The 25th International Symposium
on Automation and Robotics in Construction

June 26–29, 2008

ISARC-2008

Institute of Internet and Intelligent Technologies
Vilnius Gediminas Technical University
Saulėtekio al. 11, 10223 Vilnius, Lithuania
http://www.isarc2008.vgtu.lt/

UTILIZATION OF REMOTE CONTROLLED VEHICLE WITH HYDROSTATIC DRIVING SYSTEM

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ABSTRACT

The importance of unmanned vehicles is directly related to the applications to which it can be successfully applied. This paper will highlight applications, missions, and capabilities that have been demonstrated on the Lewiatan platform to date as well as future application and mission considerations. This platform is equipped with remote control system and surroundings observation and visualization system. It is assigned for both water and land – based operations In this paper the advantages of hydrostatic power systems as the power transmission units for unmanned vehicles have been also presented.

KEYWORDS

remote controlled vehicle, high mobility platform, hydrostatic driving system

1. INTRODUCTION

It is necessary to govern unmanned vehicles in case of operator's life hazard occurrence. It concerns either extreme environmental conditions (high temperature, working in debris of ruined buildings or pollution) or the existence of direct life hazard (removing, extermination or neutralization of hazardous materials or the ravages of terrorist attacks).

Controlling the vehicle is difficult or even impossible in case of impediment observation or intervals in transmitting visual signal. Moreover there may be obstacles not noticed or noticed too late by an operator in the surrounding of the governing vehicle. The steering system has been developed throughout applying an operator's assist system to secure a proper vehicle steering (Fig. 1). It is appropriate for controlling the surrounding. When an obstacle is discovered or an operator does not react, an assist system modifies steering signals to provide a vehicle movement on a free from the possibility of collisions track [1], [2].

The basis of working the passing round obstacles system is an assumption that steering signals are a sum of two vectors: an operator's orders vector F_O and a passing round obstacles vector F_P emitted by an operator's assist system (Fig. 1).

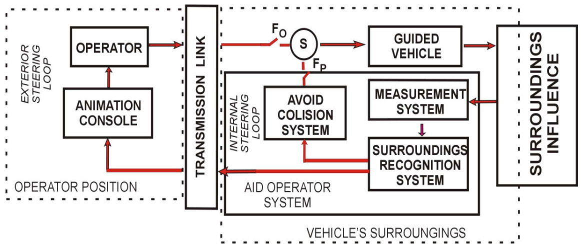

Figure 1. The diagram of vehicle remote controlling system with a passing round obstacles system

In case of missing obstacles a vehicle is governed by an operator. When a vehicle approaches an obstacle and at the same time an operator does not change its direction, a value of steering signals emitted by an assist system F_P increases gradually and a passing process begins. This task should be done smoothly without stopping a vehicle. Steering a vehicle by an operator is done in the internal feedback loop whereas steering passing an obstacle by operator's assist system is done in the external loop. A proper realisation of that task demands a parallel steering from the steering system. This realization secures smooth switching on the steering signals instead of relaying switching. At the same time a control range moves gradually either from an operator to an assist system (when an obstacles appears) or the other way round [2], [3].

2. HIGH MOBILITY PLATFORM

A mobile platform which is a basic element of a remote controlling vehicle is also a carrier for sensors kit, software, transmission connection and additional equipment depending on appropriately to a vehicle usage.

High requirements concerning the mobility of the platform, possibilities of conquering terrain obstacles, moving at minimum speed and flexibility to remote and autonomous steering are only some of the aspects for choosing a hydrostatic power transmission system.

The essential element of an Unmanned Rescue Vehicle, combining all other elements is a mobile platform. It's traction parameters determine the mobility of the whole vehicle. Mobility is the term used to describe the ability of the unmanned rescue vehicle to traverse a rough terrain without any perception. Table I (column 2) shows – set by the National Academy of Science – value of parameters determining the mobility of unmanned vehicles [4]. Because the aren't any in polish literature the authors assumed those above as criteria during the selecting of a mobile platform for an unmanned vehicle.

