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Development of Low Cost Conductive Ink for Kid Education Toy (KiEduInk)

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----------ABSTRACT----------

Nowadays gadgets are the number one source for parent to use to educate their children and also for their daily entertainment, but the gadget itself can affect the brain growth of their kids by using the gadget for a long period of time, which their kid will be expose to excessive light and some radio wave that emitted from their gadget. Our objective is to make an attractive educational application according to the current technology outside and to make sure it is affordable for all family standards. With the conductive ink in the market, it may help parents to use it and replace the gadgets for their kid education. With the using of conductive ink, it can boost their kid creativity by making their own way of learning and to make sure everything their doing is perfectly safe to avoid worrying for parents. Because conductive ink are water-based paint and it is nontoxic, easy to wash and it versatile so can be use it anywhere.

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I. INTRODUCTION

The KIEDUINK (Low Cost Conductive Ink for Kid Education Toy) is a water-based paint which it has a property to conducting electricity. It is typically created by infusing graphite and other conductive materials into ink. The purpose of using graphite in conductive ink is because it contain delocalized electron (free electron), these electron can move through the graphite, carrying charge from place to place and allowing graphite to conduct electricity. Graphite also can be obtain from pencil lead which it the production of conductive ink are low cost and the other ingredient also came from daily uses. The graphite itself are toxic which are harmful to inhale or eat and not easy to wash when it in powder state, but when the graphite are mix with the water it become a non-toxic solution which it is very safe to handle and use not only for adults but it is safe for a kid too. When creating conductive ink the resistance of the ink is tested to get the lowest resistance by measuring the resistance per cm of the ink used , to make sure that the ink are efficient and can be used for a longer period.

II. METHODS

The project methodology describes the procedures that are used in order to fulfil the objectives of the proposed project. This is important to know the progress of work for the project. The methodology includes the flowchart diagram and project planning that shows the project flow, the project designing in software, hardware prototype and troubleshoot of project.

A. Project Flow

Firstly, started with did a research using internet or book to find a suitable component and capacitive touch sensor to use. After that, the circuit was design and test. If there are any problem during troubleshooting, the circuit will be redesign. Then, the software development for the microcontroller was made at Arduino software. The functionality of the sensor was tested here. If there is a problem, the coding will be redesign again. After the circuit and software development function properly, the prototype was made.

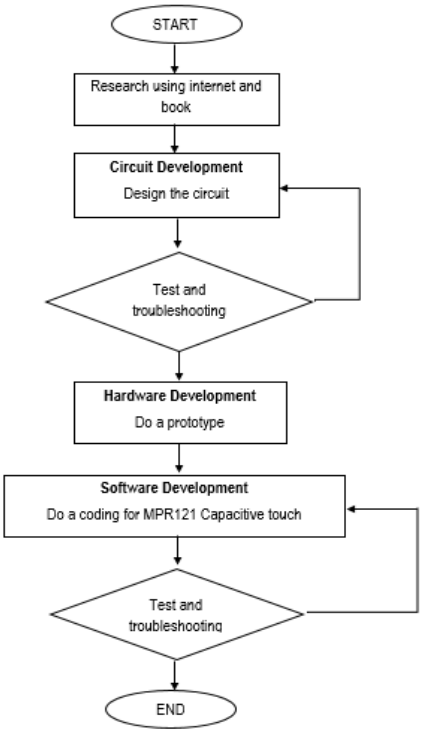

Figure 1: Project Flow for Kieduink

Figure 1 show that the project starts with the research. This research was made to find a suitable component, circuit, microcontroller and sensor that want to use in this project. The sensor that use for this project is Mpr121 Capacitive touch sensor. The coding was designed and upload in Arduino Software to test the functionality of the sensor. Besides that, the other components should be reviewed before choose as components in the circuit that was choose. After the circuit was functioning, the next step was to make a prototype. The board will not have the casing. Because it will be looked like a starter kit. There will be have the jumpers or wires to connect from the sensor input to the ink. After the circuit is functioning, the next step was to make a programing for conductive touch system. The next step is to design the interface for conductive touch system. The function of interface is to show the change of sensor signal. Lastly, the test and troubleshooting were made after the circuit was finish made and after the prototype was made.

