Development of Quality Identification of Granules based on Flow Time using Infrared Proximity Sensor and Arduino

Abdul Fadlil[1], Imam Riadi[2], Ferry Yusmianto[3]

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***Abstract*— The evaluation of granule quality before mixing into tablets includes testing moisture content, static angle, compressibility, and flow rate. Good flowability is essential for granules intended for tablet compression, as it facilitates smooth compression and ensures uniform mold filling, impacting the consistency of tablet weight and active ingredient content. Granule flow rate is measured based on the time required for a certain amount of granules to flow through a funnel, with a good flow time standard being under 10 seconds or 10 g/second. Traditional methods use a stopwatch to measure flow rate, but this study introduces an automated system based on an infrared proximity sensor and Arduino for more accurate and efficient results. Experiments were conducted with two types of granules, red and white, to test this tool's performance. Based on measurement results, the Arduino-based tool showed a low error rate compared to the stopwatch, with an average of 1.28% for red granules and 1.03% for white granules. These findings demonstrate that this automated system can reliably measure granule flow rate, improve accuracy, and reduce the potential for manual error.**

Keywords— arduino; flow rate; granules; proximity sensors;

***Intisari*— Evaluasi kualitas granul sebelum dicampur dalam tablet mencakup uji kadar air, sudut statis, kompresibilitas, dan laju alir. Kemampuan mengalir yang baik sangat penting bagi granul yang akan dikompresi menjadi tablet, karena mendukung kelancaran proses kompresi dan memastikan keseragaman pengisian cetakan, yang berdampak pada konsistensi berat serta kandungan bahan aktif dalam tablet. Laju alir granul diukur berdasarkan waktu yang diperlukan sejumlah granul untuk mengalir melalui corong, dengan standar waktu alir yang baik adalah di bawah 10 detik atau 10 g/detik. Metode tradisional menggunakan stopwatch untuk mengukur laju alir, namun penelitian ini memperkenalkan sistem otomatis berbasis sensor infrared proximity dan Arduino untuk hasil yang lebih akurat dan efisien. Eksperimen dilakukan dengan dua jenis granul, yaitu granul merah dan putih, untuk menguji unjuk kerja alat ini. Berdasarkan hasil pengukuran, alat berbasis Arduino menunjukkan tingkat kesalahan yang rendah diba ndingkan stopwatch, yakni, 1,28% pada granul merah dan 1,03% pada granul putih rata-rata. Hasil ini menunjukkan bahwa sistem otomatis ini dapat diandalkan untuk mengukur laju alir granul, meningkatkan akurasi, dan mengurangi potensi kesalahan manual.**

Kata kunci— arduino; flow rate; granules; proximity sensors.

[1,2]Lecturer, Electrical Engineering Ahmad Dahlan University, Jl. South Ringroad, Kragilan 55191 INDONESIA (tel:(0274) 563515; fax: 0274-564604; e-mail: fadlil@mti.uad.ac.id, imam.riadi@is.uad.ac.id
[3]Student, Master of Electrical Engineering Ahmad Dahlan University, Jl. South Ringroad, Kragilan 55191 INDONESIA (tel: 087838349497; e-mail:2306057002@webmail.uad.ac.id

I. INTRODUCTION

The medicine and herbal medicine industry faces challenges to ensure that Medicines can be accessed by the public at affordable costs. Cost Drug manufacturing largely depends on drug ingredients and processes making it. Medicinal ingredients are generally easy and cheap to obtain in Indonesia because of the many types of medicinal plants available there. However, process making them requires a lot of money for equipment, which is a lot imported and very expensive. Types of medicinal preparations based on substance form can be divided into three categories: liquid preparations (such as solutions, suspensions and emulsions), semisolid preparations (such as creams, lotions, ointments, gels, suppositories), and solid preparations (such as tablets, capsules, pills, granules and powder). Solida preparations have several advantages compared to liquid preparations, such as larger dosage sizes appropriate and the ability to eliminate or reduce the unpleasant taste of medicinal ingredients. Granules consist of clumps of smaller particles has an uneven shape and is shaped like a single particle larger [1]. Tablet some are also made in the form of printed tablets. Temporary Printed tablets are made by pressing a moist powder mass at low pressure into the mold hole, the felt tablet is made by pressing high pressure in powder or granules. To produce good tablets, good materials are needed, namely granule quality.Drug granule or powder quality testing equipment is equipment commonly used during the drug manufacturing process. There are several ways to test the quality of drug granules or powder, one of which is by knowing the flow speed [2]. Currently, the equipment used is mostly imported from abroad, manually operated, and relatively expensive.Granule flow time is defined as the amount of time required to flow a certain number of granules through the funnel hole in a specific amount of time. If the flow time of 100 grams of granules is no more than ten seconds, the granules are considered to be of good quality. Most current granule flow rate testing equipment is carried out manually using a stopwatch [3]. In previous studies, the hardware used to run this granule quality testing tool included an ATmega 8535 microcontroller, Arduino, and Android cellphone device. For application software to create programs [4].