After analyzing different kinds of mobile platforms, "Leviathan" has been chosen to test the surrounding recognition systems. It's a water – land vehicle with a hydrostatic drive designed to transport people, cargo, equipment and to pull a trailer. It's mobility parameters are listed in Table 1 (col. 3).

An example of a vehicle equipped in a hydrostatic power transmission system is Lewiatan which is a light multi-role conveyer and accessories carrier.

Table 1. Desired Criteria for High-Mobility UGV [4]

Discrete Obstacle Negotiation	Desired Criteria	Lewiatan's Parameters
1	2	3
Tree and stump knock over, m	0,6 – 0,9	0,5
Gap crossing, m	1 – 2	0,8
Vertical step crossing, m	0,4 – 0,6	0,35
Fording water, m	1,2 – 1,5	Amphibious
Hp/ton	20 – 40	19,4
Ground pressure, MPa	0,007	0,006
Vehicle cone index	Less than 12	6
Forward/reverse slope, %	60	100
Speed range, km/h	1-50	0 – 55
Ground clearance, m	0,25 – 0,3 – nominal 0,1 – 0,6 – desired	0,25

Lewiatan can be used either as a load carrier at a maximum weight to 1,5 t or as a basic vehicle-tools or engineering equipment carrier. Good traction properties, abilities of conquering water obstacles without initial preparation as well as a possibility of feeding additional devices with a fluid drive extends a range of its employments (Fig. 2).

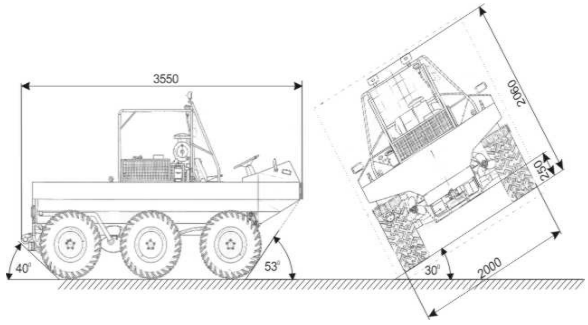

Figure 2. Main dimensions of Lewiatan vehicle

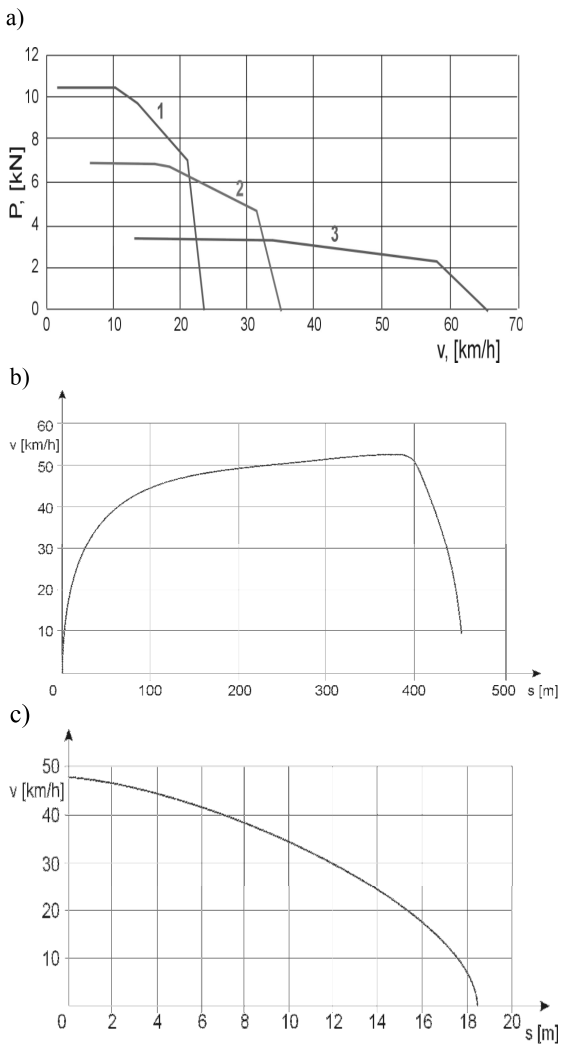

Figure 3. Vehicle characteristics: a – traction parameters; b – vehicle acceleration; c – breaking distance course

