Random Excitation of Surgical Robotic

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Abstract

The Biomedical Engineering has well-developed very rapidly in recent times, and after the intervention in all areas of medicine of life and to increase the accuracy and security of medical operations, especially surgical, where he was previously relying on a doctor in a different surgeries and this was accompanied by a lot of mistakes and the length of time and lack of precision The work of the large holes in the human body and the loss of a large amount of blood and sometimes lead to death, so was the invention of surgical robot which replaces the doctor in an all surgeries provided with camera and arms of the holes for the purpose of surgery during the operation and the withdrawal of the damage to the outside of the human body as well as to the sewing section which was performed surgery on it.

The surgical robot needs to study in order to avoid any error while doing any surgery being moved in all directions as well manufactured and metals used in precision manufacturing to prevent the interaction between the human body and the materials used.

The surgical robot when conducting any surgery, it is exposed to Dynamic movements and to vibrations co-operation in this research study and analysis of rotational and transitional arm scalpel movements (process surgical scissors) where was derived kinetic equations transition and spin of the robot during movement, analyze and find a response to each interface and detailed in this Arm and find the natural frequencies and modes and foretelling a movement for all data and thus find, responsive to the final robot through which to draw its own curves public movements during surgical operations.

By introducing the mechanical specifications and dimensional modeling Android in Ansys program by drawing the paper model and the using of Scissors force, who is the surgical operations and give the suggestions in a note to the Islamic group Ansys program as well as the moments affecting bends and shear forces for the purpose of simulation model with reality.

Where they discussed outputs, data movement, distortions, and distractions in the form and after the study results are analyzed-style geometric Medical to optimize the design and to avoid any error surgeons during surgical operations Mather the accuracy of the results and this in turn gives the safety and protection of persons during the surgical procedure.

Keywords: Biomedical engineering, Surgical Robot, Response modeling

الخلاصة

ان الهندسة الطبية قد تطورت بشكل متسارع جدا في الآونة الاخيرة و تدخل في كافة مجالات الطب الحياتي وذلك لزيادة الدقة والامان في اجراء العمليات الطبية وخصوصا الجراحيه حيث كان سابقا الاعتماد على الطبيب في اجراء مختلف العمليات الجراحية وهذا كان يرافقه الكثير من الاخطاء وطول الفترة الزمنية وعدم الدقة وعمل فتحات كبيرة في جسم الانسان وفقدانه كمية كبيرة من الدم واحيانا تؤدي الى الموت لذا تم اختراع الروبوت الجراحي الذي يقوم محل الطبيب في اجراء كافة العمليات الجراحية كونه مزود بكامرة واذرع لعمل ثقوب لغرض اجراء الجراحة اثناء العملية وسحب الضرر الى خارج الجسم الانسان وكذلك القيام بخياطه الجزء الذي تم اجراء العملية الجراحية علية .

1. Introduction

Robotic surgery is the use of robots in performing surgery. Three major advances aided by surgical robots have been remote surgery, minimally invasive surgery and unmanned surgery [1].

The world's first surgical robot was the "Arthrobot"(which is a bone mountable hip arthoroplasty surgery robot showing fast registrations), which was developed and used for the first time in Vancouver, BC, Canada in 1983.The robot was developed by a team led by Dr. James McEwen and Geof Auchinlek, in collaboration with orthopedic surgeon, Dr. Brian Day. National Geographic produced a movie on robotics which featured the Arthrobot. In related paper at that time, other medical robots were developed, including a robotic arm that performed eye surgery and another that acted as an operating assistant, and handed the surgeon instruments in response to voice commands [2].

So, the surgical robotics is a new technology that holds significant promise. Robotic surgery is often heralded as the new revolution, and it is one of the most talked about subjects in surgery today. Up to this point in time, however, the drive to develop and obtain robotic devices has been largely driven by the market. There is no doubt that they will become an important tool in the surgical armamentarium, but the extent of their use is still evolving [3].

Advanced robotic systems give doctors greater control and vision during surgery, allowing them to perform safe, less invasive, and precise surgical procedures [4].

During robotic-assisted surgery, surgeons operate from a console equipped with two master controllers that maneuver four robotic arms. By viewing a high-definition 3-D image on the console, the surgeon is able to see the surgical procedure better than ever before. Computer software takes the place of actual hand movements and can make movements very precise [5].