Based on the background of this problem, a way was found to create a granule flow rate tester that could be operated automatically. Therefore, the aim of this research is to create a design that can be used to evaluate the quality of the granules used to make tablets.

II. LITERATURE REVIEW

Research creates an automatic instrumentation system for testing the flow speed of drug granules/powders. What is done is to test the quality of the drug granules/powder as the basic ingredient. One way to test the quality of granules is through a flow speed test. Method: automatic timer and stopwatch Tools: 8535 microcontroller, LDR sensor, led, stopwatch Object: granule [7]. Research on the use of proximity sensors for automatic ablution faucets at the Larike State Mosque [8][10][11]. Research on the application of infrared sensors and Arduino Uno for simple free fall movement tools [9],[15].

III. METHODOLOGY

This study divides system design into two stages: software and hardware. During the design of this system, theories and data sheets obtained from various trusted sources were used. This is done to obtain optimal results and in accordance with the objectives. In the early stages of design, software and software are designed and created, including flowcharts, program code. In the second stage, the hardware and software are designed, including the system block diagram, electronic circuit design, sensor placement, and manufacturing of the granule funnel container.

A. Software Design

This is a software design process that includes creating program code that will initiate port initialization on components and library programs from the components used so that they operate properly. Arduino IDE software is used to create program code. The microcontroller functions as a system that tracks the proximity sensor, and data from the sensor is sent to the Arduino Uno. The flow diagram of the designed system can be seen in Figure 1.

B. System and Hardware Design

The block diagram in Figure 2 shows the design of a granule flow test tool which uses an Arduino Uno as a system controller to get a 5V power supply [18]. The proximity sensor is connected to the Arduino and functions as an Arduino input. The start, reset and stop buttons are connected to the Arduino input port. Each button functions as follows, when the start button is pressed, the Arduino will order it to System and Hardware Design

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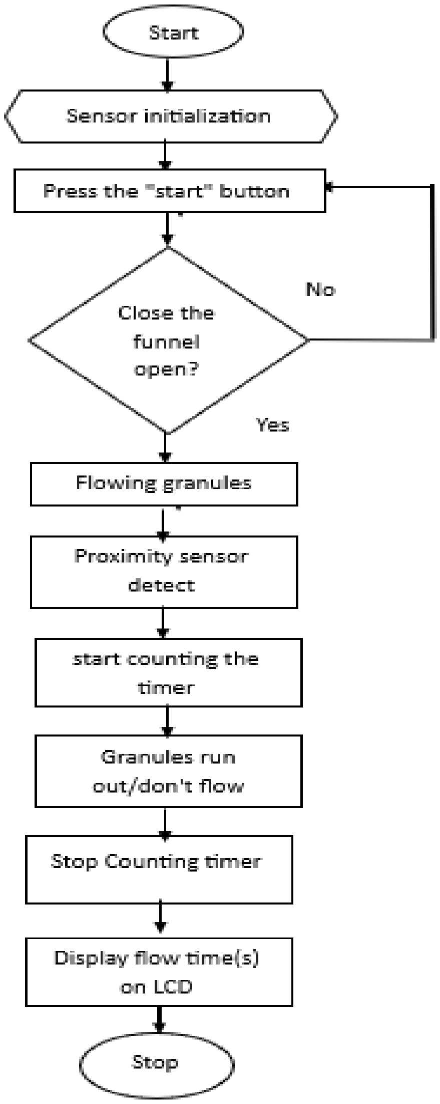

Figure 1. Flow diagram of the designed system

When the proximity sensor is blocked by a granule, Ardunio will start calculating the granule flow time. And when the granules run out and the proximity sensor is not blocked by granules, the timer automatically stop and diplays the flow time on the 16x2 LCD screen in seconds (s).

