lcd.setCursor(1,1);
348 lcd.print("00");
349 delay(1000);
350 lcd.setCursor(1,1);
351 lcd.print("00");
352 delay(1000);
353 lcd.setCursor(1,1);
354 lcd.print("00");
355 delay(1000);
356 lcd.setCursor(1,1);
357 lcd.print("00");
358 delay(1000);
359 lcd.setCursor(1,1);
360 lcd.print("00");
361 delay(1000);
362 lcd.setCursor(1,1);
363 lcd.print("00");
364 delay(1000);
365 lcd.setCursor(1,1);
366 lcd.print("00");
367 delay(1000);
368 lcd.setCursor(1,1);
369 lcd.print("00");
370 delay(1000);
371 lcd.setCursor(1,1);
372 lcd.print("00");
373 delay(1000);
374 lcd.setCursor(1,1);
375 lcd.print("00");
376 delay(1000);
377 lcd.setCursor(1,1);
378 lcd.print("00");
379 delay(1000);
380 lcd.setCursor(1,1);
381 lcd.print("00");
382 delay(1000);
383 lcd.setCursor(1,1);
384 lcd.print("00");
385 delay(1000);
386 lcd.setCursor(1,1);
387 lcd.print("00");
388 delay(1000);
389 lcd.setCursor(1,1);
390 lcd.print("00");
391 delay(1000);
392 lcd.setCursor(1,1);
393 lcd.print("00");
394 delay(1000);
395 lcd.setCursor(1,1);
396 lcd.print("00");
397 delay(1000);
398 lcd.setCursor(1,1);
399 lcd.print("00");
400 delay(1000);
401 lcd.setCursor(1,1);
402 lcd.print("00");
403 delay(1000);
404 lcd.setCursor(1,1);
405 lcd.print("00");
406 delay(1000);
407 lcd.setCursor(1,1);
408 lcd.print("00");
409 delay(1000);
410 lcd.setCursor(1,1);
411 lcd.print("00");
412 delay(1000);
413 lcd.setCursor(1,1);
414 lcd.print("00");
415 delay(1000);
416 lcd.setCursor(1,1);
417 lcd.print("00");
418 delay(1000);
419 lcd.setCursor(1,1);
420 lcd.print("00");
421 delay(1000);
422 lcd.setCursor(1,1);
423 lcd.print("00");
424 delay(1000);
425 lcd.setCursor(1,1);
426 lcd.print("00");
427 delay(1000);
428 lcd.setCursor(1,1);
429 lcd.print("00");
429 }
430 }
431 }
432 }
433 }
434 }
435 }
436 }
437 }
438 }
439 }
440 }
441 }
442 }
443 }
444 }
445 }
446 }
447 }
448 }
449 }
450 }
451 }
452 }
453 }
454 }
455 }
456 }
457 }
458 }
459 }
460 }
461 }
462 }
463 }
464 }
465 }
466 }
467 }
468 }
469 }
470 }
471 }
472 }
473 }
474 }
475 }
476 }
477 }
478 }
479 }
480 }
481 }
482 }
483 }
484 }
485 }
486 }
487 }
488 }
489 }
490 }
491 }
492 }
493 }
494 }
495 }
496 }
497 }
498 }
499 }
500 }
501 }
502 }
503 }
504 }
505 }
506 }
507 }
508 }
509 }
510 }
511 }
512 }
513 }
514 }
515 }
516 }
517 }
518 }
519 }
520 }
521 }
522 }
523 }
524 }
525 }
526 }
527 }
528 }
529 }
530 }
531 }
532 }
533 }
534 }
535 }
536 }
537 }
538 }
539 }
540 }
541 }
542 }
543 }
544 }
545 }
546 }
547 }
548 }
549 }
550 }
551 }
552 }
553 }
554 }
555 }
556 }
557 }
558 }
559 }
560 }
561 }
562 }
563 }
564 }
565 }
566 }
567 }
568 }
569 }
570 }
571 }
572 }
573 }
574 }
575 }
576 }
577 }
578 }
579 }
580 }
581 }
582 }
583 }
584 }
585 }
586 }
587 }
588 }
589 }
590 }
591 }
592 }
593 }
594 }
595 }
596 }
597 }
598 }
599 }
600 }
601 }
602 }
603 }
604 }
605 }
606 }
607 }
608 }
609 }
610 }
611 }
612 }
613 }
614 }
615 }
616 }
617 }
618 }
619 }
620 }
621 }
622 }
623 }
624 }
625 }
626 }
627 }
628 }
629 }
630 }
631 }
632 }
633 }
634 }
635 }
636 }
637 }
638 }