1.2 Advantages and Disadvantages of surgical robot

the advantages are Small incisions , Less pain , Low risk of infection , Short hospital stay , Quick recovery time , Less scarring , and Reduced blood loss ,

The disadvantages are High costs of the equipment, there can be problems for surgeons in communicating with their assistant. Technical problems sometimes arise, including malfunction and collision of instruments, while robotic surgery is potentially faster than conventional surgery, this is not always the case in practice. ,It is difficult for surgeons specializing in robotic surgery to maintain their skills because there are so few cases

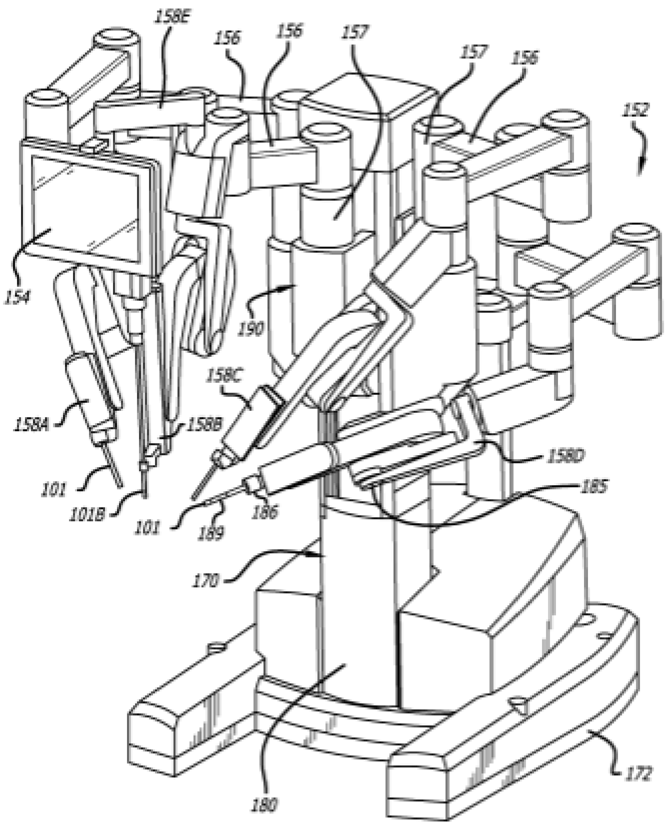

Fig. (1) The link mechanism of the surgical robot manipulator

2.1 Random process

It is the physical phenomena that result in non-deterministic data where future instantaneous values cannot be predicted in deterministic sense. e.g.; noise of jet engine wave high in a "confused" ground motion during **earthquakes**, pressure gusts encountered by an airplane in flight.

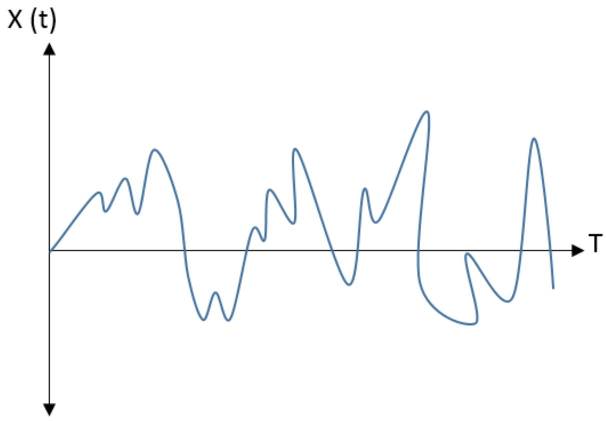

Fig. (2) Random process

In spite of the irregular character of the function many random phenomena exhibits some degree of statistical regularly and certain averaging procedures can be applied to establish gross characteristics useful in engineering design. In any statistical method, a large amount of data is necessary to establish reliability.

$$\int_{-\infty}^{\infty} x^2(t)dt = 2\pi \int_{-\infty}^{\infty} |X(j\omega)|^2 \, d\omega \qquad (3)$$

2.4 Spectral density

If the function $x(t)$ existed over the interval $-T < t < T$ and was zero outside this interval