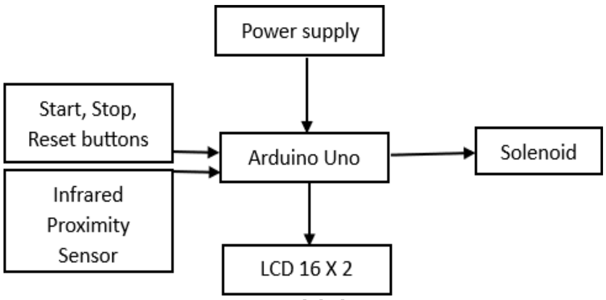

Figure 2. Blok diagram system

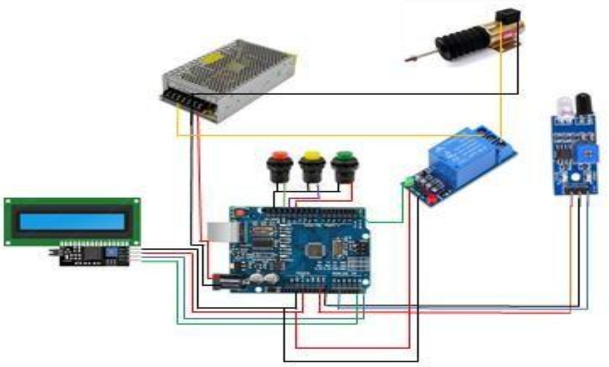

Figure 3. Wiring diagram system

Wiring drawing is shown in figure 3. Figure 3 shows the wiring diagram of the automation system for testing the quality of granule flow time. The components consist of a power supply, Arduino Uno, 5 Volt DC relay, infrared proximity sensor, 16x2 LCD, solenoid motor, and start, reset, and stop buttons.

The power supply has a 12 VDC output used to supply the Arduino Uno and solenoid motor. Arduino obtains data input from the infrared proximity sensor, and the output from Arduino is to control the solenoid motor by moving the relay and displaying the value of the granule flow time reading on the 16x2 LCD.

C. Arduino IDE

Arduino IDE is software used to develop and program Arduino microcontrollers. The Arduino IDE is available for Windows, Mac OS, and Linux and can be downloaded for free from the official Arduino website. The IDE allows users to create programs for Arduino microcontrollers using the C or C++ programming language. The Arduino IDE also provides many libraries and example programs that can be used to make programming easier. [13],[14],[17].

D. Data collection method

Data collection in this research was carried out manually and automatically. Manual, namely measuring the granule flow speed using a stopwatch. Meanwhile, automatic measurement of granule flow speed uses a tool that is made by utilizing an infrared proximity sensor and Arduino as a microcontroller to process data from sensor readings. Manual and automatic data will be compared for the level of accuracy in measuring granule flow time between manual measurement time and automatic measurement time.

IV. RESULTS AND DISCUSSION

Figure 4 shows the testing device which consists of a stainless steel box, controller box, 16x2 LCD, Arduino Uno, power supply, start, stop, reset and power buttons. Meanwhile, Figure 5 shows the position of the tool from the side which consists of a stainless box, a stainless funnel as a

Figure 4. Front view of granule testing equipment

granule holder before testing the flow time and a holder for the sensor, solenoid and infrared proximity sensor.

Figure 5. Side view of the granule tester

System testing was carried out in two stages, the first was testing the hardware device consisting of power supply, 16x2 LCD, infrared proximity sensor and solenoid, and the second was testing the overall system of how the tool works to measure granule flow speed.

A. Hardware testing

The power supply used in this research uses a voltage of 5 V DC and 12 V DC. 5 V DC voltage is used to supply the Arduino, infrared proximity sensor, and 16x2 LCD. Meanwhile, 12 V DC voltage is used to supply the solenoid component via a relay. Testing is carried out using a digital multimeter. The test results are obtained in table 1 below.

TABLE I. POWER SUPPLY TESTING

Number	Measure voltage	Rated voltage
1	12 V DC	11,7 V DC
2	5 V DC	4,8 V DC

Testing the infrared proximity sensor, namely the infrared proximity sensor functions as Arduino input to activate the timer. The output produced by the infrared proximity sensor is in the form of DC voltage. Changes in the DC voltage output from the sensor are due to changes in the resistance value of the sensor circuit. An image of the infrared proximity sensorcircuit is shown in figure 6.

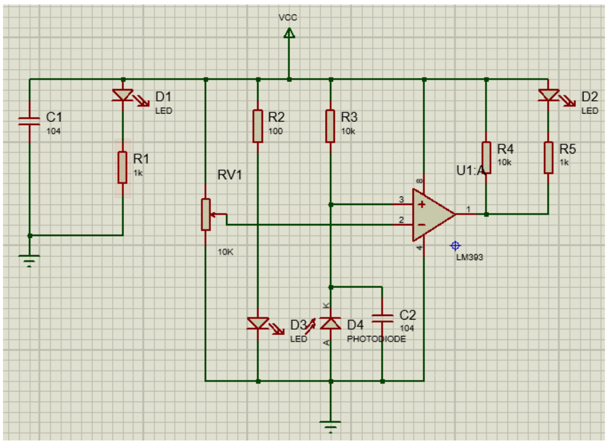

Figure 6. Schematic of the infrared proximity sensor

When the sensor is blocked by an object, the output from the sensor is 5 V DC, indicated by the green LED on the infrared proximity sensor circuit. Meanwhile, when the sensor is not blocked by objects, the output from the sensor is 0 V DC. In the infrared proximity sensor circuit there is IC LM 393. This IC functions as a comparator. The workings of the LM 393 IC are shown in Figure 8 below.

