

A. System Identification and Modeling of Resistance Spot Welding Machine
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Introduction

Resistance spot welding (RSW) is the dominant sheet metal joining processes in the automotive industry. The condition of electrodes and other components has significant effect on the quality of the process. Further, if the electrodes are changed too frequently, the productivity will be poor, if the wear electrodes are not replaced in time, the weld will fail in quality. In [1], several algorithms have been discussed to identify the presence or absence of different set-up faults, based on the force as the electrodes come together. In this paper a system model is built to analyze the pre-weld moving process. The model is verified by measurement data, and the real welding process data are also used to determine the coefficient vectors. Simulation results based on the model agree well with the measurements. The model can be used in further analysis of RSW machines, such as electrode lifetime, fault classification, etc.

System Model

The mechanic system of a RSW machine is illustrated in Figure 1.

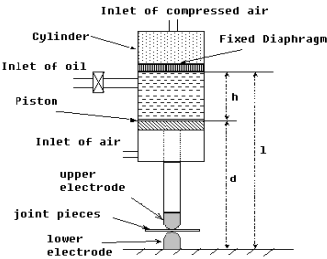


Figure 1. System diagram

As the effect of the cylinder on the complex mechanical system is negligible, only the impact system is considered to form a simplified model as shown in figure 2, which includes a spring and a dashpot.

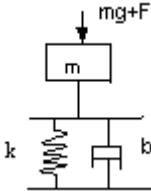


Figure 2. Simplified model

A typical plot of force as the electrodes touchdown is given in Figure 3. This process can be considered as containing several continuous impact motions, with the stiffness coefficient k , the friction coefficient b and the mass of the whole system m different for each impact. We have chosen to compose our overall time varying model as composed of 16 time invariant model as indicated by the *'s on Figure3.

System Identification and Data Processing

Experimental data are used to identify the stiffness and friction coefficients in the system model. To collect the real welding process data, an experimental set-up is built, which includes an AC welding machine, different sensors (a Load cell to detect touchdown force and a LVDT to measure the displacement) and a computer based data acquisition system.

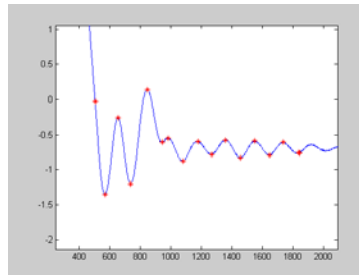


Figure 3. Typical Displacement curve

Results

To identify the parameters of the model, a set of RSW welding life tests has been done. The electrode life has been separated into five stages, ranging from new to worn respectively. The results are shown in figure 4, where the stiffness coefficients during the 16 time moments for the five groups are shown in 16 subfigures respectively. The results in the figure indicate that the stiffness coefficients during different time moments for the five groups are significantly different, so different sets of the stiffness coefficients can be used to build the different system models (such as to represent different electrodes status).

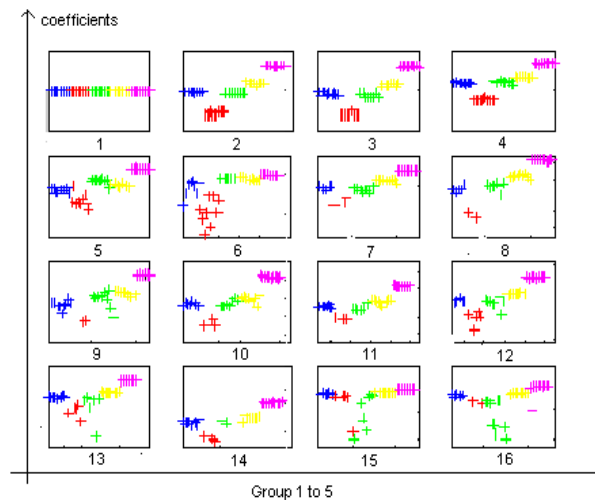


Figure 4. Results: stiffness coefficients for the five group's data during the 16 time moments

Conclusion

A system model is built to analyse the pre-weld moving process of resistance spot welding (RSW) machines. The initial conditions and coefficient vector vary in these stages while the equation set remains the same. Real welding process data are used to determine the coefficient vectors. Simulation results based on the model agree well with the measurements. The model can be used in further analysis of RSW machines, such as electrode lifetime, failure classification, etc.

References

Lyndon J. Brown, James S. Schwaber, 'Identifying Operations from Pre-weld Information for Resistance Spot Welding'. *Proceedings of the American Conference. June 2000.*