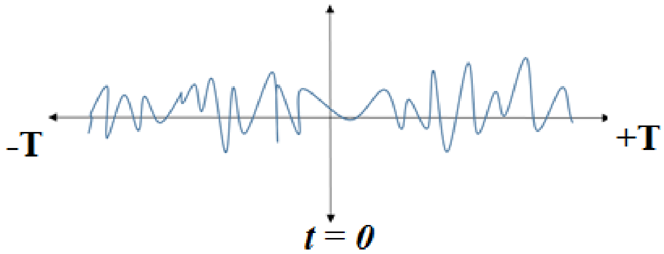

Fig. (5) Spectral density

Mean square value over the interval is

$$\frac{1}{2T}\int_{-T}^{+T} x^2(t)dt = \frac{1}{2T}\int_{-\infty}^{\infty} x^2(t)dt = < x^2(t) > = \frac{\pi}{T}\int_{-\infty}^{\infty} |x(j\omega)|^2 \, d\omega \qquad (4)$$

Now let

$T \to \infty$ In order to represent the real function.

Then

$$< x^2(t) > = \int_{-\infty}^{\infty} \lim_{T\to\infty} \left\{\frac{\pi}{T} \, |x\,(j\omega)|^2\right\} d\omega \qquad (5)$$

or

$$\langle x^2(t)\rangle \; = \int_{-\infty}^{\infty} s_x\,(\omega)d\omega \qquad (6)$$

Where

$$S_x(\omega) = \lim_{T\to\infty} \frac{\pi}{T} \, |x(j\omega)|^2 \qquad (7)$$

i.e. mean square of the function can be regarded as consisting of a continuum of frequency components

$S_x(x)$ is known as the **SPECTRAL DENSITY** of the function $x(t)$ and has the dimention of x^2 per unit second (i.e. per radian per second)

2.5 Relationship between spectral density and correlation function

$$R_{x(\tau)} = \int_{-\infty}^{\infty} s_x\,(\omega)e^{j\omega\tau} \, d\omega \qquad (8)$$

$R_{x(\tau)}$ is the inverse Fourier Transform of the power spectral density . Also

$$s_x(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} R_x(\tau)e^{-j\omega\tau} \, d\tau \qquad (9)$$

$$\zeta = 0 \quad , \quad \tau = 0 \quad , \quad \rho(0{,}0) = 1$$

∴ Pressure at a point is always perfectly correlated with itself.

$$if\ P(\zeta, t) = -P(0, t) \qquad \therefore\ \rho(\zeta, 0) = -1$$

where is perfect negative correlation when one pressure is in " anti – phase" with the other .

3. Results and discussion

The surgical robot will face for random vibrations while working. These vibrations will cause weakness and stresses in the metal of robot with time because of movement of arms of the robot to get stable and accurate movement, this movement should analyzed by modern techniques by applying (Random vibration) on this robot. After putting the mechanical properties and dimensions for surgical robot model, which manufactured for Stainless steel that has the items below:

Material Of model	C%	Cr%	Ni%	MN %	Si %	P%	S%	E	V
Stainless steel	0.15	17-19	8-10	2	1	0.2	0.15	200e9	0.29

Links	length	width	depth
1	30	5	5
2	30	5	5
3	20	5	5
4	20	5	5

All Dimension in cm

Table (1) chemical properties and dimensions of surgical robot

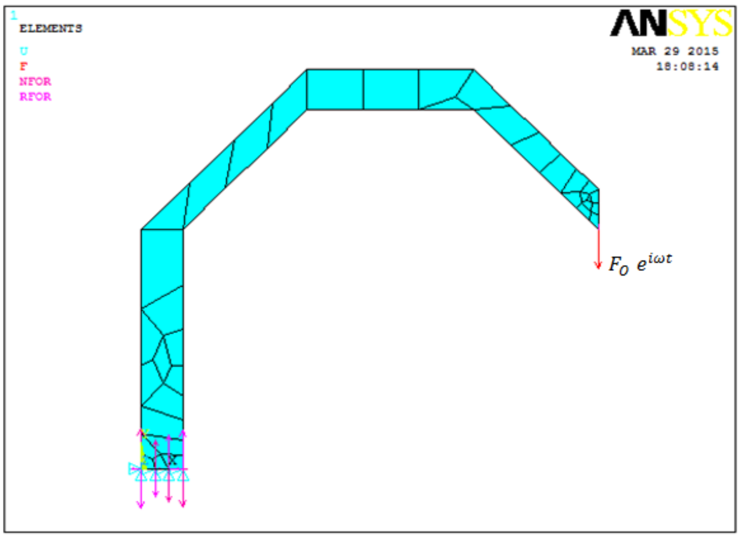

Fig. (6) Surgical robot surgical robot

We derive the translational, rotational, moments, and share force .we drew the model of surgical robot and applied the force of surgical scissors that used to do the operation. After that, the data were put in Ansys software and check the function of motion.

