

Development Laboratory Vehicles Equipped with Electrohydraulic Actuators Controlled by Global Positioning System

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Received: June 10 2013

Accepted: July 10 2013

ABSTRACT

Since in agricultural and construction Projects machinery system controlled manually , errors are great which not only increasing the cost and duration of the project but also it has adverse effects on the quality of the final result of the project , which it can be improved with automation of machinery .

The project is a laboratory car model of grader machine emulator which designed and built through solid works @ 2012 software . Electro-hydraulic actuators that are driven by groundsman blade of the car are at the desired height above the ground and By changing the height of the vehicle occurs on terrain, the terrain coordinates can be detected automatically via satellite signals. This car has the ability to move on the rail road . The car hydraulic circuit is similar to grader hydraulic circuit and designed and analysis with Automation Studios TM5.2 And more a suitable electrical Hardware has been designed and built to convert satellite signals into signals for use with a microcontroller to control the electro-hydraulic actuator. Results obtained in this study are preparation some technical documentation in order to develop machine automation control system.

KEYWORDS: RTK GPS, Automation, Grader, Electrohydraulic actuator.

1. INTRODUCTION

One of the newest patents is “Global Positioning System” or GPS , which has many applications including military, construction, agricultural, transportation, and In this project, a precision GPS system known as RTK GPS, is used toward the automated machinery. which with using this technology instead of old methods, the cost and duration and also errors in agricultural and construction projects reduces and the quality and accuracy increases, And most importantly, another advantage of using GPS systems in construction projects, will be deleting the Engineering Surveyor. This reduces the cost and increase the speed the project , and even when the bad weather of some places does not allow to mapping manually this system mapping the terrain without any limitations, and in agricultural machinery automation it give the proper slope to the farmland cause increase in the quality and quantity of products. All this are part of the objectives of the project.

In this project we have tried to design a good example of automotive electrical, hydraulic systems and electrical hardware that uses a global positioning system coordinates of the desired location, then by using designed sample control hydraulic jack with high accuracy automatically in suitable height during the movement of the machine, which it could be used in agricultural and construction machinery. [1]

Tractor is a vehicle that can be used for drawing movable equipment and agricultural machinery. Also this machine is used to actuate machines residing on the farm, in this case tractors provides the power required by the driven empowerment.

Hydraulic systems in agricultural and industrial tractor use engine or transmission chain to move. Tractor could supply the power of the tools and equipment that are connected to it three ways. these vims include: 1 - drawbar power 2 - Axis Power ratings 3 - Hydraulic power. Our tractor hydraulic system equipped with controllers in order to control the hydraulic system .these controllers are: 1) Pressure Control System 2) Traction Control System (Bar) 3) Position Control System (H) 4) Position and Traction Control System. [2]

Preity Atynk et al. had a Widespread research on the Repeatability of RTK GPS systems under different environmental forces on 2012. In this study, , numerous studies and experiments conducted on factors such as buildings and trees that make up errors and reduce accuracy RTK GPS , which The tests on two different areas of tall buildings and trees has been done , some of coordinates obtained from RTK GPS (the coordinates of these points were already known) were compared in both areas , And the result is expressed as follows :

Trees and tall buildings cause a reflection on the signal sent from the satellite to the RTKGPS receiver and can cause large errors in systems and Increasing the number of stations is very convenient and efficient way to correct the error reported for this problem. [3]

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In 2006 two tubing projects in Iceland performed, which two different traditional and modern methods has been used with same machinery and manpower. In modern way machinery equipped with RTKGPS and Run-time efficiency, reduce errors that occur during the project design, cost and manpower required for the project was announced. [4]

Adam chok has research on how to control automation machinery through satellite in 2006 and The results can be expressed as follows: with Using the RTK GPS system, with having the location for agricultural machinery anywhere in the land they could be controlled and navigated and that will lead to the improvement of agricultural land in terms of having sufficient slope, careful planting and harvesting crops increase the quantity and quality of the products. [5]

1.1 What is RTKGPS?

RTK word is derived from the term “Real Time Kinematic” That means an immediate seeing of results during the operation (non-stop). These GPS’s compared to conventional GPS has great features, they can process the satellite information in any time continuous and uninterrupted, these features can be used in agricultural machinery and construction equipment, all terrain mapping, navigation of ships and submarines and ... another important feature of RTKGPS is centimeter accuracy, which obtain from complex function on received wavelength from satellite and also error correction in sending signals. [6]

2 . MATERIALS AND METHODS

2.1 Car design by software SOLIDWORKS ® 2012

The first step in this project is the design of the mechanical parts or the stimulus part of the car. For this purpose, the two-dimensional maps and 2012 ® Solid Works design software took part. After The model design, dynamic analysis has been made on the car. Automotive design in this project consists of three main parts which are:

The driver of automobiles part, hydraulic parts, the RTK GPS part.

2.2. Chassis design and all needed Car parts

Automotive chassis design and all the necessary parts in this section were performed here. Figure (1) show examples of automotive design and figure (2) shows three point hitch taken from three point hitch of the tractor.