In a vehicle road wheels are driven independently by hydraulic motors. Special blocks are applied in the system that allow:

– Switch on and switch off individual motors
– Synchronization of drive wheels work
– A turn in a place by a motors drive forward at one side of the vehicle and backward at the other side of the vehicle
– A turn and a choice of the swimming direction
– A choice of a vehicle drive direction.

Permanent productiveness auxiliary pumps have been installed behind the main pump to feed aided steering system, braking system and external receivers.

Steering a hydrostatic transmission is done by an electronic automatic transmission ratio system influencing pump productiveness. Due to a number of transmissions and using motors of permanent absorptive initial choice of off-road or road transmissions is done by switching off following axles motors. In that way a variable and summary motors absorptive is achieved. Figure 3a shows a traction characteristic of a vehicle on which individual curves show different variants of transferring drive on the drive wheels:

a) six motors drive
b) four motors drive
c) two motors drive

A simultaneous work of driving bolts and chosen wheel motors is possible at the time of driving into and out a water obstacle. On the following figures a few research results of traction properties of Lewiatan equipped in a hydrostatic power transmission system are showed: a characteristic of vehicle acceleration for wheel pressure 0,2 MPa (Fig. 3b) and an example of breaking distance (Fig. 3c). A vehicle gathers maximum 54 km per hour speed in 31 seconds and its breaking distance (on hardened surface) is about 18 metres. A minimum turning radius has also been researched and amounts 3,38 m for a left turn and 3,86 for a right turn.

Test carried out in Military University of Technology (MUT) proved that Leviatan is fully capable of performing tasks as an unmanned platform for working out and testing of rescue actions and performing tasks connected with transporting dangerous materials, taking samples of contaminated soil and so on. It's capable of crossing rough terrain and it's important feature is the ability to cross water obstacles without having to carry out any actions (Fig. 4).

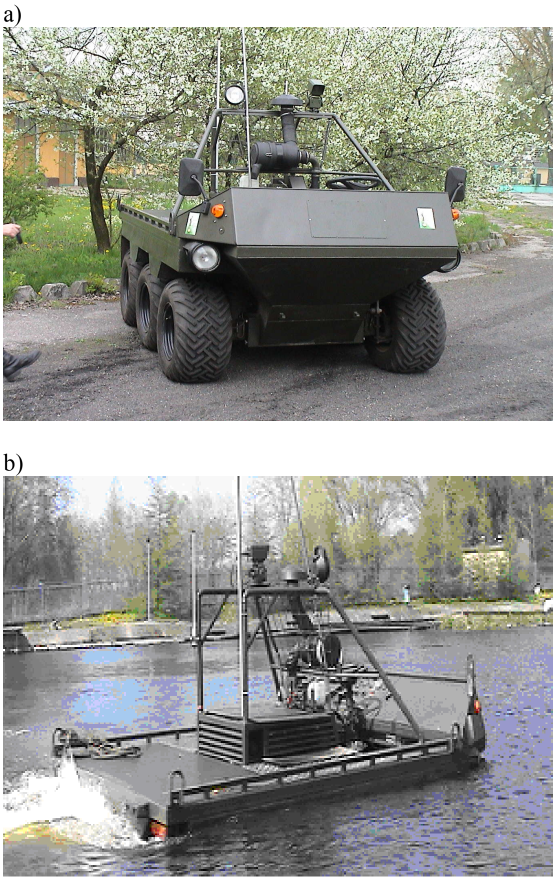

Figure 4. Remote controlled vehicle „Lewiatan" during test bad: a – driving in the terrain; b – sailing in the water

