FEM Study on Effects of Laptop Heat on Human Body

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***Abstract*— The rise of portable computing has affected human life in both positive and negative ways. There is an increase in the usage of portable devices like laptop computers are getting more popularity among businessmen, students, and teachers due to small size and lightweight. Most people's feel comfortable using laptops on their legs. Usage of a laptop for a long time on the top of the legs can cause heat generation from different parts inside the laptop. The laptop CPU, battery, hard drive, power supply, and CD/DVD drives are big sources of heat generation inside the laptop. Laptop heat can cause erythema ab igne, Pinkish, and brownish skin. Laptop heat effects are investigated in this research through the different distances between the laptop and the human leg. Heat transfer into the leg through different distances are measured to check the safe distance between the laptop and human leg. Heat transfer analysis between laptop and human leg are performed in finite element analysis (FEM).**

***Keywords*– FEM Study, Thermal Radiation and Laptop Injury**

I. INTRODUCTION

Laptop computers are more popular today because of portability, lightweight, and smaller size and mostly the better battery power in the laptop is more popular than before. You can use laptops in many positions Sitting down and most commonly using your laptop on your lap [1]. Laptop generates heat because of different parts generate very high temperature inside the laptop. High temperature can cause toasted skin syndrome this is the condition where the skin becomes pinkish or brownish and gets red marks on the skin. This problem can cause Itchiness and feels burns on the skin and sometimes it can leave with deep red marks [2]. Through many studies, researchers have found evidence that radiation effects on the human body from wireless devices and laptops are harmful to human health and it can lead to cancer. Skin contact with any source of heat for a long time can cause Erythema ab igne [3].

Laptops are a big source of heat generation while using on a lap. The laptop battery, hard drive, power supply, and CD/DVD drives are big sources of heat generation inside the laptop. Thermal radiation from a laptop used on top of legs for a long time is the cause of pigmentation, toasted skin syndrome. Continuously closed to thermal radiation can produce a skin burn [4]. Heat transfer analysis performed between the leg and laptop through finite element analysis (FEM). As some resources show that a laptop can generate 43°C-47°C while using on a lap for a long time [5]. The laptop minimum temperature set to 22°C as room temperature and to do analysis maximum temperature set to 47°C.Heat transfer measured through different distances between the laptop and human leg starting from 0mm, 25mm, 65mm, 124mm,164mm, 214mm, 282mm, 326mm up to 335mm.

II. METHODOLOGY

A. Modeling

Model for laptop and human leg were created in open source modeling software laptop has 2 bodies 2468 nodes and 11229 elements after generating the mesh and human leg has 13 bodies 1723 nodes and 826 elements after generating the mesh.

B. Finite element analysis (FEM)

Simulations are done through FEM based software. FEA is a simulation of any physical model design to computer model designing to stressed and analyzed to get specific results through mathematical models. It can be used for new product design or existing product refinement. Through finite element analysis, we are predicting that how on a real-world object will react when we put forces, vibration, or heat on that object whether it will break or wear out or it will work the way it was designed. Through this, we do virtual prototyping in hours rather than spending weeks on hard prototyping.

Through finite element analysis, we can increase productivity and revenue. There are commonly two types of analysis used by industry 2D modeling and 3D modeling. 2D models are very simple and do not require high specification computer analysis can be done on a normal computer but in 2D the accuracy of the result can be less. 3D modeling analyzation can produce more accurate results, but it requires high specifications computers to get accurate results. The programmer can insert different algorithms in these models which makes the system behave linearly or non-linearly. Linear systems are less complicated and usually do not consider plastic deformation. Non-linear systems can do plastic deformation and many also can test a material all the way to fracture [6].

C. Materials

For the laptop model, ABS plastic is selected. Plastic body laptops are made of acrylonitrile butadiene styrene and known as ABS plastic. Such kind of plastic material is inexpensive and lightweight, and its density is 1.08 grams per cubic centimeter [7].