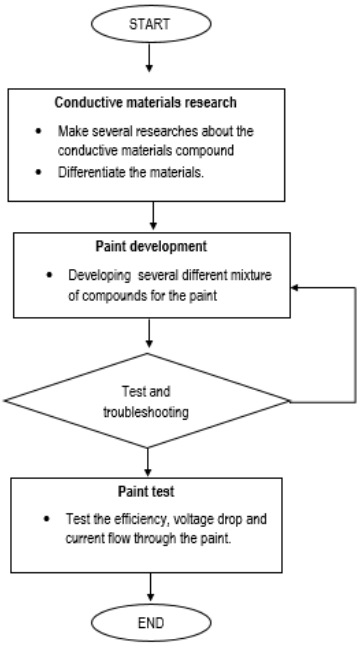

Figure 2: Project Flow for Conductive Ink

Figure 2 shows the project flow for development of conductive ink. The research on the conductive paint was doing itself. By saying that, conductive paint can be made up from the conductor materials include allotrope of carbon, copper, aluminum, platinum, gold, silver, ionized water and tree. From this research, we are focusing on Graphite which is an allotrope of carbon to make the conductive paint. Conductive paint is electrically conductive. Is a non-toxic carbon-based conductor paint. [2] Several mixtures are made to find the comparison between their conductivity, resistivity, efficiency, voltage drop, also current flow. The measurement or quantity of the mixtures being used are measured and tested until get the desired appearance (like a water color) for every mixtures. For test and troubleshooting were test the ink from different mixtures. The quantity of the materials used in the mixtures are important in affecting the conductivity. The ink cannot be too watering and too thick. It must be in moderate humidity. The ink was tested on a paper and connected with the 9v battery supply with at the end of it has an LED. Difference length of ink, and thickness of the ink on the paper were tested. The reading also was recorder and plotted on the graph between several mixtures.

B. Research about Conductive Ink

Conductive Inks are paints infused with conductive particles like silver and carbon. They are used to create both hand-painted and printed electrical traces on paper, and are at the base of one of the most promising branches of material science: printed electronics. Printed electronics allow us to create cheap, flexible and recyclable circuits using standard paper, a slightly modified document printer and conductive ink. The types of conductive ink currently available outside university laboratories are still too resistive to replace copper and other conductors we use for traces [1]. For education, conductive ink is a new level for children to be more creative, critical and innovative about electrical, electronic, and science as a new beginner. Made up from organic ingredients it is safe for human when handle the conductive ink it will not irritated their skin. It is safe for human if they swallowed the conductive ink. The current is low It is safe for human to handle with bare hand. The voltage drop is low as it can conduct electricity. The texture is suitable for drawing. Being easy to use and drying at room temperature

III. RESULT AND DISCUSSION

The material used in this product includes graphite, water, salt and acrylic paint. The main material used to grind the conductive paint is graphite. Graphite is a mineral composed exclusively of the element carbon. It has the same chemical composition as diamond, which is also pure carbon, but the molecular structure of graphite and diamond is entirely different. This causes almost opposite characteristics in their physical properties. Graphite is soft and slippery because there are only weak intermolecular forces between its layers

Graphite is a good conductor of heat and electricity. This is because like metals, graphite contains delocalized electrons. These electrons are free to move through the structure of the graphite.Water conducts electricity since there are small amounts of calcium and magnesium salts dissolved in it, pure water (distilled or deionized) has nothing at all in it that can conduct electricity. [3] Salt is a crystalline compound, sodium chloride (NaCl) occurring as a mineral, a constituent of seawater and more. Sodium chloride (NaCl) called electrolytes, as they are able to conduct electricity. Other than that, sodium aluminium silicate occurs naturally as an acid salt combination of silicon, sodium, aluminium and oxygen. [4] It is also used in grinding the conductive paint.

Acrylic paint is a fast-drying paint made of pigment suspended in acrylic polymer emulsion. Acrylic paints are water-soluble, but become water-resistant when dry. It is depend on how much the paint is diluted with water, or modified with acrylic gels, media, or pastes, the finished acrylic painting can resemble a water color or an oil painting. [5] It is typically used for crafting, or in art classes in schools because it does not require any chemicals, and rinses away with just water. It also is less likely to leave a stain on clothes than oil paint. The use of acrylic paint in this conductive paint is to make the paint moisture and ready to use. It is also act as a drying element, so the user will only take a few minutes to wait for it to dry.

