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Comparison of Proximity Sensor Responsiveness Levels on Samsung Smartphones

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***Abstract*---**Measuring the responsiveness of the proximity sensor on a Samsung smartphone at the Teuku Umar Samsung Service Center has been carried out. The proximity sensor used in smartphones is a photoelectric proximity type with diffusion type, where it works using a light-sensitive element called a receiver. The measuring method is to use a barrier board that is moved closer to the smartphone from a certain distance until the sensor is 1 and measures the distance between these barriers using a ruler or ruler which is then recorded so that the maximum distance of the sensor response is obtained. From the results obtained, it can be explained that every year for the same class it has an increase, although not too significant, whereas if it is reviewed from the class between the lower class series and the upper-class series with the same year, it will have a more significant difference.

***Keywords*---**proximity sensor, receiver, responsiveness, Samsung, smartphone.

Introduction

In keeping up with the times, which are increasingly sophisticated, many electronic devices are starting to use sensors as optimization in running the system. On smartphones that we often use, there is a sensor that we can see from the outside, namely a proximity sensor or sensor that can detect the presence of objects without physical contact. The proximity sensor emits an electromagnetic field or beam of electromagnetic radiation (eg infrared) and detects changes in the field by returning a signal (Kejık et al., 2004; Victores et al., 2011; Daponte et al., 2013).

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Of the several types of proximity sensors, the optical type proximity sensor is the most widely used, because the optical type proximity sensor is cheaper and simpler than other types of sensors, and can detect objects up to a distance of 5 cm or more. The proximity sensor on a smartphone is usually located in front of the smartphone, precisely above the smartphone screen. In this case, it is known that the more sensitive the proximity sensor, the better its performance in the speed of delivering information to the system to turn off the screen when a call occurs. However, it is still unknown whether the sensitivity level of the proximity sensor in each Samsung smartphone has a different level, especially in each class (Guntara & Ryanjas, 2016).

Proximity sensor

The Proximity Sensor or in Indonesian called the Proximity Sensor is an electronic sensor that is able to detect the presence of objects in the vicinity without any physical touch. It can also be said that the Proximity Sensor is a device that can convert information about the motion or presence of an object into an electrical signal. Proximity sensors can be classified into 4 types, namely Inductive Proximity Sensors, Capacitive Proximity Sensors, Ultrasonic Proximity Sensors and Photoelectric Sensors. The following is a brief explanation of these four types of Proximity Sensors.

- Inductive proximity
  Inductive Proximity Sensor is a proximity sensor that is used to detect the presence of metal, both ferrous and non-ferrous.
- Capacitive Proximity
  Capacitive Proximity Sensor adalah Sensor Jarak yang dapat mendeteksi gerakan, komposisi kimia, dan tingkat komposisi cairan maupun tekanan.
- Ultrasonic proximity
  Ultrasonic Proximity Sensor is a proximity sensor that uses an operating principle similar to that of radar or sonar, namely by generating high-frequency waves to analyze the echoes received after they are reflected from approaching objects.
- Photoelectric proximity
  Photoelectric Proximity Sensor is a proximity sensor that uses light-sensitive elements to detect objects. Photoelectric Proximity Sensor consists of a light source (Emitter) and Receiver (Receiver).

Photoelectric Proximity Sensor is a sensor used in smartphones with the design used in the smartphone is a defuser, where the transmitter and receiver are placed simultaneously and use light reflected directly from the object to detect. The selection of this type of photosensor must consider the color and type of object surface (rough, smooth, blurry, bright). In the diffuse design, it has a similar shape to the retro reflector but the working principle is different if the retro reflector will be worth 1 if the receiver does not receive light while the diffuse is the opposite because the light emitted is in all directions so if there are objects in front of the sensor it will reflect some light to the receiver and when the light received by the receiver is sufficient, the sensor will be worth 1. To clarify the meaning, see Figure 1 and the logic in Table 1 (Tehuayo et al., 2018).