639 }
640 }
641 }
642 }
643 }
644 }
645 }
646 }
647 }
648 }
649 }
650 }
651 }
652 }
653 }
654 }
655 }
656 }
657 }
658 }
659 }
660 }
661 }
662 }
663 }
664 }
665 }
666 }
667 }
668 }
669 }
670 }
671 }
672 }
673 }
674 }
675 }
676 }
677 }
678 }
679 }
680 }
681 }
682 }
683 }
684 }
685 }
686 }
687 }
688 }
689 }
690 }
691 }
692 }
693 }
694 }
695 }
696 }
697 }
698 }
699 }
700 }
701 }
702 }
703 }
704 }
705 }
706 }
707 }
708 }
709 }
710 }
711 }
712 }
713 }
714 }
715 }
716 }
717 }
718 }
719 }
720 }
721 }
722 }
723 }
724 }
725 }
726 }
727 }
728 }
729 }
730 }
731 }
732 }
733 }
734 }
735 }
736 }
737 }
738 }
739 }
740 }
741 }
742 }
743 }
744 }
745 }
746 }
747 }
748 }
749 }
750 }
751 }
752 }
753 }
754 }
755 }
756 }
757 }
758 }
759 }
760 }
761 }
762 }
763 }
764 }
765 }
766 }
767 }
768 }
769 }
770 }
771 }
772 }
773 }
774 }
775 }
776 }
777 }
778 }
779 }
780 }
781 }
782 }
783 }
784 }
785 }
786 }
787 }
788 }
789 }
790 }
791 }
792 }
793 }
794 }
795 }
796 }
797 }
798 }
799 }
800 }
801 }
802 }
803 }
804 }
805 }
806 }
807 }
808 }
809 }
810 }
811 }
812 }
813 }
814 }
815 }
816 }
817 }
818 }
819 }
820 }
821 }
822 }
823 }
824 }
825 }
826 }
827 }
828 }
829 }
830 }
831 }
832 }
833 }
834 }
835 }
836 }
837 }
838 }
839 }
840 }
841 }
842 }
843 }
844 }
845 }
846 }
847 }
848 }
849 }
850 }
851 }
852 }
853 }
854 }
855 }
856 }
857 }
858 }
859 }
860 }
861 }
862 }
863 }
864 }
865 }
866 }
867 }
868 }
869 }
870 }
871 }
872 }
873 }
874 }
875 }
876 }
877 }
878 }
879 }
880 }
881 }
882 }
883 }
884 }
885 }
886 }
887 }
888 }
889 }
890 }
891 }
892 }
893 }
894 }
895 }
896 }
897 }
898 }
899 }
900 }
901 }
902 }
903 }
904 }
905 }
906 }
907 }
908 }
909 }
910 }
911 }
912 }
913 }
914 }
915 }
916 }
917 }
918 }
919 }
920 }
921 }
922 }
923 }
924 }
925 }
926 }
927 }
928 }
929 }
930 }
931 }
932 }
933 }
934 }
935 }
936 }
937 }
938 }
939 }
940 }
941 }
942 }
943 }
944 }
945 }
946 }
947 }
948 }
949 }
950 }
951 }
952 }
953 }
954 }
955 }
956 }
957 }
958 }
959 }
960 }
961 }
962 }
963 }
964 }
965 }
966 }
967 }
968 }
969 }
970 }
971 }
972 }
973 }
974 }
975 }
976 }
977 }
978 }
979 }
980 }
981 }
982 }
983 }
984 }
985 }
986 }
987 }
988 }
989 }
990 }
991 }
992 }
993 }
994 }
995 }
996 }
997 }
998 }
999 }
1000 }

```

Figure 16. Incorrect and Correct Programming

From the programming above, if the password entered is incorrect, the display that will appear on the LCD screen on the door is as follows:

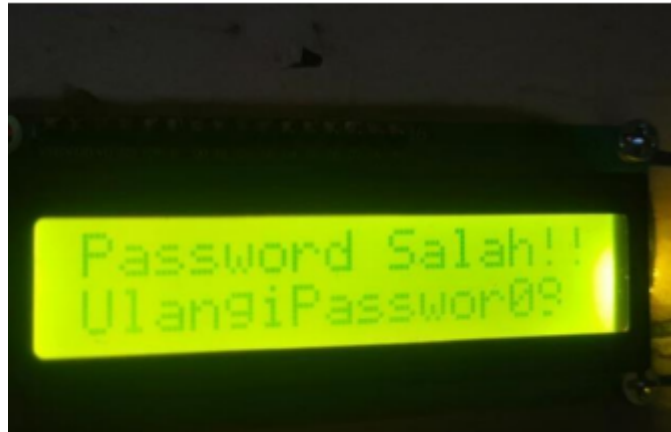


Figure 17. LCD display if the password is incorrect

From the programming above, if the password entered is incorrect, the display that will appear on the LCD screen on the door is as follows:



Figure 18. LCD display if password is correct

The servo motor will activate and the door will automatically open when the password entered is correct. Conversely, if you enter the wrong password, a prompt will appear to re-enter the correct password after 10 seconds. If the user wants to open the door from the inside, just press the push button (Novianti, 2019).