The performance of the developed product is compared with the well-established product as well as other ingredient. The performance parameters are voltage drop, resistivity and also the current flow between the mixtures.

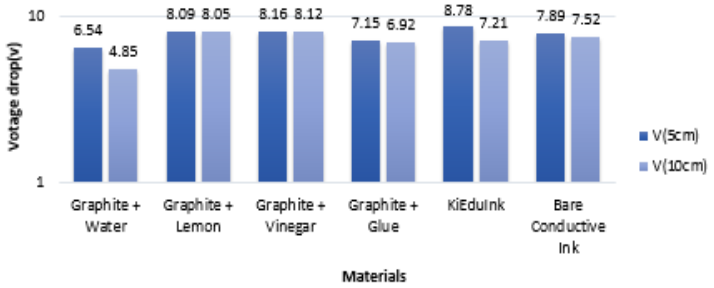

Figure 3: Comparison of voltage drop

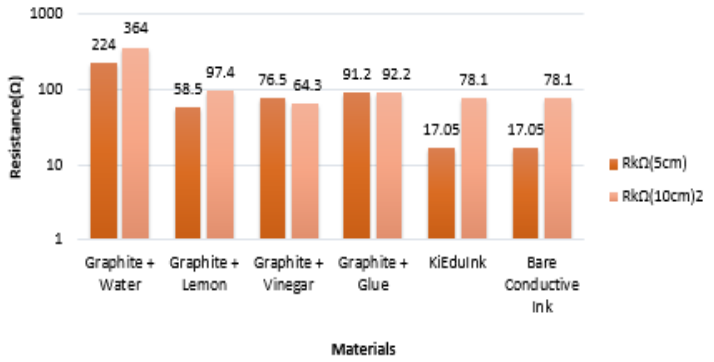

Figure 4: Comparison of resistance

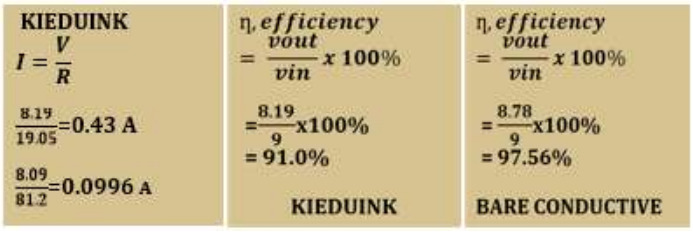

Figure 5: Comparison of efficiency

The comparison graph shows that KIEDUINK paint and Conductive Bare Electric Paint have slightly different value after its dry and connect to the supply. As we can see from Figure 3, 4 and 5, the voltage value of KIEDUINK with length test of 5 cm and resistance of 19.05 kΩ gives 8.19 V and 10 cm length and resistance of 81.2kΩ with 8.09 V by 9 V supply battery. While Conductive Bare gives 8.78 V for 5cm length and resistance of 17.05 kΩ and 8.21 V for 10 cm length and resistance of 78.1 kΩ with the same supply of 9V battery. The value for KIEDUINK product can be consider because the aim of this project is low cost and affordable to family from every levels. This final results were gained after doing several test to a different materials. The voltage values were measured after the paint completely dry because it will be more conductive and voltage easy to go through. The current flows through the conductive paint are also low and safe to use. The efficiency of this project is also comparable and it can be improve in future with by using proper equipment to measure the values of material used.

IV. Conclusion And Recommendation

In a nutshell, we would like to prove that devices no longer have to look high tech to be high tech and our goal is to put interactivity onto objects people don't expect. In the presence of conductive ink, we hope to attract the attention of children to learn in their own way to create. The product has the appearance and consistency of runny marmite, but dries quickly when exposed to the air. Conductive paint opens up an enormous range of creative opportunities By using conductive
ink as learning tools, children will able learn it through art,
games, music and many more. This will boost the children creativity, soft skill and others during learning progress. As conductive paint becomes increasingly common, we can look forward to a future. This is one of the new alternative and creative way to introduce new era of youth education learning using conductive ink.

Soon, it can be upgraded to be an ink and adhesive to repair PCB board for university students. This is another benefit for students to help them complete their circuit test or experiment before they apply it to a bread

board. From here we can see that, KIEDUINK ink help to cut cost from buying wires and jumper. Moreover, their circuit test will be look more simplified and easy to use.

Acknowledgment

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