3. REMOTE CONTROL SYSTEM

Research on elaborating the remote control system is being carried out in Institute of Machine Buildings. Beside the remote control system a vehicle will be equipped in systems providing autonomous working. On the ground of self-research and literature studies [1], [3] a remote control system of Lewiatan vehicle in teleoperator system was elaborated. The system consists of a console, visualization system which are assembled on the operator's station and a programmer with detectors assembled on the vehicle. Detectors are divided into three groups: environment reconnaissance, vehicle localization and vehicle parameters control. Environment reconnaissance is done by video cameras and ranging laser. The pictures from cameras are transmitted by radio to an operator's station (external feedback loop) whereas the signals from ranging laser are sent in two directions: to an operator's station and to an aided operator's steering system. According to the steering signals and signals from ranging laser (internal feedback loop) an aided operator's steering system works out signals for governing a vehicle. Localization of the vehicle in terrain is done by GPS system and a detector of angle of vehicle inclination measurement. That information is projected on an operator's console. Signals from detectors that measure parameters of the vehicle are sent to steering system (Fig. 5).

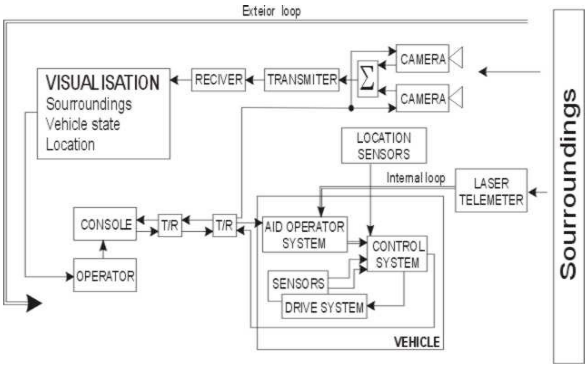

Figure 5. Functional scheme of the teleoperated control system of unmanned ground vehicle

Figure 5 shows unmanned land vehicle with some elements of remote control system and environment reconnaissance built on the ground of Lewiatan. It consists of: a ranging laser SICK, video cameras, a vehicle programmer, a radio kit for transmitting and receiving and an operator's console.

Tests of adapting Lewiatan to a use as UGV, carried out in MUT, fully confirmed that - it can be used as an unmanned platform to elaborating and testing rescue operation and also actions connected with lifting and moving hazardous loads, drawing of samples of ground contamination.

Figure 5. Vehicle Lewiatan with remote controlled system

4. CONCLUSIONS

Specific conditions of work of remote controlled vehicles prevents from coping the existing solutions used in mobile robots. Analysis presented in this paper show that an individual approach to the subject of remote controlled system in such vehicles is needed. This approach depends on technological tasks which the vehicle will have to carry out.

As a unmanned platform, LEWIATAN could play a pivotal chain role. The platform is specially predisposed to rummage contaminated areas. It can move through difficult terrain, and it's low pressure exerted on the ground allows it to drive safely on snow, ice and swampy terrain. Furthermore it possesses an important ability is to cross water obstacles without having to change it's configuration.

This paper shows that the major problem with realizing the control system of tele-autonomous controlled vehicles is obstacles negotiation subsystem. Its main task is to generate information about object's location and calculate safety path for moving vehicle.

Our project built on the basis of a laser telemeter may be used for localization of terrain obstacles, as a machine vision and surroundings visualization system.

Research carried out show that it is possible to use the 2-D laser telemeter for creating a 3-D representation of the environment. The main problem that will have to be handled in the further is to find the way to recognize the obstacles more precisely. However recent research are directed on working out algorithms for calculating the best path according to criteria given by the operator.

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