The load had applied by dividing it to ten steps. The mode shape, response, or deflection as

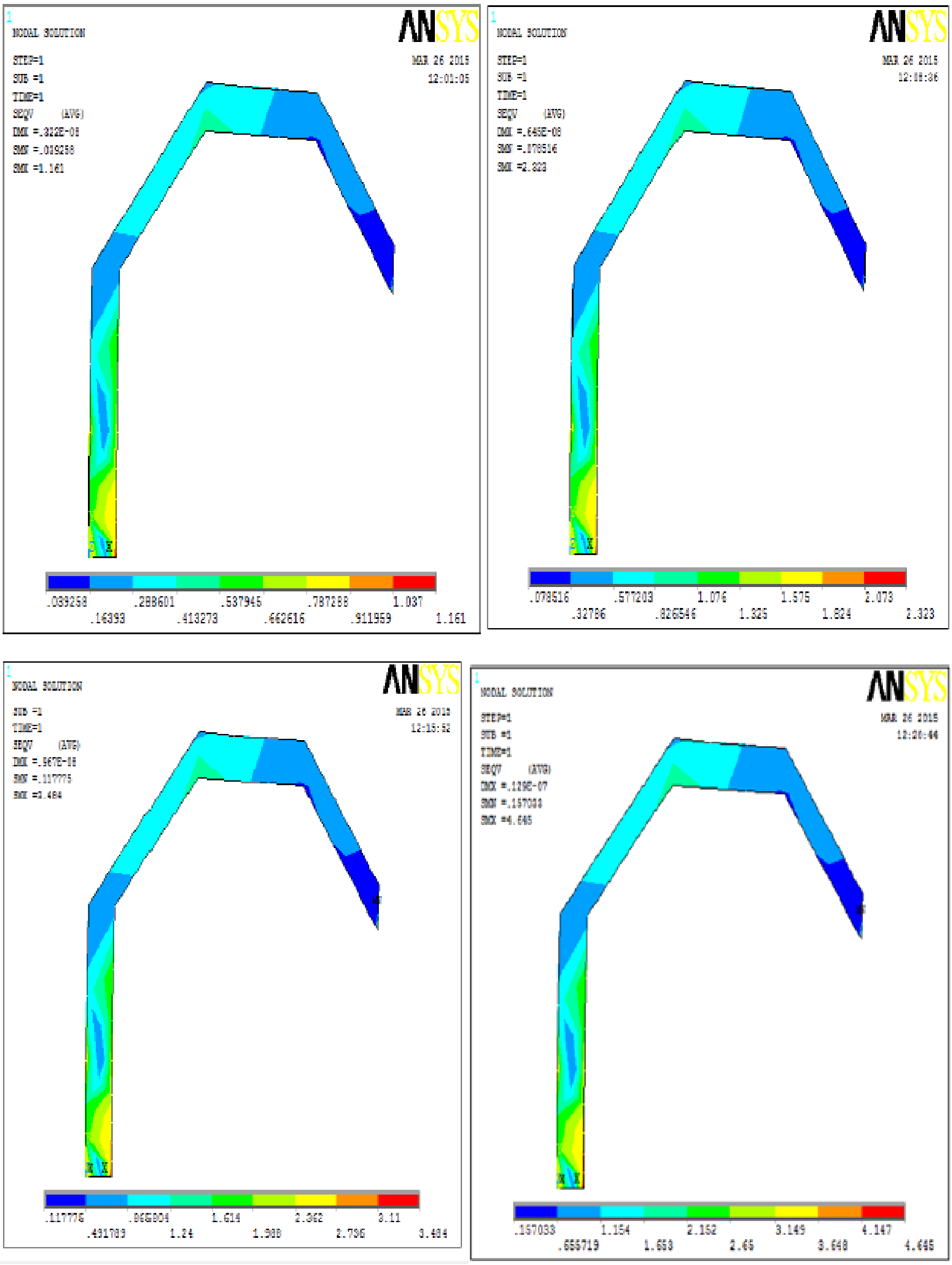

Fig. (9) Nodal solution

In this case, the surgical robot was assumed to be consisting of one element (solid frame). The figures below explain the stresses concentration in the robot:

