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Topological Approach for Mechatronic Systems

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Abstract: In this study, we propose a topological methodology for mechatronic systems which is much more focused on the mechanical part of the mechatronic system based on the work of Casner. The methodology starts with the optimization of the electronic and control models (control command). Then, a characterization is done to highlight the optimization constraints that may affect the mechanical model. Finally, the topological optimization of the mechanical model is done by taking into account the physical and functional constraints brought by the control-command part. A topological approach to mechanical systems integrating the constraints of the control-command part is proposed. We have applied this approach to a mobile robot "ELEGOO smart car" and we have made a comparison between the methodology of integrated mechanical systems and that of a simple mechanical system.

Keywords: Topological Methodology, Mechatronic System, Optimization, Topological Approach, Characterization

Introduction

The definition of mechatronics has evolved from the original definition of the Yasakawa Electric Company. Yasakawa defined mechatronics this way (Yaskawa-Electric, 1969; Kyura and Oho, 1996): The word mechatronics is made up of the "mecha" of the mechanism and the "tronic" of electronics. In other words, the technologies and products developed will increasingly incorporate electronics into the mechanisms, intimately and organically, and make it impossible to tell where one ends and the other begins. The definition of mechatronics continued to evolve after Yasakawa suggested the original definition. The journal "International IEEE Transactions on Mechatronics", established in 1996, defines: "Mechatronics as a synergistic combination of mechanics, electronics, computers, and control" (Kyura and Oho, 1996; Mori, 1969). The standard NF E01 -010 gives a more comprehensive definition of mechatronics as "an approach aiming at the synergistic integration of mechanics, electronics, automation, and computer science in the design and manufacture of a product in order to increase and/or optimize its functionality"(Afnor, 2008; Diagne, 2015). Figure (1) shows us the different disciplines constituting mechatronics.

The topology of mechanical systems is much more akin to topological optimization, which is a mathematical method for finding the optimal material distribution in a given volume under stress (Allaire *et al.*, 1996).

Indeed, its main interest lies in a considerable lightening of the parts studied, which leads to a reduction in the total mass of the part. This is done with the aim of reducing the cost of manufacture, transport, and purchase (Samon and Tchouazong, 2022).

The increasing development of technology and the current increase in user requirements are driving manufacturers to improve mechanical systems by integrating components from different technologies into complex systems known as mechatronics. There is a need to propose a method of topological optimization of these systems always with the aim of reducing the total mass.

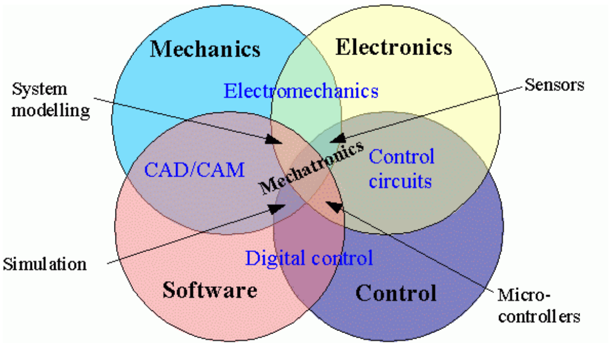

Fig. 1: Multidisciplinarity of mechatronics (Turki, 2008; Bishop, 2002; Salem and Mahfouz, 2013)

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Indeed, mass matters a lot even in the case of vehicles using complex (mechatronic) technologies. Electric vehicles, for example, have a range limited by the capacity of their battery. This limiting distance would increase if the total mass of the vehicle decreased, we will speak here of the topological optimization of the electric vehicle (Deserranno, 2019).

In our work it is necessary to differentiate between the topological optimization we are working on and multi-objective optimization, which is also one of the distinct approaches in engineering and design like topological optimization.

Multi-objective optimization seeks to optimize several objectives simultaneously, often in conflict with each other. Used in fields where several criteria need to be taken into account, such as product design, logistics, or resource management. Using methods to find a balance between different objectives, such as the method of integrating intelligent algorithms to help designers make design decisions, can considerably improve the efficiency of the work presented in the article by Fu *et al.* (2024). Multi-objective optimization uses approaches such as Pareto fronts, and genetic algorithms for multi-objective optimization features. These genetic algorithms are better elucidated in Fu *et al.* (2024).

In summary, topological optimization focuses on the optimal hardware distribution for a single objective, while multi-objective optimization aims to balance several objectives simultaneously.

In the literature, mechatronic topology is not very well explored. There are some topological approaches applicable to mechatronic systems: The KBR topological graph, and the MGS language which both amount to the topological modeling of systems from topological graphs. We also have the topological approach proposed by Casner *et al.* (2011) which proposes a principle of topological optimization of mechatronic systems based on multilevel optimization. In topological optimization, we can distinguish the case where the whole system is optimized in one operation and the multilevel optimization (Coelho and Breitkop, 2009).

Optimizing the complete system in one operation is already done on mechanical systems. Due to the multidisciplinary nature of mechatronics, it is necessary to use multi-level optimization (Coelho and Breitkop, 2009) which consists, for example, of performing a first optimization of different subsystems constituting the mechatronics (mechanical, electronic, automatic...) before performing a global optimization of the mechatronics system as shown in Fig. (2).

Casner *et al.* therefore propose to perform a topological optimization of each sub-component constituting the mechatronic system (mechanical component, electronic component, control component...) and then to assemble the different sub-components to obtain the mechatronic system which can be further optimized in a last step to obtain the optimized mechatronic system. The topological optimization principle proposed by Casner *et al.* (2011) is presented in Fig. (3).