Table 1
Proximity sensor logic

Emiter	Receiver	Sensor
0	0	0
0	1	0
1	0	0
1	1	1

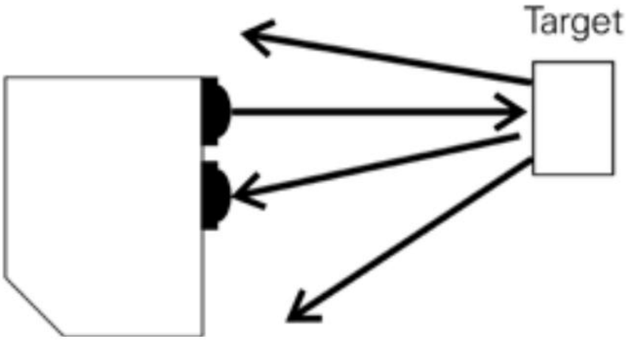

Figure 1. Diffuse working principle (Tehuayo et al., 2018)

Proximity function on a smartphone

The proximity sensor is mandatory equipment that has been used by some smartphone or smartphone manufacturers today. When a smartphone user makes a phone call or receives a call, the smartphone will be brought to his ear. The proximity sensor will detect an object that is approaching it and give a signal to turn off the touch screen function so that the touch screen will not respond if it is touched by the ear or other body parts. However, when the call or phone reception is finished and the smartphone moves away from the ear, the proximity sensor will send a signal to reactivate the touch screen function. Thus, the touch screen function will be active again and the screen will come back to life. In general, for every smartphone that we know today, especially the Samsung brand, the proximity sensor used is a type of photoelectric proximity because it works on a principle like a transistor as a switch. This sensor works due to the activity or movement of light, light energy will be converted into an electrical signal. The concept used is the reflection of light waves emitted to objects by the transmitter and then the reflected waves are received by the receiver (Jackman, 2020; Sukarasa et al., 2018; Narváez & Castro, 2021).

Research Method

The data collection process starts from November 6 to 14, 2020. The data taken is the maximum distance value of the proximity sensor from several Samsung smartphones. This is done to find out whether each Samsung smartphone has a different level of responsiveness. The difference is obtained from the comparison of data from each smartphone that has been measured. Data retrieval is done by giving the object in front of the sensor from a distance of ± 30 cm and moving it closer to the sensor until the sensor is worth 1. Observations were made together with the PKL activity supervisor and the results were recorded. After the data is obtained, the data is processed to find the average value so that the level of responsiveness can be compared on each smartphone (Mylonas et al., 2013; He et al., 2017; Wu et al., 2013; Sianturi et al., 2022). To determine the level of accuracy of the data taken at the time of measurement, one can use the standard deviation, relative error, and correctness error. The following is the formula for calculating the standard deviation.

$$\Delta X = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n(n-1)}} \quad (1)$$

description:
X = standard deviation
X_i = measured variable
X = average of measured variables
n = lots of data

From equation (1), it can be obtained the calculation of the relative error with the formula:

Relative Error=ΔX/X ×100% (2)

Then, from equation (2), the correctness error is obtained, with the formula:

Correction error=100%-Relative error (3)

The results obtained from the measurement of the responsiveness level of the proximity sensor on Samsung smartphones were processed with Microsoft Exel to obtain the average value, standard deviation, relative error, and correctness error. The following is the measurement data obtained during the Field Work Practice.

