Prof Tarek M Sobh, PhD

ROBOTS IN PITS

Changing tyres – be at Formula One car racing or at the garage – involves a lot of science and technology and Prof *Tarek M Sobh,* PhD, knows about it much better than many others. He and his team have developed a robotic system that can be used for changing tyres while the vehicle is in motion after reaching dangerous pressure and temperature values. Without human intervention, his robotic process will change tyres safely and quickly

PTA News Bureau

When Prof Tarek M Sobh, PhD studied the challenges engineers faced while changing tyres during pit stops during Formula One car racing, he realised that there are technological solutions that could be devised.

Researchers at Connecticut's University of Bridgeport brought to the project his knowledge in the fields of computer science and engineering, control theory, robotics, automation, manufacturing, artificial intelligence, computer vision and signal processing to device an effective system.

He is Vice President for Graduate Studies and Research and Dean at the School of Engineering and Distinguished Professor of Engineering and Computer Science of the University.

Pit engineers consider changing tyres of a car while they are almost in motion, after reaching dangerous pressure and temperature values. It's a very risky challenge during competitive racing.

Knowing this Prof Sobh felt there is a need to devise a system that would make sure that the tyre change is done quickly and at the same time ensure that only equal time is taken for all drivers so as to ensure fairness in this fierce competitive sport.

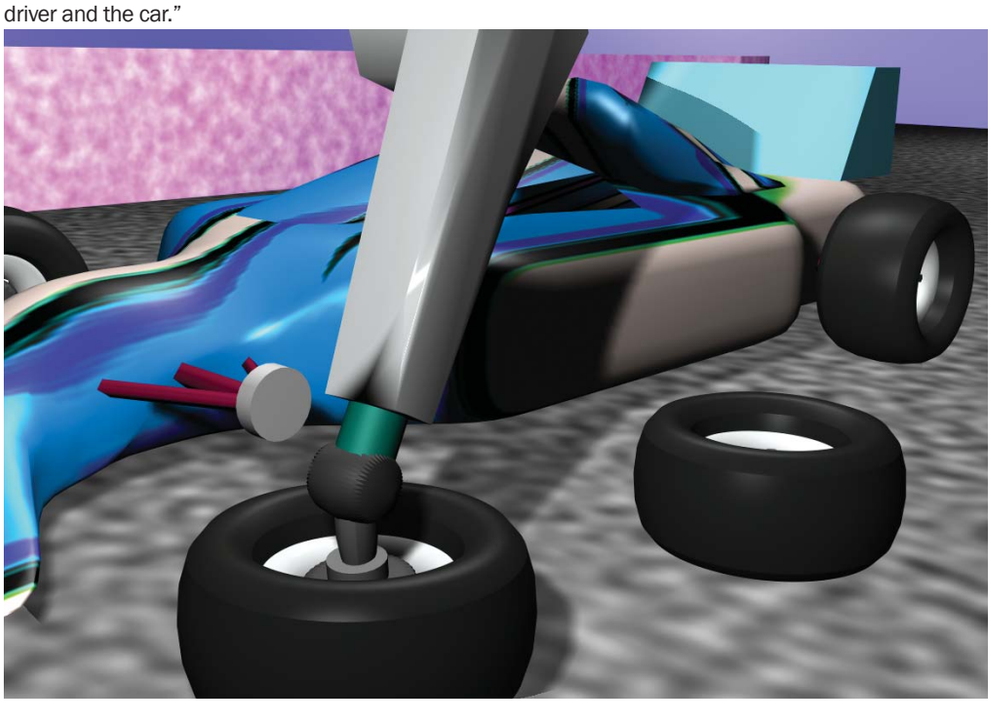
"Well, the whole purpose of the project was to try and make absolutely sure that the races are as fair as possible," he told Polymers & Tyre Asia in an interview. "Fair in the sense that we would like to make sure that the driver and the car are the main factors affecting the outcome of the race; not necessarily the tyre changing process."

He elaborated: "Thus, from that point of view, our interest has been to try to devise an automated manner by which the tyres at the pit stop would change, more or less, at the same amount of time for all the teams; such that the main deciding factor in a Formula One car racing would be the competitiveness and the skills of the actual driver and the car."

But for the tyre-changing process itself, he wanted to ensure more or less a uniform, or as close to a uniform distribution as possible in the time that it takes for each team and or each driver and car for the tyre changing process to take place. That will ensure fairness to all.

A very risky challenge is not necessarily the case, but on the contrary Prof Sobh wanted to ensure that the human problems and the risks associated with humans undertaking the change of the tyre process are eliminated.

"As a matter of fact, in some of the literature that we have actually reviewed and some of the videos that have documented our own studies, there have been several actual accidents in the pit stops. And one of the reasons for doing this was actually to eliminate these accidents in the pit," he explained.