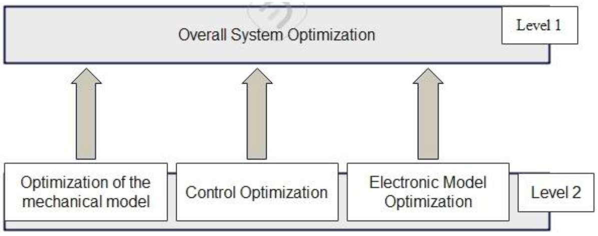

Fig. 2: Possible multi-level optimization methodology (Coelho and Breitkop, 2009)

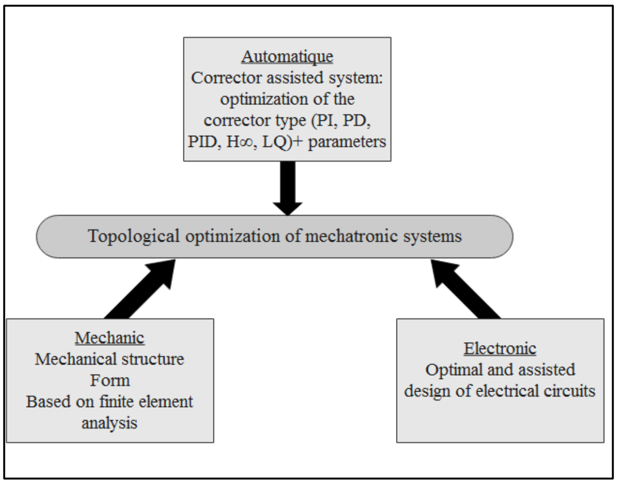

Fig. 3: Principles of topological optimization of mechatronic systems

We ask ourselves a question about the principle of topological optimization of mechatronic systems. How will the assembly of the different optimized subsystems be done to obtain the optimized mechatronic system? The application of this principle has a disadvantage in the assembly. Obtaining a complete (assembled) optimized system will be a very big challenge in the assembly. It might be difficult or even impossible. This leads us to the proposal of a topological approach.

Materials

To carry out our optimization work we used:

- Solid works 2020 is software for solid modelling, simulation, computer-aided design, computer-aided engineering, 3D CAD design and collaboration, analysis and product data management. Our work was much more focused on the topological optimization of the mechanical part of a mechatronic system, the stages of which we presented. The work was a simulation using solid works software. The software enabled us firstly to draw up a diagram of our ELEGOO Smart Car mobile application (part by part diagram and then assembly). We then selected the various parts that would be subject to stress, applied the corresponding materials and carried out the simulation on these parts

- We used EdrawMax for our different diagrams. EdrawMax is a tool that helps you create diagrams ranging from flowcharts and network diagrams to HVAC diagrams, floor plans, computer graphics, 3D maps, flowcharts, quality diagrams and safety diagrams
- We used ELEGOO smart mobile robot, which is an educational kit designed for beginners and professionals to gain practical experience in programming, electronic assembly and knowledge of robotics. It is presented in the application cases section (Fig. 8)

Methodology

A mechatronic system consists of several mechanical parts. The parts we are interested in are the parts that are in contact with the components of other disciplines. Figure (4) shows us a procedure for the application of the topological optimization principle of integrated mechanical systems.

Figure (5) shows the topological optimization procedure used based on the SIMP.

Characterization of the Control and Command Part

In a mechatronic system, in practice the control system consists of:

- The electronic system which is generally the motherboard of the system made up of electronic components: Transformer, diode, capacitor, transistor, microcontroller, microprocessor, sensor, resistor, led