Table 2
Measurement data

No	Type	Sensor response distance (cm)									
		1	2	3	4	5	6	7	8	9	10
1	J3 pro	6,50	7,50	8,00	7,00	6,80	7,50	7,00	6,50	7,00	7,00
2	J5prime	5,00	4,50	6,00	4,80	5,50	5,00	4,80	6,00	4,50	5,00
3	S7 edge	10,00	12,00	10,50	11,00	10,30	11,00	11,20	11,50	10,50	11,00
4	S8	8,00	11,50	9,00	9,50	8,80	10,00	11,00	10,20	9,50	9,00
5	S8+	9,00	10,50	9,70	10,00	9,80	9,50	10,20	9,20	9,00	10,00
6	A6	6,00	7,00	6,50	8,00	7,50	6,30	6,80	7,00	7,80	7,30
7	S9+	8,50	11,50	11,00	9,00	10,00	9,50	10,00	10,50	9,00	9,30
8	A10s	3,30	3,80	5,00	3,50	4,50	3,00	5,50	6,00	5,50	4,00
9	A20s	10,00	8,00	7,50	9,00	8,50	9,50	8,30	10,00	8,00	7,00
10	A21s	11,00	11,50	13,00	12,50	11,30	12,20	11,40	11,80	12,00	13,00

From the data in table 2, it will be processed to find the average value so that it can be compared with each smartphone and to determine the level of accuracy on each smartphone. From all the data and calculations that have been obtained, each smartphone can be compiled into one table which can be seen in table 3.

Table 3
Comparison of the average measurements of each smartphone

No	Type	$\bar{X} \pm \Delta X$			truth error	
1	J3 pro	7,08	±	0,148174	97,90715	%
2	J5prime	5,11	±	0,173494	96,60482	%
3	S7 edge	10,9	±	0,187972	98,27549	%
4	S8	9,65	±	0,333417	96,54491	%
5	S8+	9,69	±	0,161555	98,33277	%
6	A6	7,02	±	0,204287	97,08992	%
7	S9+	9,83	±	0,301865	96,92915	%
8	A10s	4,41	±	0,330807	92,49871	%
9	A20s	8,58	±	0,324482	96,21815	%
10	A21s	11,97	±	0,221635	98,14841	%

Results and Discussion

From the results of the calculation of the measurement data, the highest average value is 11.97 which is owned by the A21s type. So the sensitivity level of the proximity sensor on the A21s type smartphone is superior to other types of smartphones that have been measured. This is because the proximity sensor receiver on the A21s type is bigger than the proximity sensor receiver in the previous type and also the A21s type is a new type that came out in 2020 so the specifications are higher.

Samsung smartphones have different levels of responsiveness, when viewed every year for the same increase although not too significant like the galaxy S8 and S9 which only have a difference of 0.18mm when viewed from the class point of view between the lower-class series and the upper-class series in the same year will have a more significant difference like j3 pro 2016, J3 prime 2016, and S7 edge 2016 it can be seen that from the J series the highest in 2016 is J3 pro with an average response distance of 7.08cm while on the S7 edge which is a smartphone the upper class at that time had an average level of responsiveness of 10.9cm which made the difference between the two 3.81cm.

The level of data accuracy is based on the correctness error on each smartphone, namely the J3 Pro smartphone type of 97.91%, J5 Prime 96.61%, S7 edge 98.28%, S8 96.54%, S8+ 98.33%, A6 is 97.09%, S9+ is 96.93%, A10s is 92.50%, A20s is 96.22%, and A21s is 98.15%. For the level of accuracy of the measurement data, the most accurate in this measurement is the S8+ smartphone type. The accuracy of the data may be affected by inconstant hand movements (Paziewski et al., 2021; Guido et al., 2012; Rinartha et al., 2018).

Conclusion

- Based on the type of proximity sensor used in the smartphone is photoelectric proximity where the way it works is by using a light-sensitive element as a receiver (receiver) and light emitter (emitter).
- The sensitivity level of the proximity sensor can vary due to the different size of the receiver area, this happens because the wider the receiver size, the

more photoelectric light will be caught when a reflection occurs, and conversely, the smaller the receiver, the less photoelectric light will be caught when it occurs. reflection.
- Samsung smartphones have different levels of responsiveness, if reviewed every year for the same class, the increase is not too significant, but if viewed from the class, the lower-class series and the upper-class series in the same year will have more significant differences (Stoyanov, 2000; Sheinker et al., 2016; Eshankulovna, 2021).

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