For the human leg body,
Mooney Rivlin hyperplastic material properties were used in the simulation. As human skin behaves
like hyperplastic material.
Mooney Rivlin hyperplastic material properties are widely used to simulate the human body tissues [8], [9].

D. Simulations setup and boundary conditions

Simulation is performed in steady-state thermal. It has six steps engineering data, geometry, model, setup, solution, and results. Materials are selected through engineering data in FEM software material library. ABS plastic is used to assign material to the laptop body and moony Rivlin material properties are used for the human leg model. 3D models are loaded into geometry. In model and setup simulations parameters were set to generate a mesh and boundary conditions. Initialized the temperature for simulations minimum at 22°C and maximum to 47°C. Thermal radiation, convection, and temperature conditions are set for both bodies. The ambient temperature set to 22°C and correlation was set to surface to surface and emissivity is set to 0.7. Solved the solution and generate results.

III. RESULTS

As some studies show that laptops can produce 44°C-47°C heat while using on the lap for a long time. [5] The minimum temperature for the laptop was set to 22°C and the maximum temperature is set to 47°C. The laptop is considered as a heat source and temperature transfer from a laptop to the human leg is measured through different distances from 0mm, 25mm, 65mm, 124mm, 164mm, 214mm, 282mm, 326mm up to 335mm. Time is set to 300 seconds (5 Minutes).

TABLE 1
RESULTS BY DISTANCE

	Distance	Maximum [°C] on Leg
1	0mm	38.279
2	25mm	36.901
3	65mm	34.602
4	124mm	31.848
5	154mm	30.732
6	214mm	28.548
7	282mm	27.023
8	326mm	26.078
9	335mm	23.33

Heat transfer is measured through 0mm distance and maximum temperature transfer to the leg is recorded 38.279°C**.** For the results see (Fig. 1**).**

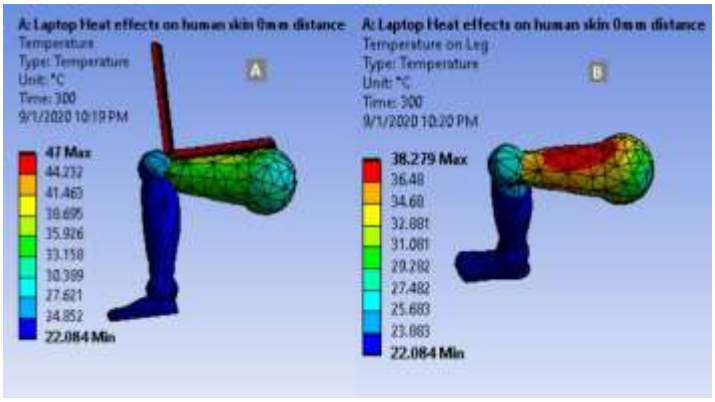

Fig. 1: (A) 0mm Distance, (B)38.279°C Maximum on leg

Heat transfer is measured through 25mm distance and maximum temperature transfer to the leg is recorded 36.901°C**.** For the results see (Fig. 2**).**

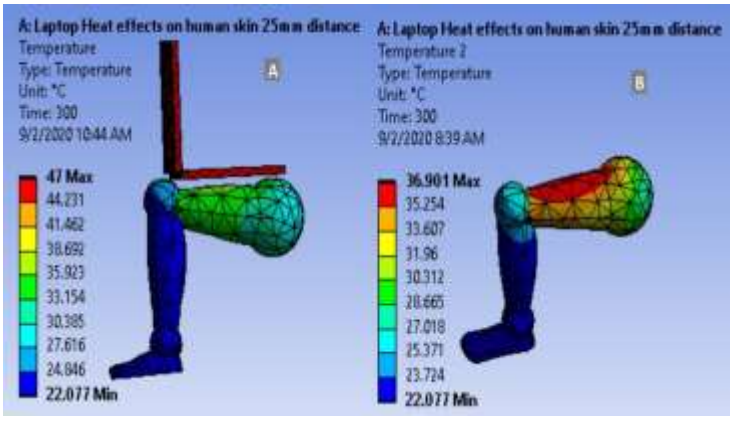

Fig. 2: a) 25mm distance, b) 36.901°C Maximum on leg

Heat transfer is measured through 65mm distance and maximum temperature transfer to the leg is recorded 34.602°C**.** For the results see (Fig. 3**).**