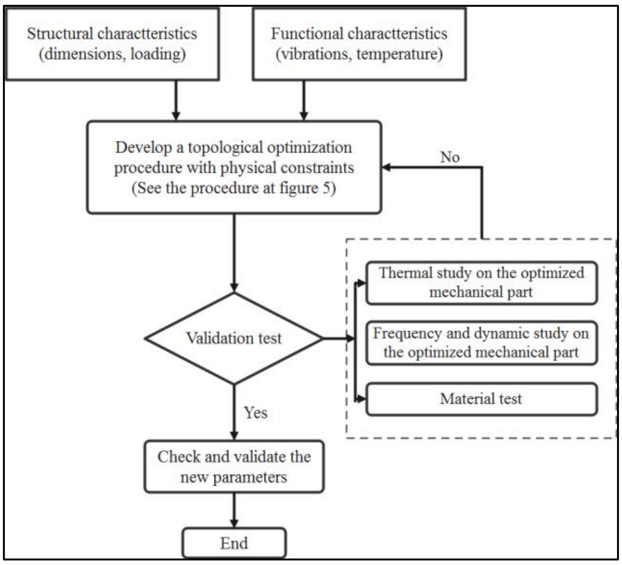

Fig. 4: Methodological flow chart for integrated mechanical systems

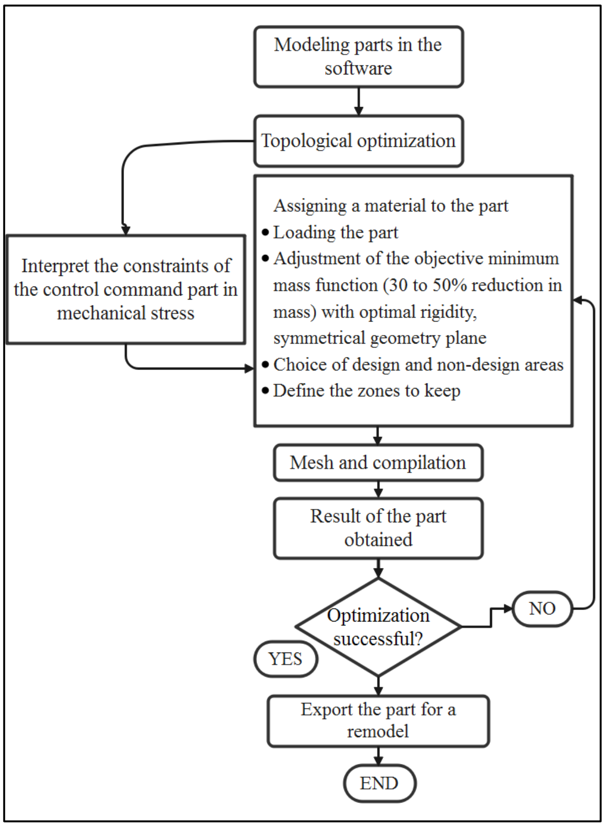

Fig. 5: Topological optimization procedure used

- Controls are made up of several components: Sensors, comparators, and correctors. These control elements are at the same time electronic components, except that the function they perform is a control function pre-programmed by software
- In a control system, the sensor and the motherboard are the components of interest because their physical characteristics (thickness, length, width, weight) can be a constraint for the optimization of the mechanical model. Figure (6) presents a temperature sensor and its physical dimensions

Apart from the physical constraints, there are also functional constraints (temperature and vibration of certain components).

Optimization Constraints that May Affect the Mechanical Model

From this we can highlight our various constraints on the control part that may affect the mechanical model. These constraints will be our optimization constraints and will be presented in two groups.

Physical constraints related to the dimensions or shape (thickness, length, width) of the electronic board or sensor, related to the weights of the electronic board or sensor which can be interpreted during the topological optimization of the mechanical model as a loading.

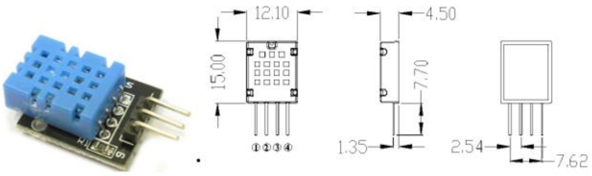

Fig. 6: Temperature sensor and its physical dimensions (Pitch-Technologies, 2021)

Functional constraints related to the operation of certain components. One example is temperature. Some electronic components generate a lot of heat, which affects the choice of material for the mechanical structure (transistors, microprocessors, resistors, etc.). There are also vibrating components (vibrator, hard disk...) that generate vibrations during operation.

We can see after the characterization that we have two types of opposites that can affect the mechanical model during the optimization: The physical constraints and the functional constraints. The physical constraints will intervene at the level of the static study to have the initial parameters of our structure, and the topological optimization so the procedure is defined more in Fig. (5).

The functional constraints will be used for a frequency analysis to obtain the different resonance frequencies of the structure (as the system is subjected to engine vibrations). In most cases, the aim is to avoid a system entering into resonance. The frequency analysis does not calculate stresses or displacements. The dynamic study will use frequencies and eigenmodes to evaluate the response of the structure to dynamic loading at certain points as a function of time. Thermal study: The components of the control and command part give off heat, so a thermal study must be carried out to find out the degree of temperature given off by these components and to check whether the material of the structure is capable of withstanding it.

Proposal of the Topological Approach to Integrated Mechanical Systems

The topological approach proposed by Casner *et al.* (2011), brings together the different methods of topological optimization of systems (mechanical, electronic, and control). This is defined by the topological optimization of each part separately until the assembly and obtaining of the final optimized system by using the topological optimization methods specific to each part (mechanical topological optimization for the mechanical part, electronic topological optimization for the electronic part, and control optimization for the control part). However, it turns out that obtaining a complete (assembled) optimized system will be a very big challenge at the assembly level. Hence, a new principle was proposed which focuses on the mechanical part of the mechatronic system. The principle presents a simple topological optimization of the Mechatronic system and will not present any assembly problems. After optimizing the electronic and control parts, the topological optimization of the mechanical part is done while taking into account the constraints that the other two models (electronic and control model) will bring. Note that in this article the topological optimization of the electronic and control model is not too detailed. The proposed topological optimization principle is presented in Fig. (7).

Our optimization principle is as follows.

It is known that the optimization of the Mechatronic system requires the optimization of all its different disciplines. The topological optimization of the electronic model and then the topological optimization of the control. After the optimization of the electronic model and the control, the optimization of the mechanical model will follow taking into account the integration constraints of the first two optimized models (electronic model and control model). To avoid having at the end a system that is difficult or even impossible to assemble. By noting that the electronic and control part in practice is seen as a single module that can be called the control command.

The topological optimization of the electronic model, which can also be classified as an electromechanical system, is based on the miniaturization of electronic or mechanical components (which become micro-electro-mechanical systems) and the use of an optimized and assisted design of the electronic circuits, which will make it possible, among other things, to reduce the space occupied by the components, lighten the weight, reduce the price and consumption of materials, etc. It would therefore be necessary to know the physical and dynamic properties of these Micro-Electro-Mechanical Systems (MEMS) because, in the optimization of the final mechanical model of our study, their constraints could affect the mechanical model.