From the results of this research, an Arduino-based automatic door lock system with the use of a PIN number offers an effective solution in securing homes and offices. This system solves several problems related to traditional locking systems and offers enhanced safety, utility, and adaptability (Dekker et al., 2008). Mechanical locks introduced here come with physical keys, and these are easily lost or duplicated leading to great insecurity. On the other hand, using digital PIN-based system erases the above vulnerabilities, supporting earlier studies that call for an implementation of digital security measures (Lontoh et al., 2017).

Its most significant form of integration is with the Arduino microcontroller, which forms the core of the processing precinct, receiving input commands from the keypad and issuing output instructions to the servo motor and LCD screen. Supplementing the Arduino board, the Arduino IDE was proven to be a proper tool for programming since it supported smooth communication with components integrated into the circuit (Blum, 2019; Pradhan, 2017;

Kuzlu et al., 2023; Prabhu & Urban, 2020). This has been supported in multiple studies that demonstrate the modularity and simplicity of Arduino systems in security applications (Martani & Arfiani, 2022). The findings of this study support the efficiency of the Arduino-based system in providing appropriate and proper responses that concern pins, as evidenced by the servo motor unlocking and locked the door following distinct instructions appropriately (Kaul, 2023).

However, functional success implies that there are some restrictions that should not be overlooked (Morgante & Peverati, 2020). I noticed one major problem, namely the use of the 4x4 matrix keypad for entering the PIN number. Although this design is simple and easy to navigate, it also has a weakness. It raises questions about the actual security of the system because it encourages people to use weak passwords like their birth numbers, names or anniversary dates, etc. Earlier research has also pointed out the issue about the usage of PINs in the security systems for emphasizing educating users about the choice of strong and powerful PIN code (Samsuddin et al., 2020). This is true whether the system employs biometric recognition as a back-up feature or uses fingerprint scanners or RFID tags to improve security as well as address the risks inherent in the PIN based systems (Gultom & Susanto, 2020).

As is expected, the hardware components of this system, especially the servo motor, also passed the tests well. The motor was able to execute the instructions given to it appropriately and open and close the door as required (Ito et al., 2022; Hasibuan et al., 2021; Chen et al., 2020). However that was an issue with the motor driver system and was noticed during the longer tests. Taking into account the execution of the above-mentioned system, the motor has voltage limitations, so certain problems arise in its work, for example, overheating in case of long-time operation. Setiawan et al. (2022) pointed out the same problem, according to which motor overheating is quite frequent for automated door lock systems. In this regard, the subsequent versions of the system should adopt a DC motor that possess better voltage resistance together with appropriate heat sinks on the circuit board used. Such change would improve on the robustness and dependability of the system especially in areas where the lock is put to frequent gebruik (Serfontein, 2024).

In addition, the current design does not include a back up power source for contingencies such as power losses that may render the system nonfunctional at some point (Ukil et al., 2020). The unsatisfactory adaptability to power failures could be solved through adding a backup power source (for example, a battery) or by designing the system to switch to manual usage in case of power failure. This has been seen in the literature for automated door locks, as several of the papers have pointed to the need to have backup power supply to support the system (Adella et al., 2020). There is also an additional option of enhancing the system reliability through adding a cloud-based monitoring system that gives notifications of power problem.

