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Design, Simulation and Manufacturing of a Tracked Surveillance Unmanned Ground Vehicle

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***Abstract*— This paper describes design, Simulation and manufacturing procedures of HIRAD - a teleoperated Tracked Surveillance UGV for military, Rescue and other civilian missions in various hazardous environments. A Double Stabilizer Flipper mechanism mounted on front pulleys enables the Robot to have good performance in travelling over uneven terrains and climbing stairs. Using this Stabilizer flipper mechanism reduces energy consumption while climbing the stairs or crossing over obstacles. The locomotion system mechanical design is also described in detail. The CAD geometry 3D-model has been produced by CATIA software. To analyze the system mobility, a virtual model was developed with ADAMS Software. This simulation included different mobility maneuvers such as stair climbing, gap crossing and travelling over steep slopes. The simulations enabled us to define motor torque requirements. We performed many experiments with manufactured prototype under various terrain conditions Such as stair climbing, gap crossing and slope elevation. In experiments, HIRAD shows good overcoming ability for the tested terrain conditions.**

I. Introduction

It appears that the unmanned ground vehicles were used originally for military applications in World War II [1]. The first UGVs in combat were apparently Russian Teletanks in 1939 or 1940, followed by unmanned German demolition midget tanks (named Goliath) based on a French prototype. So it can be said that the armed, unmanned and remote-controlled tanks/ground vehicles are at least a 69 year-old technology. Unmanned ground vehicles are now in fashion. Thousands are in use in Iraq and Afghanistan in military use, mostly as short range scouts to inspect possible bomb sites - a task very similar to the one of police robots since many years [2]. iRobot, Packbot and Foster-Miller TALON are the most Popular Military robots those are deployed widely in US armed forces. Foster-Miller claims the TALON is one of the fastest robots in production, one that can travel through sand, water, and snow as well as climb stairs. The Talon has been deployed in military service since 2000 - for example, in Bosnia for the movement of munitions and EOD (explosive ordnance disposal) to get rid of grenades. It was also used in Ground Zero after the September 11th attacks in search and recovery. It is the only robot used in this effort that did not require any major repair. Foster-Miller claims the Talon was used for a classified mission by US Special Forces in the war against the Taliban in Afghanistan as well as in an EOD role. In Iraq its standard role has been performing EOD and IED destruction missions. Its combat SWORDS version is now being used there in a guard role protecting front line buildings from attack. According to Foster-Miller, the robot has performed around 20,000 EOD missions in the conflicts in Iraq and Afghanistan. PackBot is a series of military robots produced by iRobot. More than 2000 PackBots are currently on station in Iraq and Afghanistan, with hundreds more on the way. Now, most PackBots perform EOD roles with the ensuing addition of fairly simple effector arms and grippers.

UGVs have been used recently for USAR (Urban Search and Rescue) activities [3] such as searching for victims, searching paths through the rubble that would be quicker than to excavate, structural inspection and hazardous materials detection. Using UGVs in September 11, 2001 USA disaster at world trade center and also in searching victims in Bam, Iran after earthquake 2003 are two of brightest examples of this kind of UGV missions. Aftershocks occurring a while after the main earthquakes cause secondary collapses and bring many difficulties for rescue personnel to search victims. In order to minimize the risks for rescuers, while increasing victim survival rates, fielding teams of collaborative robots or UGVs is a very helpful.

To make use of robots in these various circumstances, robots should have the ability of passing through rough terrain such as stairways. In that sense, the track mechanisms have good mobility over rough terrain environments but they consume more energy than the other types of mechanisms used in mobile robotic such as wheeled or legged systems [4]. This paper mainly presents the optimum design and manufacturing of a tracked small unmanned ground vehicle (SUGV).

The HIRAD project consisted of many phases; First, Many Successful Projects in the field of Tracked Mobile robots and UGVs Concentrating on their mechanical structure and locomotion Systems were studied [5-10] and concluded to a preliminary sketch of our robot and its subsystems and parts. In a different process we called "Conceptual Design", a series of physical and dimensional constraints were defined and robot's main functional and operational properties were denoted. Regarding to these properties and parameters, the

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