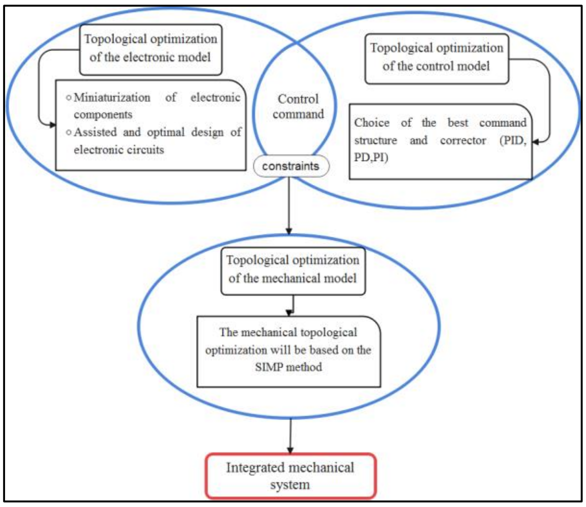

Fig. 7: Proposed principle of topological optimization of mechatronic systems

He (2024) in his article Periodic solution of a micro-electromechanical system examined the periodic motion of the Micro-Electromechanical System (MEMS), which facilitates understanding of its dynamic properties. Furthermore, we cannot talk about mechatronic systems without defining Micro-Electromechanical Systems (MEMS).

Microelectromechanical Systems (MEMS) have been a driving force behind the technological revolution. They are used in a multitude of cutting-edge applications, including Fifth-Generation (5G) mobile networks, chips, ultra-sensitive sensors, robots, tsunami monitoring, and wearable smart fabrics. This is due to their extremely simple structure, ultra-thin size, ultra-lightweight, minimal power consumption, extremely high reliability, and extremely low cost (He, 2024).

For the topological optimization of the control, the controller is optimized. The selection of the control algorithm and the control unit are directly linked to each other. Thus, a better control structure and corrector can be chosen, such as ON-OFF control, P, PI, PD, and PID control, intelligent control, fuzzy control, adaptive control, and neural network control. The main factors that can influence the decision to choose a control unit and algorithm are Simplicity, space and integration, processing power, environment (e.g., industrial, software...), accuracy, robustness, unit cost, final product cost, programming language, safety criticality of the application, time to market requirement, reliability and number of products to be manufactured. For example, we would like the controller to fulfill a certain number of functions, including precision, stability, speed, etc. We will therefore act on the controller's algorithm or program (we can modify it) so that it is even faster, more stable, and more precise because if the information returned by the controller is a little late, the system could be affected.

After the optimization of the electronic and control modules, which we will group into one, i.e., the control command (because in practice in mechatronic systems, it is difficult to separate the electronic part, the control part, and the computer part), we will characterize it in order to bring out its different constraints that can affect the mechanical model.

The Topological Optimization of the Mechanical Model

This will be done by taking into account the integration parameters of the two other models (electronic model and control) which we have called the control (control system which coordinates the different tasks of a system without the operator having to intervene directly). We will define its integration parameters as topological optimization constraints of the mechanical model. The topological optimization of the mechanical model will be based on the SIMP (Solid Isotopic Material with Penalization) method presented above. This method (SIMP) is implemented in topological optimization software.

Application Example: ELEGOO Smart Car Mobile Robot

In order to make our principle more concrete, we propose to apply it to a mobile robot ELEGOO Smart because it is an educational kit for beginners and professionals to gain practical experience in programming, electronic assembly, and robotics knowledge. It is an integrated solution for learning robotics and is designed for education. ELEGOO Smart Robot is controlled remotely by an infrared remote control and can also be controlled via a phone, Android iOS tablets, etc.

With the following characteristics: Arduino IDE programming software, ELEGOO Robot, input: Infrared photoelectric sensor, ultrasonic sensor, buttons, aluminum body, dimensions 35.56×35.56×12.06 cm, weight 6.08 kg, payload 3.17 kg, range 152.4 m. Figure (8) shows the ELEGOO smart car mobile robot.

Topological to be Optimized Optimization with Physical Constraints Choice of Parts

In our case study, we have chosen two parts to be optimized because these parts are directly in contact with other components such as the electronic board, the vibrating motors, and the sensors. Therefore, the optimization of these parts is affected by the different characteristics (constraints) that the other components will bring. It should be noted here that the other parts of the system (ELEGOO smart car) can be optimized in a general way (simple mechanical optimization).

Figures (9-10) show our initial parts to be optimized.

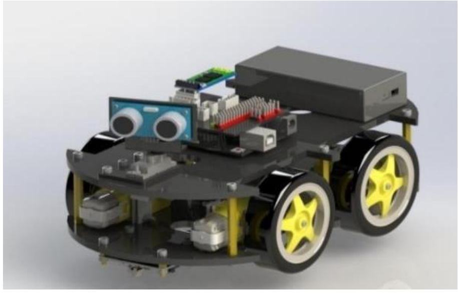

Fig. 8: ELEGOO smart car mobile robot (Shop, 2022)