Taking some time to highlight the activities that were carried out during development of the project, it was found that the utilization of the Arduino Integrated Development Environment, or IDE for programming was of great help (Kondaveeti et al., 2021; Tupac-Yupanqui et al., 2022). The given software ensured that it was easy to interconnect all the various pieces of hardware so that the system's response was conforming to the user input. The specific change in the use of LCD display to give real-time response to the users made the system more usable by providing the user readable icons that showed whether the door was locked or opened or whether a wrong PIN was entered (Reiss, 2012; Noyes & Baber, 1999). These interactions enable the satisfaction of needs for the users because previous studies have indicated that easy-to-navigate interfaces significantly determine the uptake of digital security systems (Novianti, 2019).

However, the defined system still holds potential for improvement in the overall user interface which includes the mobile integration where one can open the door lock via his/her cell phone (Hazazi, 2024). This would be more convenient and more flexible because the users at times they cannot physically be at that place. Research has shown that mobile integration enhances user experience and convenience in the smart home systems such as IoT in smart home systems by providing real-time alert and remote access among others (Gultom & Susanto, 2020; Domb, 2019; Talal et al., 2019; Yar et al., 2021). The current system could be extended in this direction by incorporating Bluetooth or Wi-Fi modules whereby the users can operate the lock using their cellular phones.

Despite the fact that this study was done using a simple PIN based system, the findings show that there could be added security is added in future versions of the system. An enhancement regarding this aspect is the biometric forms of authentication such as finger prints or face patterns which if incorporated in the system, would enhance security. Biometric systems are considered to be more secure than PIN based systems since they use physical features which cannot be imitated or taken from someone (Samsuddin et al., 2020). Implementing such features into the present system not only has the effect of improving security, but also some of the issues of PIN insecurity such as PIN guessing attacks due to simple or common PINs (Khan et al., 2020).

Another area of future possibilities is the use of multiple factors of security and control with the given application. Multi-factor authentication based on the concept of using something that is known to the user and something that is possessed by the user in the form of a PIN number, a smartphone or an RFID card has been widely accepted as a means of increasing security. On the same note, studies have revealed that the systems that incorporate MFA are much more secure as compared to the one that use only a single factor (Adella et al., 2020). Such approach may be applied to the current system and provide more efficient security measures without negative impact on its usability.

The outcomes of this research support the findings done towards other automated door lock systems, especially those that are based on Arduino technology. Lontoh et al. (2017) also observed the same results in their study of an Arduino based Bluetooth enabled door lock wherein the authors highlighted that the proposed system offered better security and operational convenience than conventional locks. Despite this, the present study has stalled beyond the previous reports by calling for sophisticated security elements and highlighting the drawbacks of the current systems that comprise power management and motor performance. Setiawan et al. (2022) studying the application of Arduino in door lock systems adopted similar manner which was however desecrated by the type of hardware used that caused the system to strain under high usage. In this work we extend their research by suggesting certain modifications in the frame of the robot's construction which implies employing a DC motor and more effective power supply system. Furthermore, this study has also pointed out the need to consider the user interface design which was not well focused on in the previous literature.

Conclusion

The results of the design and tests that have been carried out on the Arduino-based automatic door locking system with a password show the conclusions. Making an automatic door locking system via PIN can be done using the ATmega328 microcontroller. The control center and circuit were created and programmed using the Arduino IDE software. The Arduino Uno microcontroller is capable of controlling the working system of automatic door locks using a sequence of programming language instructions, namely C++.

Suggestion

Based on the results of the tests that have been carried out, the author provides suggestions so that further development can be carried out in the future. This automatic locking device using a password can also be done by utilizing the addition of other security sensors. Examples include using fingerprints, RFID, voice sensors, or through the use of other Android programs.

References

- Adella, A. F., Fardika, M., Putra, P., Taufiqurrahman, F., & Kaswar, A. B. (2020). Pintu Otomatis Berbasis Ultrasonic Internet of Things. *Jurnal MEDIA ELEKTRIK*, 17(3), 80–84.
- Adkins, H., Beyer, B., Blankinship, P., Lewandowski, P., Oprea, A., & Stubblefield, A. (2020). *Building secure and reliable systems: best practices for designing, implementing, and maintaining systems*. O'Reilly Media.