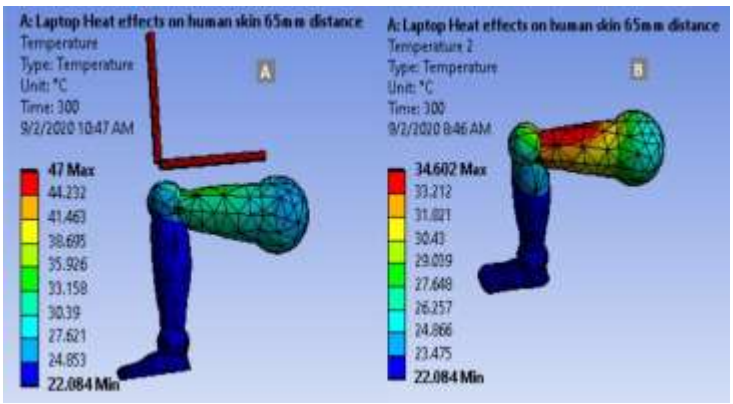

Fig. 3: a) 65mm distance, b) 34.602°C Maximum on leg

Heat transfer is measured through 124mm distance and maximum temperature transfer to the leg is recorded 31.848°C**.** For the results see (Fig. 4**).**

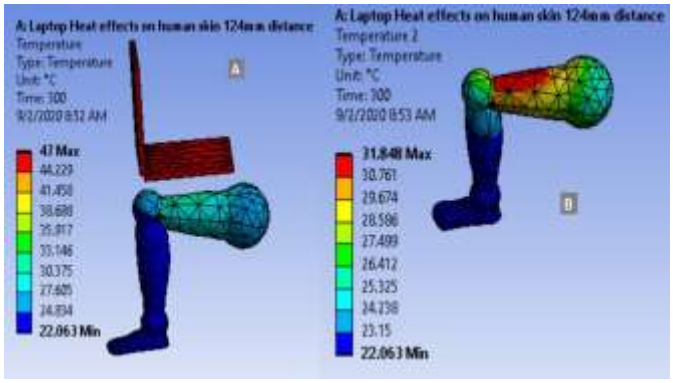

Fig. 4: a) 124mm distance, b) 31.848°C Maximum on leg

Heat transfer is measured through 154mm distance and maximum temperature transfer to the leg is recorded 30.732°C**.** For the results see (Fig. 5**).**

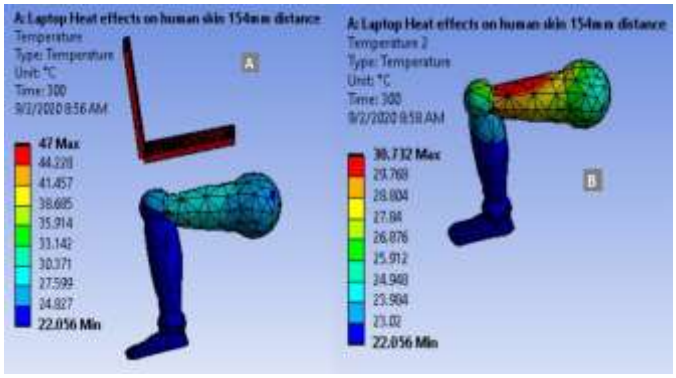

Fig. 5: a) 154mm distance, b) 30.732°C Maximum on leg

Heat transfer is measured through 214mm distance and maximum temperature transfer to the leg is recorded 28.548°C**.** For the results see (Fig. 6**).**