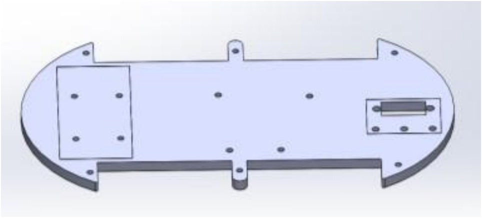

Fig. 9: Top base plate

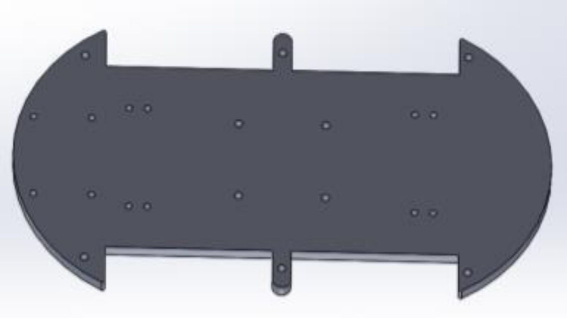

Fig. 10: Lower base plate

Topological Optimization of the Top Plate

Assigning a material to the part: Aluminum1060:

- Alloy
- Weight: 0.256784 kg
- Volume: 9.51052e-05 m^3
- Density: 2,700 kg/m^3
- Weight: 2.51648 N
- Elasticity module: 6.9e +10 N/m^2
- Poisson's ratio: 0.33

Loading of the part: In our study, we have 4 different loads as shown in Fig. (11D).

The first is the charge brought by the battery pack with an intensity of 5 N.

The second is the load brought by the electronic card with an intensity of 1 N.

The third is the load brought by the sensor ultrasonic telemetry with an intensity of 1 N.

The fourth is a fixed charge.

Adjustment of the objective minimum mass function (at 50% mass reduction) with optimal rigidity, symmetrical geometry plane. Choice of design and non-design areas. Once the various stresses on the part have been defined, the next step is to mesh the part (Fig. 12).

The area in blue (Fig. 11A) represents the dimensions of the ultrasonic telemetry it will therefore be defined as a non-design zone.

The area in blue (Fig. 11B) represents the dimensions of the battery block, so it will be defined as a non-design area.

The zone in purple (Fig. 11C) represents one of the supports of the electronic card, it will therefore be defined as a nondesign zone. We note here that the electronic card has 4 supports:

- Define the zones to keep

The different areas to keep are:

- The contours of the room
- The different areas with loads

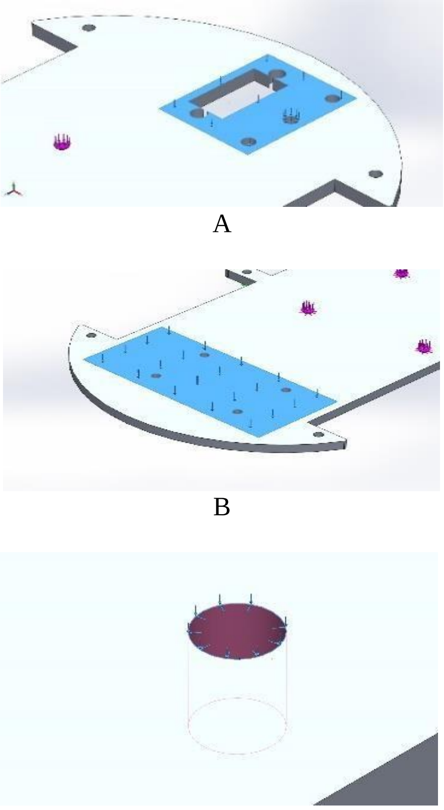
A
B
C

Fig. 11(A-C): Shows the model of our top plate subjected to different physical stresses

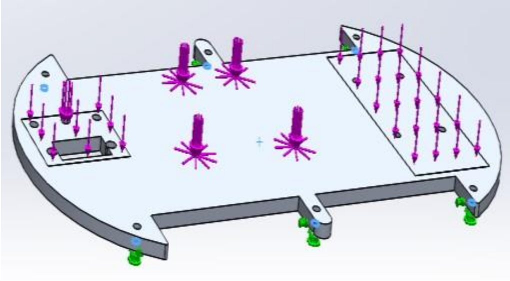
D

Fig. 11(D): Upper plate subjected to different physical stresses

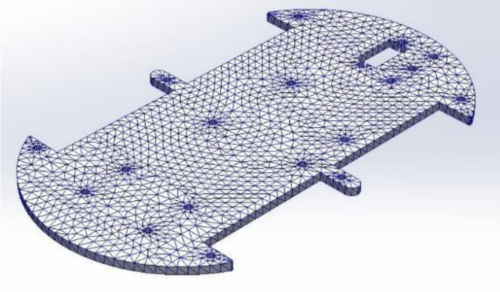

Fig. 12: Upper plate mesh

Figure (13) shows the variation of the topological stress of the top plate.

Figure (14) shows the optimized model of the top plate.

Figure (15) shows the final topology of the redesigned top plate with:

Weight : 0.154611 kg
Volume : 5.72637e-05 m^3
Density : 2,699.98 kg/m^3
Weight : 1.51519 N