From figure 7, there are 2 input legs of the comparator IC, namely pin number 2 and pin number 3. One of the pin legs functions as a reference voltage input, in figure 8 pin number 3 is the reference input for the trimpot voltage output and the pin leg number 2 as the input voltage to be compared. In the infrared proximity sensor, the IC LM 393 input voltage is obtained from a photodiode light sensor which is assembled into a voltage divider circuit.

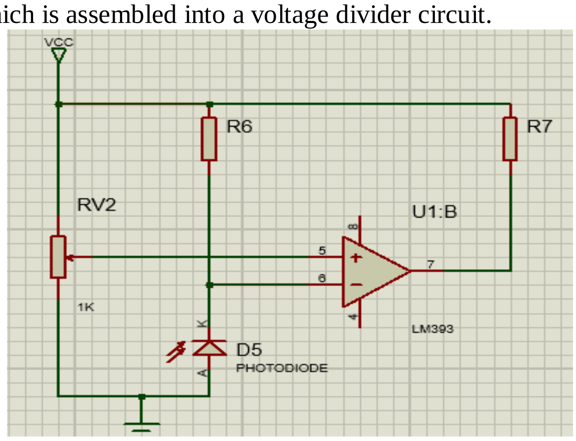

Figure 7. LM 393 IC circuit

- If the pin voltage (+) > pin voltage (-) then the comparator output (+) 5V DC
- If the pin voltage (+) < pin voltage (-) then the comparator output (-) 0V DC

Romadhon makes a faucet with an automatic system that can turn on/off according to the presence/absence of an object. This automatic faucet is made using an infrared (IR) sensor module to detect objects in the form of human hands and uses data processing carried out by an Atmega328P microcontroller [12],[13],[16]. LCD 16x2 test which functions to display the results of granule flow time measurements. The test results are shown in figure 8.

Figure 8. 16x2 LCD display

Test results show that the 16x2 LCD can display characters or writing that have been programmed on the Arduino IDE. Tool testing is carried out to obtain test result data from the tool system that has been created and this data is used to determine the performance of the tool being designed. Data was taken with two different types of granules, red and white, with the same weight, namely 100 grams, and each was tested 15 times. Table 2 shows the results of testing the first granule, namely red granules.

TABLE II
TEST RESULT MEASURIN THE FLOW TIME OF THE FIRST GRANULE

Test to	Many granules (gr)	Auto tool time (seconds)	Stopwatch time (seconds)	Error (%)
1	100	10	10,12	1,19%
2	100	10	10,06	0,60%
3	100	10	10,15	1,49%
4	100	10	10,19	1,88%
5	100	10	10,07	0,70%
6	100	10	10,13	1,29%
7	100	10	10,11	1,09%
8	100	10	10,14	1,39%
9	100	10	10,12	1,19%
10	100	10	10,14	2,37%
11	100	10	10,08	0,80%
12	100	10	10,16	1,59%
13	100	10	10,17	1,69%
14	100	10	10,10	1,00%
15	100	10	10,09	0,90%

average	**100**	**10**	**10,12**	**1,28%**

From the data from the results of the first granule flow test in table 2, the data obtained by testing granule flow was 15 times, the percentage error between the automatic tool time and the stopwatch time was an average of 1,28%. For the first granule quality category, it is poor because the flow time is more than 10 seconds.The test results for the second granule are shown in table 3 below. Table 3 shows the results of the second granule test, namely white granules.

TABLE III
TEST RESULT MEASURIN THE FLOW TIME OF THE SECOND GRANULE

Test to	**Many granules (gr)**	**Auto tool time (seconds)**	**Stopwatch time (seconds)**	**Error (%)**
1	100	9	9,05	0,55%
2	100	9	9,12	1,32%
3	100	9	9,10	1,10%
4	100	9	9,09	1,00%
5	100	9	9,04	0,44%
6	100	9	9,04	0,44%
7	100	9	9,09	1,00%
8	100	9	9,13	1,43%
9	100	9	9,14	1,54%
10	100	9	9,16	1,76%
11	100	9	9,08	0,88%
12	100	9	9,11	1,21%
13	100	9	9,10	1,10%
14	100	9	9,07	0,77%
15	100	9	9,08	0,88%
average	**100**	**9**	**9,09**	**1,03%**

From the data from the results of the second granule flow test in table 3, the data obtained by testing granule flow was 15 times, the percentage error between the automatic tool time and the stopwatch time was an average of 1,03%. For the first granule quality category, it is good because the flow time is less than 10 seconds [19] [20].

V. CONCLUTION

A tool that can work automatically to test granule flow speed has been created. According to the analysis of test results, this tool has ideal performance, namely 1,28% for the first granule and 1,03% for the second granule. In the next research, this tool will be developed by adding a test method, namely measuring the angle of repose of granules.

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