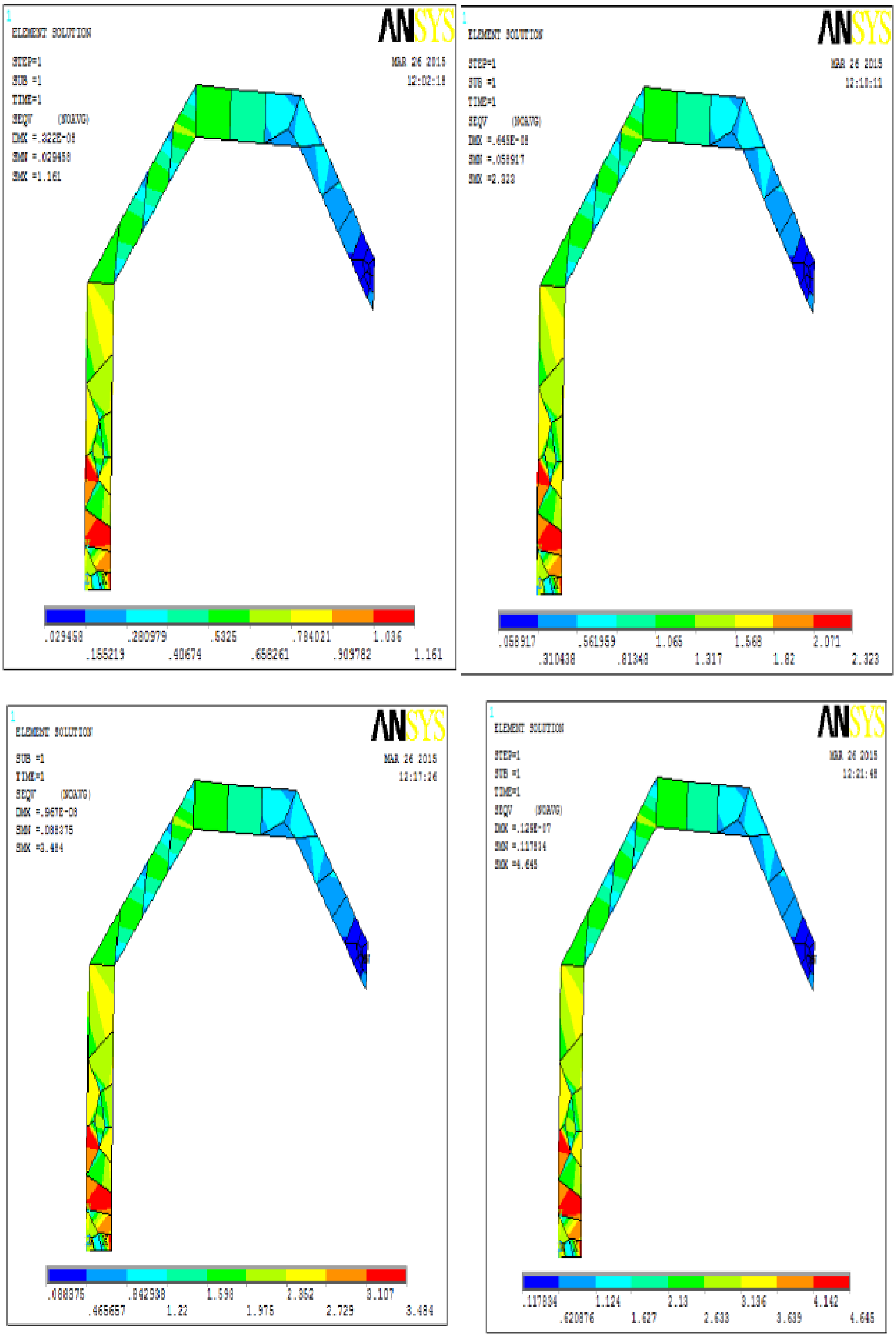

Fig. (10) Element solution

Furthermore, these figures below explain the effect of random vibration on the surgical robot in the case of subjected the arm to translational, rotational or compounded motion