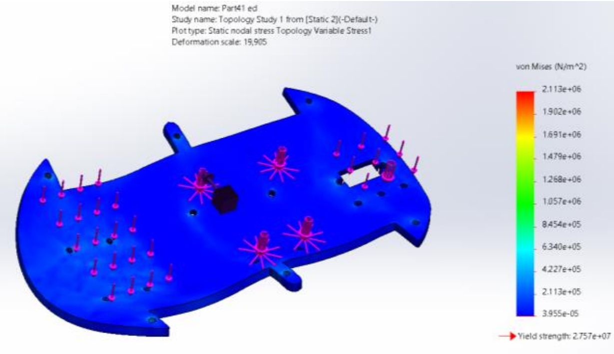

Fig. 13: Variation of the topological stress of the upper plate

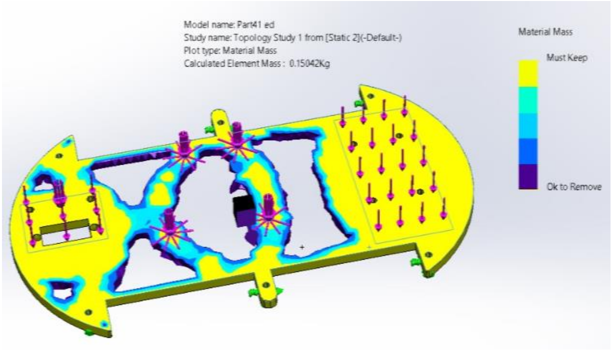

Fig. 14: Optimized model of the top plate

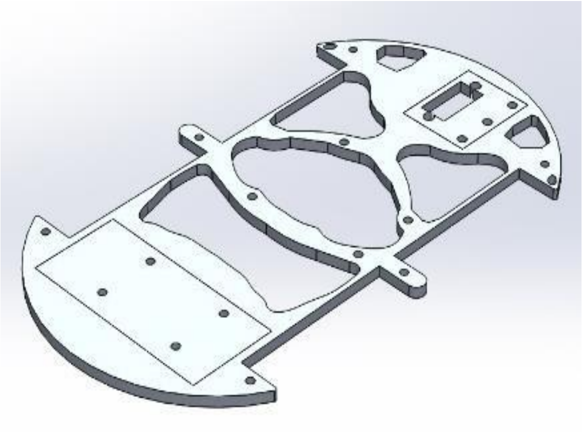

Fig. 15: Final topology of the top plate

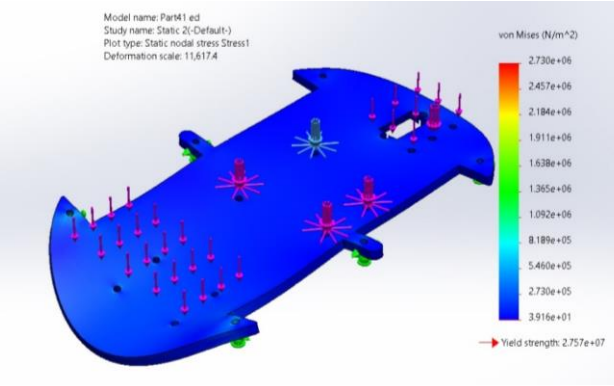

Fig. 16: Von misses stress distribution in the initial upper plate

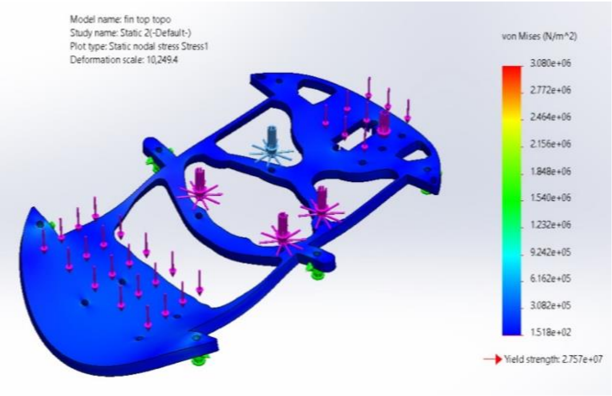

Fig. 17: Von misses stress distribution in the final upper plate

Static Study of the Initial and Optimized Upper Plate

This study is carried out in order to compare the maximum stress of Von Misses in the initial and optimized upper plate. Figures (16-17) show the distribution of the Von Misses stress in the initial and optimized upper plate, respectively.

Discussion of the Results of the Optimization of the Topology of the Top Plate

We can see from Fig. (9) (which shows the initial model of the top plate) that the initial mass was 0.256784 kg and in Fig. (15) (the final model of the optimized plate) that the mass is now 0.154611 kg. We therefore have a mass gain of 60.21%. When comparing the von misses stress of the optimized upper plate to the yield strength: 3.080e +06 N/m^2 <2.757e07 N/m^2 we can therefore validate our final topology.

Topological Optimization of the Bottom Plate

Assigning a material to the part: Aluminum1060 alloy:

- Weight: 0.260678 kg
- Volume: 9.65472e-05 m^3

- Density: 2,700 kg/m^3
- Weight: 2.55464 N
- Poisson's ratio: 0.33

Loading of the part: In our study, we have 4 different loads:

- The first is the load brought by the motherboard with an intensity of 0.9 N
- The second is the load brought by the sensor block with an intensity of 1 N
- The third is the charge brought by the charges of all the upper elements (sensor ultrasonic telemetry, top plates, electronic card, battery pack) with an intensity of16 N
- The fourth is fixed geometry
- Adjustment of the objective minimum mass function (at 50% mass reduction) with optimal rigidity, symmetrical geometry plane
- Choice of design and non-design areas
- The configuration of the part will be taken here as our non-design zone and all the parts subjected to solicitations
- Define the zones to keep

The different areas to keep are:

- The contours of the room
- The different areas with loads

Once the various stresses on the part have been defined, the next step is to mesh the part (Fig. 19).

Figure (18) shows the model of our lower plate subjected to different physical constraints.

Figure (20) shows the variation of the topological stress of the top plate.

Figure (21) shows the optimized model of the bottom plate.