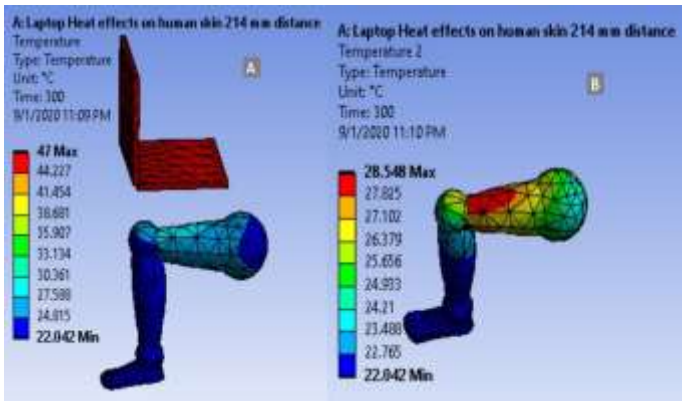

Fig. 6: a) 214mm distance, b) 28.545°C Maximum on leg

Heat transfer is measured through 282mm distance and maximum temperature transfer to the leg is recorded 27.023°C**.** For the results see (Fig. 7**).**

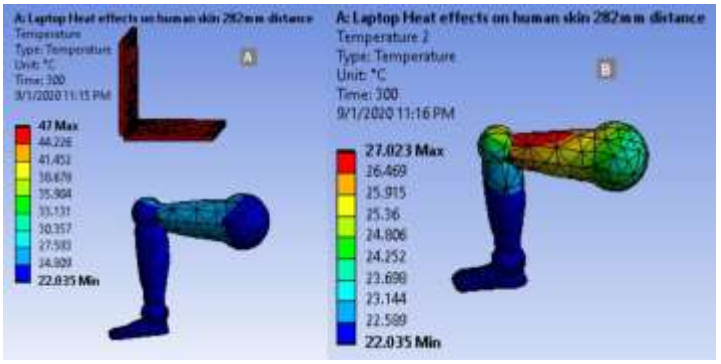

Fig. 7: a) 282mm distance, b) 27.023°C Maximum on leg

Heat transfer is measured through 326mm distance and maximum temperature transfer to the leg is recorded 26.078°C**.** For the results see (Fig. 8**).**

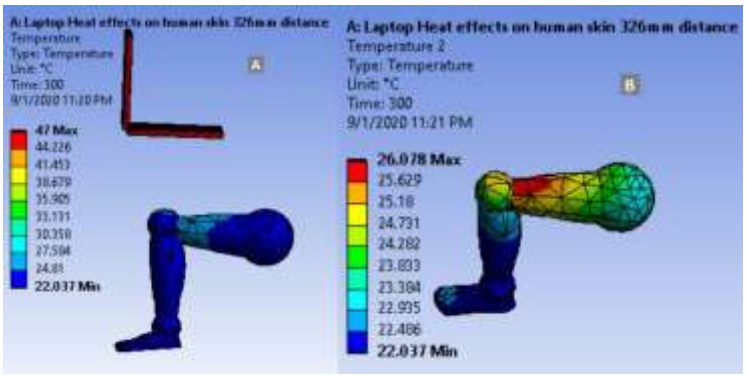

Fig. 8: a) 326mm distance, b) 26.078°C Maximum on leg

Heat transfer is measured through 335mm distance and maximum temperature transfer to the leg is recorded 23.33°C**.** For the results see (Fig. 9**).**