Eliminating error

This can be accomplished by introducing an automated system consisting of four robotic arms that does the actual change, instead of actually having human beings placed so close in such a risky situation doing the change in an as much fast as possible.

There are two reasons to think in that line, one of them is actually having the robotic system doing the change of tyres and eliminating the human risk from the pit teams doing the change themselves in hazardous conditions and the second is the fairness factor for the drivers.

The system developed by Prof Sobh's team almost does not require human intervention in changing the tyres.

Explaining the robotic process, particularly on checking for pressure and alignments etc automatically during the changing process, he said that this can also be done although these issues are yet to be explored significantly. But he said the alignments and the pressure checking during the pit stops can be done very easily.

"Our interest has been more in the physical process of moving the tyres out and putting new ones in and screwing them in. This is a much more involved physical process than just checking the pressure and doing the alignments of the tyres," he explained.

Prof Sobh's current research interests include reverse engineering and industrial inspection, CAD/CAM and active sensing under uncertainty, robots and electromechanical systems prototyping, sensor-based distributed control schemes, unifying tolerances across sensing, design, and manufacturing, hybrid and discrete event control, modelling and applications and mobile robotic manipulation.

"Our robotic process is concerned with having simultaneously, in parallel, four robotic arms, hanging from the top, actually approaching, very rapidly and precisely, concisely and comprehensively all four tyres at the same time, unplugging them, pulling them."

This would require significant robotic devices that are accurate and with significant load-bearing capabilities, to actually take the four tyres out and then, have these same four arms pick four tyres and actually plug them in and screw them in, as fast and concise and precise a manner as possible.

"In terms of the tyre pressure, and the alignment, we have not explored that significantly, but that should not be a very tedious task to perform after the physical change has been performed," he explained.

Next step

Although the fully robotised system is yet to be used in actual conditions during a competitive car race, his team is working towards that goal.

"Actually the interesting thing is that we have not actually used this yet in actual conditions during a car race, and that remains to be actually the next step," says Prof Sobh.

"What we have is a developed system, a precisely-calibrated parametric model, the simulation and a very well-conceived framework for doing it. But the actual robotised system has unfortunately not yet been used in an actual car race. This would be our next step in the development of the project," he explained.

For the robotic tyre-changing process in Formula One pit stop, the objective is to ensure more or less a uniform or as close to a uniform distribution as possible in the time that it takes for each team and or each driver and car for the tyre changing process to take place. That will ensure fairness to all

He is certain that the robotic system can be used in safely changing and inspecting installing tyres in a garage and tyre changing centre.

"As a matter of fact, it would be a much safer and easier to manage a task, comparable to a time-pressured situation as the pit stops in Formula-1 car racing!" he remarked. "That would be a very natural application."

He said robotic application used for changing and inspecting installing tyres in a garage or a tyre-changing centre could be explored as it is a much less hazardous environment. "It could be done in a much precise, concise, comprehensive, safe and efficient manner while saving significant human skills and time. This could be done particularly in garages and automotive centres with high volume of cars flowing in and out to justify the cost."

Prof Sobh has consulted for several companies in the U.S., Switzerland, India, Malaysia and Egypt, to support projects in robotics, automation, manufacturing, sensing, numerical analysis, and control.

Cost factor

When asked to give a rough estimate of the cost of installing such a robotic system in F1 pits and in automated garages, Prof Sobh said one could work out the cost based on the number of robotic manipulators.

At pit stops, there could be a need for four of these robotic manipulators. They are mostly RRR (revolute, revolute, revolute) articulated robotic manipulators with six degree of freedom, three of them being the articulated link and the final one being the wrist, or, the end effector that would actually do the unscrewing and the screwing.

"My sense, for each one of these top-hanging robotic articulated manipulators, the cost would run anywhere between maybe thirty to US$60,000-US$70,000 at the most. So, if you multiply these figures by four for the robotic devices to be used, the cost would probably run between a US$150,000-US$250,000 or so.

That alone, of course, is in the case of the Formula One car racing, in addition there is the need for the actual station, meaning the actual steel beams, on which these four robotic manipulators would be hanging.

"My guess, for the whole set-up including the robotic framework on which these four manipulators would be hanging, plus the actual computers to control these four robotic manipulators and the end effector design, again, it depends on mass production or if this is only going to be a few instances, would be somewhere between US$200,000, all the way to US$300,000-US$400,000 depending on how complicated and how accurate and how fast one would like these four robotic manipulators to perform, in real time at maximum efficiency."

In terms of having the same set up in a garage setting, he does not think there would be so much of a difference, and again, it depends on the speed, so it could very well be the case, in a garage setting.

He hastened to add that speed is not necessarily a very dramatic or significant requirement at a garage setting and one robotic arm can be used that would actually be moved around the car.

In that case, the cost could be less than half, if not even less than that, so it might actually run to be anywhere between maybe US$100,000-US$200,000.