<u>Project Summary</u>: Dynamic System of Touch, Physics of Collision without Bounce, Law of Touch: Jumpulse Experimentation and Simulation, Transforming Sports Technology/Physics/Physical Education

This proposed research deals with dynamic contact or how to make a mobile machine to safely come into contact with an uncontrolled environment. It will measure quantitatively a historically first demonstration of a jumpulse mechanism, which generates a jumpulse with a sudden elimination of one of the two opposing forces with precise timing. The dynamic system of touch has not been formally addressed or solved by Isaac Newton and all the physicists since Newton for the past three hundred years, yet Japanese Sixth Generation Computer Science, Robotics, failed because robots could not touch; a robot finger bounces off a surface, as a ball bounces off a racket. This initial small proposal will demonstrate with both computer simulations and actual physical experiments the problem and the solution of touch. This research by overcoming the bottleneck of touch in robotics could define a robot as a machine that can touch and lead to the Phase II of the feasibility of the commercial transformation of the current low-tech auto industry into a high-tech robotics industry and to the ultimate Phase III of building Self-Manufactured General Purpose Robots. The Father of Chinese Physics, Ta-You Wu coined the word "jumpulse" to denote a sudden change of force, as Newton's impulse is a sudden change of momentum. The Principal Investigator and Wu define jumpulse to be:

$$\{ (J, t_1 \text{ and } t_2) \mid J \equiv \int_{t_1}^{t_2} m\, d^3x/dt^3\, dt, \quad \text{where } (t_2 - t_1) \text{ can approach zero} \}$$

which implies the newly formulated Law of Touch, which states: "Unlike position and velocity, acceleration and all higher derivatives of time can change instantaneously." In a collision without bounce, the jumpulse must occur within the impulse; it is a delta function within a delta function or an impulse function. Touch or collision without bounce shares the same concept of jumpulse with prolonged contact in sports. Touch can be considered permanent prolonged contact, but at near zero speed. This research will settle, once for all, whether prolonged contact exists or not. If it does, the concept of jumpulse will revolutionize sports with the secret of consistency in sports, namely, prolonged contact. Very high-speed cameras and sensors with resolutions in milliseconds will be used to study collision, which occurs in around 4 milliseconds in tennis. As a long-term vision, touch is an essential design criterion of a Self-Manufacturing General Purpose Robot, which will be programmed by completely automated software. And, in the process of mankind's self-creation, the Robot will become human, and the software, DNA. Instead of bailing out the auto industry, the non-competitive US auto industry should be transformed, with public funding and with a bounceless Active Shock Absorber based on jumpulse, into a robotics industry, for the auto industry uses more robots than any other industry.

Intellectual Merit: The newly recognized Law of Touch, if verified by this research, will be one of the most relevant principles in Mechanics. The ability of touch, one of the most subtle physics problems, should define a robot. This research will make physical education truly scientific with the phenomenon of prolonged contact and will differentiate between Creational Technology and Human Engineering.

Broader Transformative Impact: The confirmation of prolonged contact in sports will immediately affect the athletic half of the human population. In particular, the (PASCO) web-based educational experiment and the simulation of touch will be readily accessible to all school children, university students, and teachers world-wide. Hopefully, this sports breakthrough will ignite a robotics revolution.