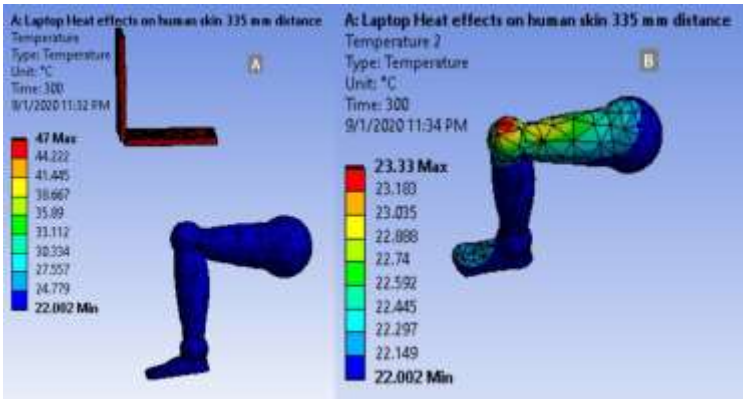

Fig. 9: a) 335mm distance, b) 23.33°C Maximum on leg

From the analysis above has been observed that the maximum temperature transfer on a human leg through 0mm are 38.279 °C and it's decreasing up to 23.33°C on 335mm.

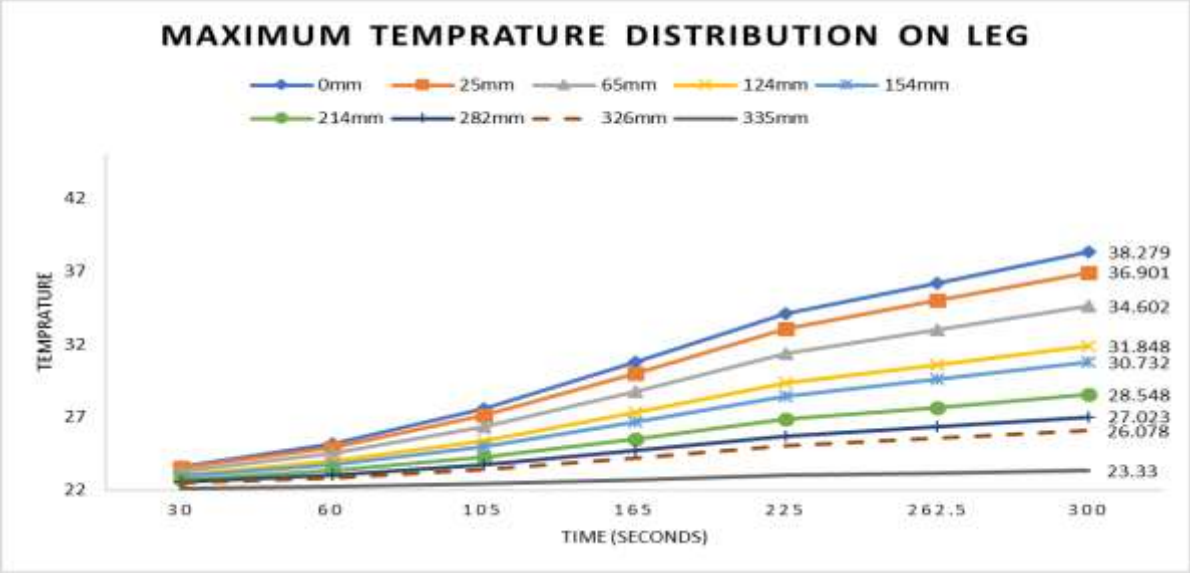

Fig. 10: Maximum Temperature Analysis

IV. CONCLUSION

The effects of laptop heat on the human body have been investigated in this research. An analysis is done on the effects of temperature from the laptop using the top of the leg for a long time. The laptop was considered as a heat source and heat transfer mood is thermal radiation. An analysis is performed in steady-state thermal. Laptop temperature was considered a minimum 22°C degree as room temperature and a maximum 47°C degree and heat stress are checked on the human body. An analysis is performed through different distances 0mm, 25mm, 65mm, 124mm, 164mm,214mm,282mm,326mm, and 335mm, and from the results temperature maximum values are selected. Air was considered for the heat transfer source between the laptop and the human leg. Analysis are started form 0mm distance and maximum heat transfer to the leg was measured 38.279°C and then increased the distance to 335mm and maximum heat transfer is measured 23.33°C. From the above analysis, it has been observed that 335mm distance is safer than using a laptop directly on top of the legs.

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