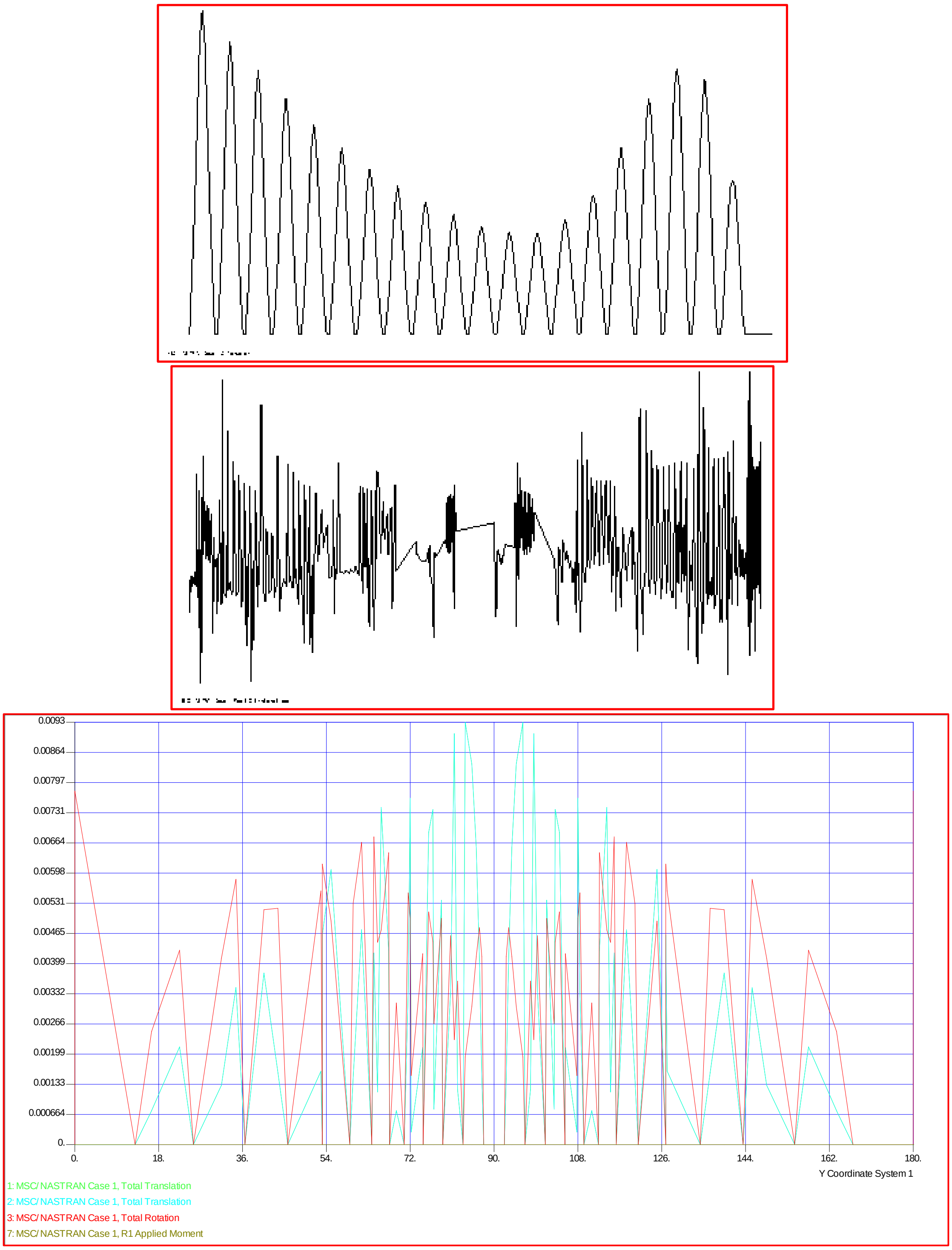

Fig. (11) Translational response of random vibration

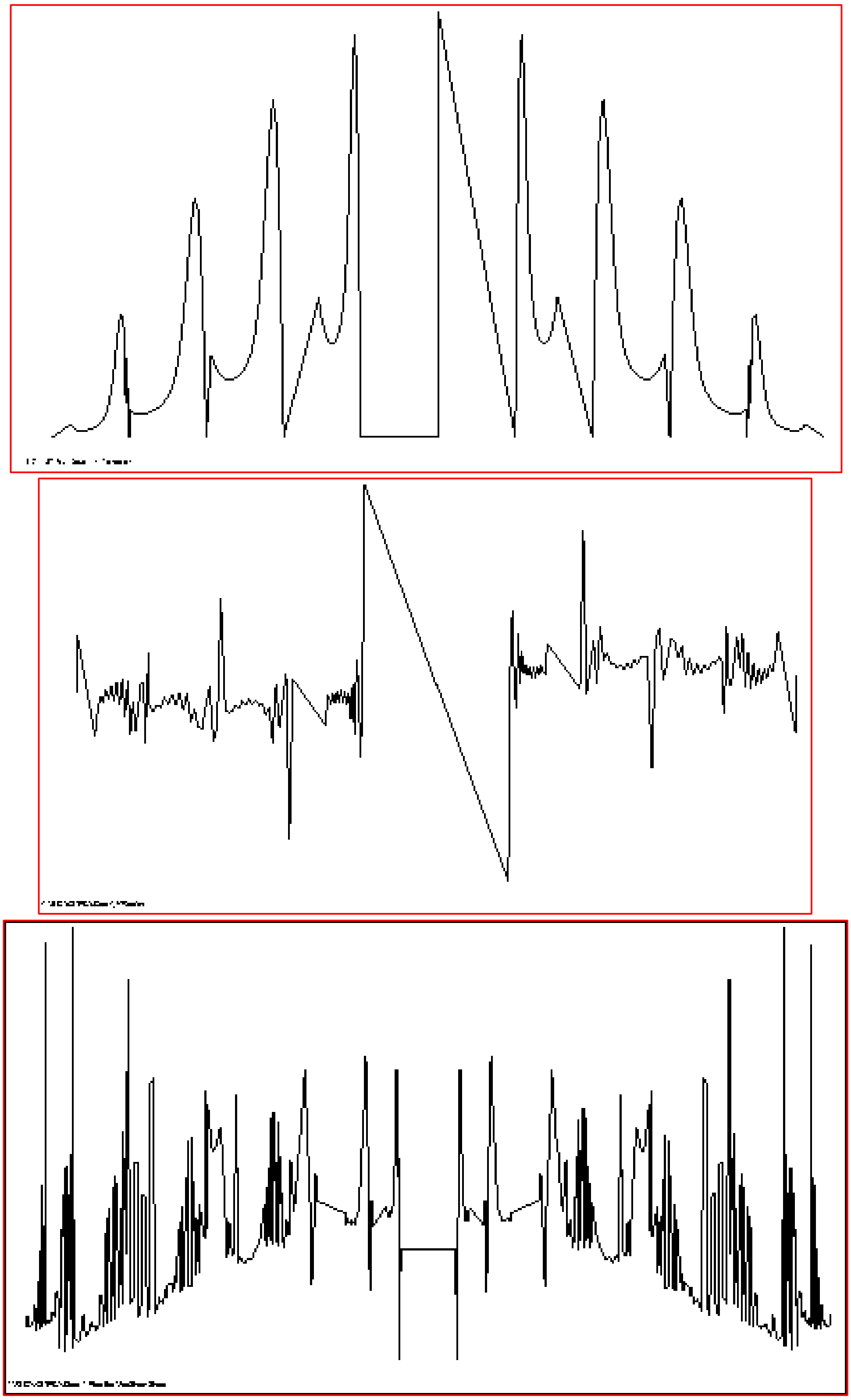

Fig. (12) Rotational response of random vibration

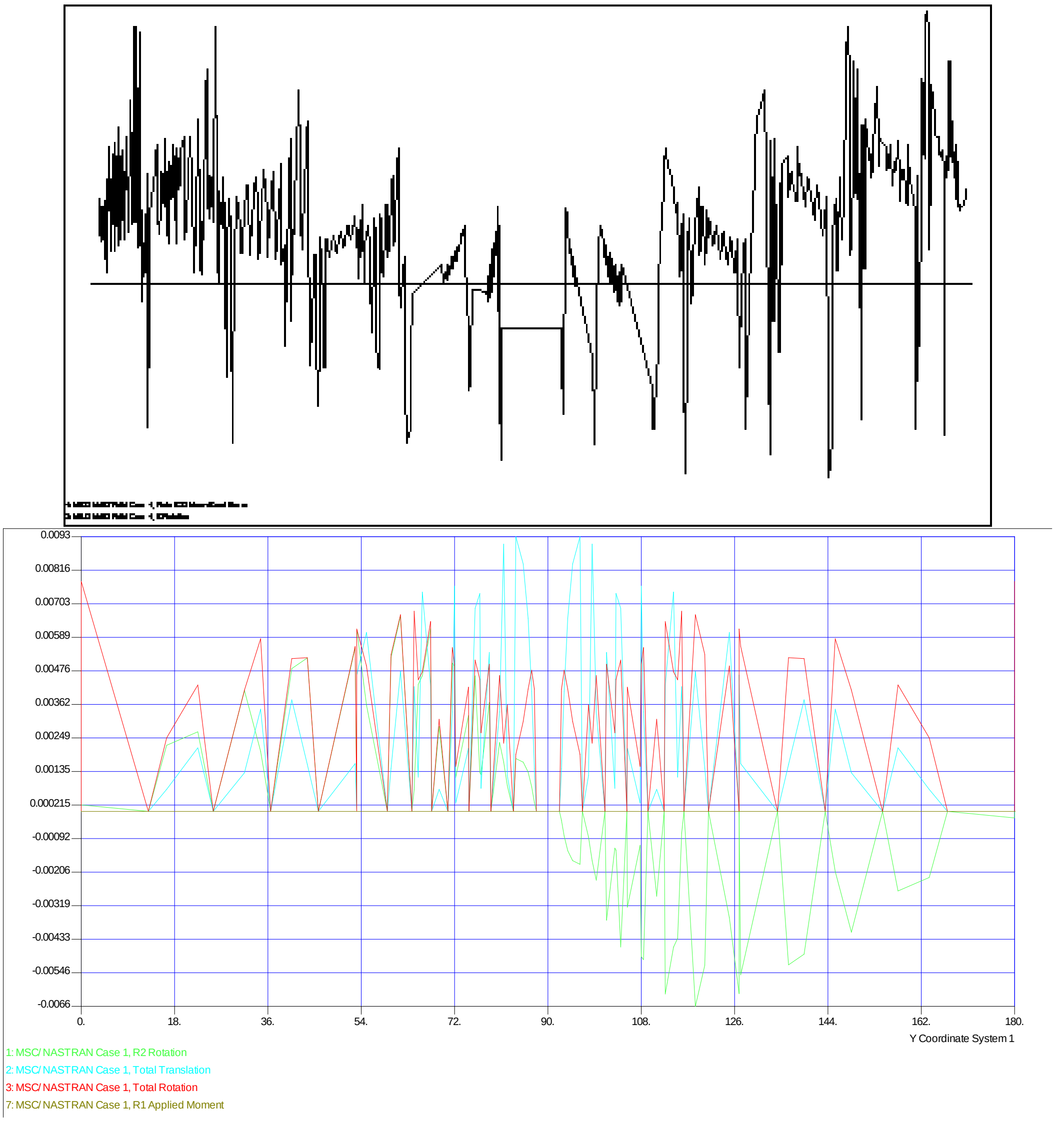

Fig. (13) Compound response of random vibration

4. Conclusion

The paper to conduct an analytical study of surgical robot under the influence of forced vibration represent by sinusoidal function because it gives a description of the vulnerability or response to the surgical robot better and more accurate and that representation of the robot system vibrations study the dynamic motion to any machine which is representing in this paper the surgical robot, this research is important.

If apply the load on surgical robot will face to random vibration and stresses its caused by random motion of surgical robot we conclude from resulting found from Ansys software program, The surgical robot if consist of from some nodes is best than consists of from element type because the stresses and vibration will divided on every node in this arm, consequently, we can discard the stress constriction problem.

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