- Blum, J. (2019). *Exploring Arduino: tools and techniques for engineering wizardry*. John Wiley & Sons.
- Chen, V., Gupta, A., & Marino, K. (2020). Ask your humans: Using human instructions to improve generalization in reinforcement learning. *arXiv preprint arXiv:2011.00517*. <https://doi.org/10.48550/arXiv.2011.00517>
- Dekker, S., Hollnagel, E., Woods, D., & Cook, R. (2008). Resilience Engineering: New directions for measuring and maintaining safety in complex systems. *Lund University School of Aviation*, 1, 1-6.
- Domb, M. (2019). Smart home systems based on internet of things. In *Internet of Things (IoT) for automated and smart applications*. IntechOpen. <https://doi.org/10.5772/intechopen.84894>
- Gultom, D., & Susanto, M. F. (2020). Studi Aplikasi Smartlock Pada Pintu Rumah Dengan Arduino Berbasis Iot Dengan Sensor Suara. *Prosiding Industrial Research Workshop and National Seminar*, 11(1), 239–245. <https://doi.org/10.35313/irwns.v11i1.2001>
- Hasibuan, A., Rosdiana, R., & Tambunan, D. S. (2021). Design and Development of An Automatic Door Gate Based on Internet of Things Using Arduino Uno. *Bulletin of Computer Science and Electrical Engineering*, 2(1), 17-27. <https://doi.org/10.25008/bcsee.v2i1.1141>
- Hazazi, H. (2024). *Understanding and Improving the Usability, Security, and Privacy of Smart Locks from the Perspective of the End User* (Doctoral dissertation, The University of North Carolina at Charlotte).
- Ito, H., Yamamoto, K., Mori, H., & Ogata, T. (2022). Efficient multitask learning with an embodied predictive model for door opening and entry with whole-body control. *Science Robotics*, 7(65), eaax8177. <https://doi.org/10.1126/scirobotics.aax8177>
- Kaul, L. (2023). *Practical Arduino Robotics: A hands-on guide to bringing your robotics ideas to life using Arduino*. Packt Publishing Ltd.
- Khan, H., Ceci, J., Stegman, J., Aviv, A. J., Dara, R., & Kuber, R. (2020, December). Widely reused and shared, infrequently updated, and sometimes inherited: A holistic view of pin authentication in digital lives and beyond. In *Proceedings of the 36th Annual Computer Security Applications Conference* (pp. 249-262). <https://doi.org/10.1145/3427228.3427240>

- Kondaveeti, H. K., Kumaravelu, N. K., Vanambathina, S. D., Mathe, S. E., & Vappangi, S. (2021). A systematic literature review on prototyping with Arduino: Applications, challenges, advantages, and limitations. *Computer Science Review*, 40, 100364. <https://doi.org/10.1016/j.cosrev.2021.100364>
- Kuzlu, M., Jovanovic, V., Popescu, O., & Sarp, S. (2023). Development of Sensing and Programming Activities for Engineering Technology Pathways Using a Virtual Arduino Simulation Platform. <https://doi.org/10.18260/1-2--43164>
- Lontoh, J. H., Mamahit, D. J., & Tulung, N. M. (2017). Rancang Bangun Kunci Pintu Elektronik Menggunakan Bluetooth berbasis Android. *Jurnal Teknik Elektro Dan Komputer*, 6(3), 97–104. <https://doi.org/10.35793/jtek.v6i3.18067>
- Martani, A., & Arfiani, I. (2022). Perancangan Sistem Pintu Otomatis Menggunakan ESP32CAM. *Jurnal Teknologi Dan Komputer (JTEK)*, 2(01), 104–110. <https://doi.org/10.56923/jtek.v2i01.60>
- Morgante, P., & Peverati, R. (2020). The devil in the details: A tutorial review on some undervalued aspects of density functional theory calculations. *International Journal of Quantum Chemistry*, 120(18), e26332. <https://doi.org/10.1002/qua.26332>
- Mostakim, M. N., Mahmud, S., Jewel, M. K. H., Rahman, M. K., & Ali, M. S. (2020). Design and development of an intelligent home with automated environmental control. *International Journal of Image, Graphics and Signal Processing*, 10(4), 1. <https://doi.org/10.5815/ijigsp.2020.04.01>
- Novianti, T. (2019). Rancang bangun pintu otomatis dengan menggunakan RFID. *Jurnal Teknik Elektro Dan Komputer TRIAC*, 6(1), 8–13. <https://doi.org/10.21107/triac.v6i1.4878>
- Noyes, J., & Baber, C. (1999). *User-centred design of systems*. Springer Science & Business Media.