Figure (22) shows the final topology of the redesigned bottom plate with:

- Mass: 0.18663 kg
- Volume: 6.9122e-05 m^3
- Density: 2,700.01 kg/m^3
- Weight: 1.82897 N

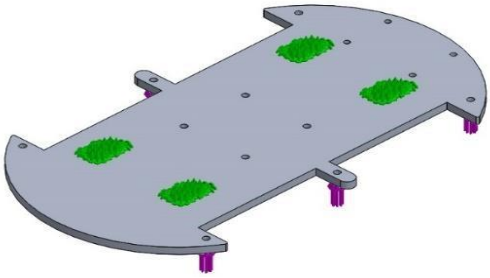

Fig. 18: Lower plate subjected to different physical stresses

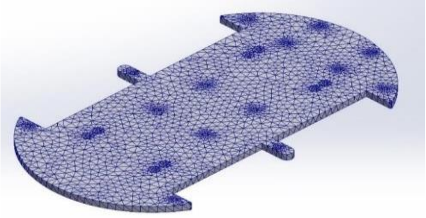

Fig. 19: Lower plate mesh

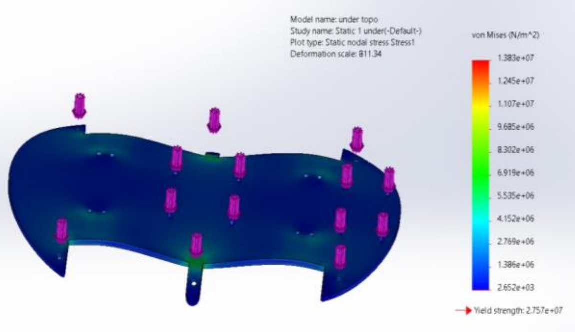

Fig. 20: Variation of the topological stress of the lower plate

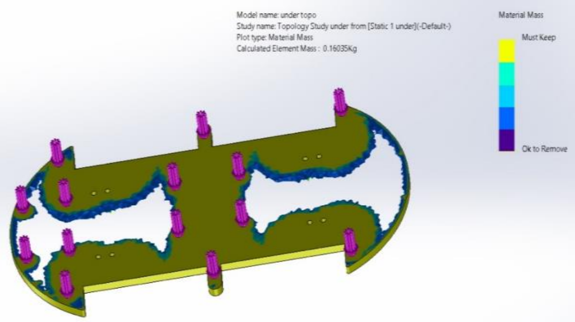

Fig. 21: Optimized model of the lower plate

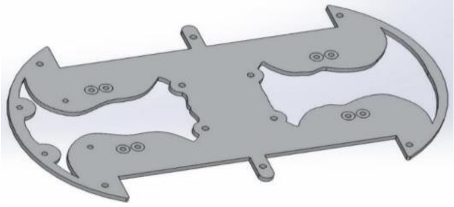

Fig. 22: Final topology of the lower plate

Static Study of the Initial and Optimized Lower Plate

This study is carried out in order to compare the maximum stress of Von Misses in the initial and optimized lower plate. Figures (23-24) show the distribution of the von misses stress in the initial and optimized lower plate, respectively.

Discussion of the Results of the Optimization of the Bottom Plate Topology

We can see from Fig. (10) (which shows the initial model of the bottom plate) that the initial mass was

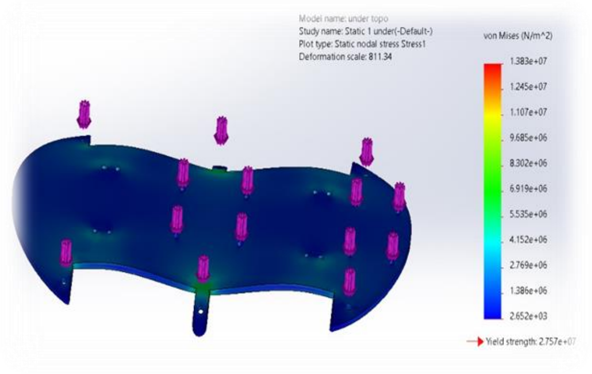

Fig. 23: Von Misses stress distribution in the initial lower plate

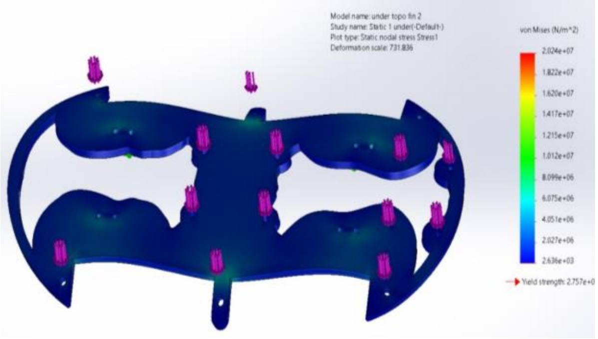

Fig. 24: Von misses stress distribution in the final lower plate

0.260678 kg and in Fig. (22) (the final model of the optimized plate) that the mass is now 0.18663 kg. We therefore have a mass gain of 71.59%. Figures (23-24) also show the von misses stress distribution in the initial and optimized upper plate 1.383e and 2.024e +07 N/m^2 which gives us a difference of 0.641e +06 N/m^2. When comparing the von misses stress of the optimized upper plate to the yield strength: 2.024e+07N/m^2<2.757e07 N/m^2 we can therefore validate our final topology.

Discussion

In this part, we will compare our topological optimization methodology to that of a simple mechanical system. Figure (25) presents a protocol for topological optimization of a part in the solid works 2018 software proposed by Samon *et al*. (2021) in order to optimize the different parts of a hammer mill.

In a mechatronic system, the mechanical system will be called an integrated mechanical system because it is the base where the different components of other disciplines (electronic components and control) are grafted. The topological optimization of this system will therefore be very different from the topological optimization of a simple mechanical system. We have proposed in Fig. (4) a methodological flow chart with its topological optimization protocol used for integrated mechanical systems (Fig. 5) and we have presented in Fig. (25) the topological optimization protocol in the solid work 2018 software of a mechanical part proposed by Samon *et al.* (2021). We can therefore see that the topological optimization protocol for integrated mechanical systems and that for simple mechanical systems differ in several respects, which we have grouped together in the table.

Table (1). Comparison of simple mechanical and integrated mechanical topology optimization protocols.

It can therefore be seen that the topological optimization of a simple mechanical and integrated mechanical system can be done using the same software (solid work) also with the same objective function which will be a minimization of the mass. Also when optimizing a simple mechanical system, there is more design area and less non-design area (on the part to be optimized) because the simple mechanical system only takes into account the physical constraint which is the load applied to the system. On the other hand, with the integrated mechanical system during the optimization, there is less design area and more non-design area because the integrated mechanical system takes into account the physical constraints (dimensions and loads of the components of the control-command part of the system characterized in the methodology section: Characterization of the control-command part) and the functional constraints (temperature and vibration of the components of the control-command part of the system characterized in the methodology section: Characterization of the control-command part). The functional constraints will lead to two further studies of the integrated mechanical system as shown in Fig. (4): A thermal study has to be done first on the electronic part of the complete system (mechatronic system), which is usually the electronic board of the Mechatronic system to evaluate the temperature generated by it and then on the integrated mechanical model to check if the material used can withstand this temperature.

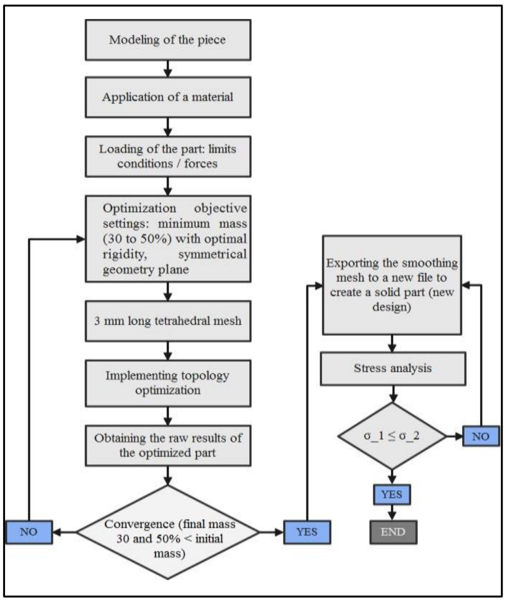

Fig. 25: Flowchart of the optimization protocol in the Solidwork 2018 software (Samon *et al*., 2021)

Table 1: Comparison of simple mechanical and integrated mechanical topology optimization protocols

	Constraints								
	Physical		Functional						
Systems	Dimensions	Charge	temperature	Vibrations	Choice of design areas	Choice of non design areas	Definition of areas to keep	Objective function	Optimization n software
Simple mechanical system		✓			More	Less	Less area to keep	Minimize mass	Solid work
Integrated Mechanical system	✓	✓	✓	✓	Less	More	No more areas to keeps	Minimize mass	Solid work

A frequency analysis to obtain the resonance frequencies of our system and then a dynamic study to vary the forces as a function of time and see the behavior of our structure.

Conclusion

This study proposes a topological optimization methodology specific to mechatronic systems that is much more focused on the mechanical part of the mechatronic system.

As a first step, we have carried out a state-of-the-art in order to list the research works carried out on the topological optimization of mechatronic systems. Research work carried out in the field of topological optimization of mechatronic systems. Then we proposed a topological optimization methodology based on the work of Casner, which leaves the optimization of the electronic and control models (control command) and then we made a characterization to bring out the optimization constraints that can affect the mechanical model. The topological optimization of the mechanical model will be done by taking into account the physical constraints brought by the control command part. We then applied the optimization principle to a mobile ELEGOO smart car robot and finally compared our topological optimization methodology for an integrated mechanical system to that of a simple mechanical system proposed by Samon *et al*. (2021).

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Author’s Contributions

Damasse Harold: Is the principal author of this study. He began his doctoral research at ENSAI in Ngaoundere, Cameroon, and is currently pursuing it at Erciyes University in Turkey. He collected the essential data and drafted the document under the supervision of his teacher Samon Jean Bosco. He designed the research plan, organized the study, contributed to the drafting of the manuscript, and participated in all the proofreading and revisions of the document.

Jean Bosco: Is the co-author of this article because he defined the research topic. He supervised the research as a whole.

Ethics

I hereby the corresponding author of the manuscript declare that the manuscript titled: Proposal for a topological method for mechatronic systems, has not been published, that it is not under consideration for publication elsewhere, that its publication is approved by all authors, and tacitly or explicitly by the responsible authorities where the work was carried out. It is not stolen or unsheathed from master's theses or doctoral dissertations that are not supervised by the author or of any other research. I take all the legal responsibilities in case the provided information is not correct. I make a sincere effort to ensure the accuracy of the material described herein. No funds have been received for this study. The use of part of the document or all of its content deserves to cite the author or to seek his approval. I confirm that I have reviewed and complied with the relevant instructions to authors, ethics in publishing policy, declarations of interest disclosure, and information for authors. I am also aware of the publisher's policies with respect to retractions and withdrawals.

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