- Prabhu, G. R. D., & Urban, P. L. (2020). Elevating chemistry research with a modern electronics toolkit. *Chemical Reviews*, 120(17), 9482-9553. <https://doi.org/10.1021/acs.chemrev.0c00206>
- Pradhan, P. (2017). *The role of arduino for increasing performance and interest in programming for first-year engineering students* (Master's thesis, University of Cincinnati).
- Purnama, B. E. (2013). Sistem Pengendalian Keamanan Pintu Rumah Berbasis SMS (Short Message Service) Menggunakan Mikrokontroler Atmega 8535. *Indonesian Journal of Networking and Security (IJNS)*, 2(4). <http://dx.doi.org/10.55181/ijns.v2i4.156>
- Rahajoeningroem, T. (2013). Home Security System with Monitoring using Cellular Phone Network. *Telekontran: Jurnal Ilmiah Telekomunikasi, Kendali dan Elektronika Terapan*, 1(1), 9-9. <https://doi.org/10.34010/telekontran.v1i1.1558>
- Reiss, E. (2012). *Usable usability: simple steps for making stuff better*. John Wiley & Sons.
- Samsuddin, S., Susmanto, S., Munawir, M., Hidayat, T., Irfandi, I., & Maulinda, M. (2020). Perancangan Pintu Otomatis Menggunakan KEYPAD Berbasis Arduino AT Mega 328. *Jurnal Pendidikan Dan Pengabdian Vokasi (JP2V)*, 1(1), 138–147. <https://doi.org/10.32672/jp2v.v1i1.3241>
- Saputro, K. H. (2023). Prototype Pintu Otomatis Di PT. Kaltim Nitrate Indonesia Menggunakan Sensor PIR Berbasis Arduino Uno di Masa Pandemi Covid-

19. *Journal Of Power electric And Renewable Energy*, 1(1), 7-11.
<https://doi.org/10.59811/jper.v1i1.52>
- Sayeduzzaman, M., Hasan, T., Nasser, A. A., & Negi, A. (2024). An Internet of Things-Integrated Home Automation with Smart Security System. *Automated Secure Computing for Next-Generation Systems*, 243-273.
<https://doi.org/10.1002/9781394213948.ch13>
- Serfontein, G. (2024). Development and Verification of an Electro-mechanical Docking Mechanism for Flight.
- Setiawan, D., Nofriandi, N., Aziz, F., & Hamdi, F. (2022). Desain Dan Analisis Pintu Otomatis Menggunakan Sensor Ultrasonic Berbasis Arduino Uno. *Jurnal Karya Ilmiah Multidisiplin (JURKIM)*, 2(1), 62-68.
<https://doi.org/10.31849/jurkim.v2i1.9074>
- Tajadod, F. (2021). *Voice command android-based smart home system for controlling door lock, lights, and home appliance for physically disabled people based on iot* (Doctoral dissertation, California State University San Marcos).
- Talal, M., Zaidan, A. A., Zaidan, B. B., Albahri, A. S., Alamoodi, A. H., Albahri, O. S., ... & Mohammed, K. I. (2019). Smart home-based IoT for real-time and secure remote health monitoring of triage and priority system using body sensors: Multi-driven systematic review. *Journal of medical systems*, 43, 1-34.
<https://doi.org/10.1007/s10916-019-1158-z>
- Tupac-Yupanqui, M., Vidal-Silva, C., Pavesi-Farriol, L., Ortiz, A. S., Cardenas-Cobo, J., & Pereira, F. (2022). Exploiting Arduino features to develop programming competencies. *IEEE Access*, 10, 20602-20615.
<https://doi.org/10.1109/ACCESS.2022.3150101>
- Ukil, A., Yeap, Y. M., & Satpathi, K. (2020). *Fault analysis and protection system design for DC grids*. Berlin: Springer. <https://doi.org/10.1007/978-981-15-2977-1>
- Yar, H., Imran, A. S., Khan, Z. A., Sajjad, M., & Kastrati, Z. (2021). Towards smart home automation using IoT-enabled edge-computing paradigm. *Sensors*, 21(14), 4932.
<https://doi.org/10.3390/s21144932>