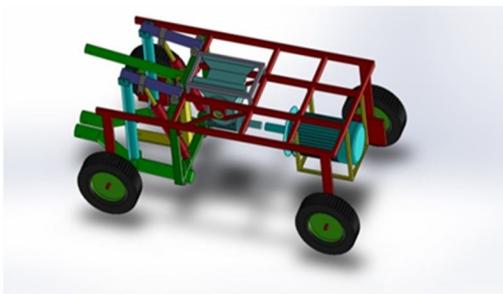


Fig. 1. examples of automotive design

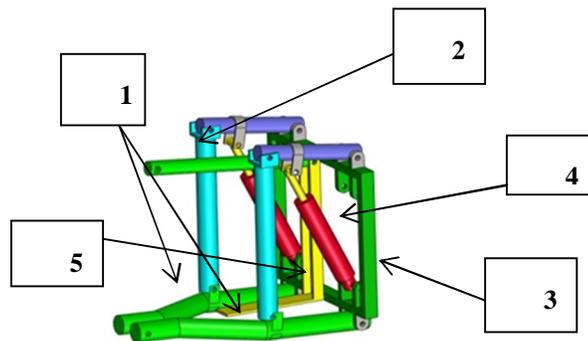


fig.2.three point hitch sample

Three point hitch components (Figure 2) are:

1 - lateral arms 2 - arm support center 3 – Chassis 4 - Hydraulic Jack 5 – drawbar

2 . 3 Vehicle power supply design

Here the components which needs to make movement power of cars is introduced.

Components necessary to drive the vehicle are as follows:

- Three-phase electric motors: driving force supply by a motor 75 kw and 2800 R/M.
- Inverter: Different cycles could be created By changing the frequency of the inverter to the motor . Inverters are able to adapt the load characteristics with the engine characteristics, which makes engines, load lower electrical power from grid and expensive load factor modification boards and not require, Importantly, the engine can launch quiet and softly, which causes loss of electrical shock and mechanical stress on the engine components and this advantage cause decrease in prematurely sublation of motor and other parts. the Machine model is SV008IGSA, inverter power 75 kw and a voltage of 220/380 v.
- industrial electrical switch: This switch is equipped with the left- and right circular.
- Belt: power transmission from the engine to the transmission is done by belt.
- Helical gearbox: a worm gear 32/1 vehicle is required.
- Pulley: to Transfer gearbox power to the for wire rope that is supposed to traction the vehicle.

- Pulley: placed on output shaft of the Engine and transmission and the belt falls on it.
- Wire rope
- Cable: 4 cable length 1.5 m is required.

2.4 Car Production

Upon completion of the design, Car produced and all the necessary equipment installed on the vehicle which is shown in figure (3). It should be noted that the installation a variety of agricultural and construction vehicles on the three point hitch like chisel blade, groundman, disk and ... different usage can be defined for this vehicle, in this example chisel is used as a plow the soil and the cars can be considered a tractor simulator machine.

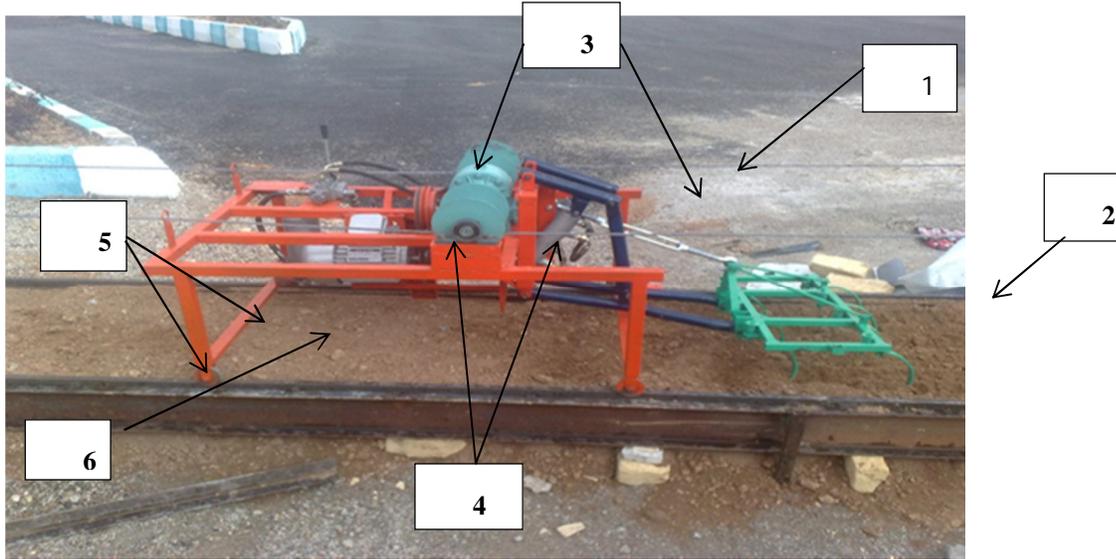


Fig. 3. Rail and road car made

Auto parts shown in this image are:

1. Connect the three points
2. Chisel (an instrument for soil tillage)
3. Hydraulic jacks and other hydraulic circuit components
4. Electric Motor and Gear
5. dirt road, rail and tank
6. The main chassis of the car

2.5 . Hydraulic circuit design and simulation of vehicle

In this part , First , design calculations were performed according to the relationship between hydraulic circuit components then with hydraulic circuit simulation created by Automation Studio™ 5.2 software hydraulic circuit operation, were reviewed and analyzed And the calculations were compared with the results obtained from simulation software, the results were similar. Figure 4 shows the hydraulic circuit design. Below a summary of the calculations results obtained through the relationship of the components of the hydraulic circuit is shown Which are:

- Inside diameter of the pipe in the pump suction line = 0.036 m
- Inside diameter of the pipe lines = 0.024m
- Required hydraulic circuit flow rate = $54.7 \frac{l}{min}$
- Required pressure of the hydraulic circuit = 96 bar
- Cylinder Opening speed = 5 cm/s

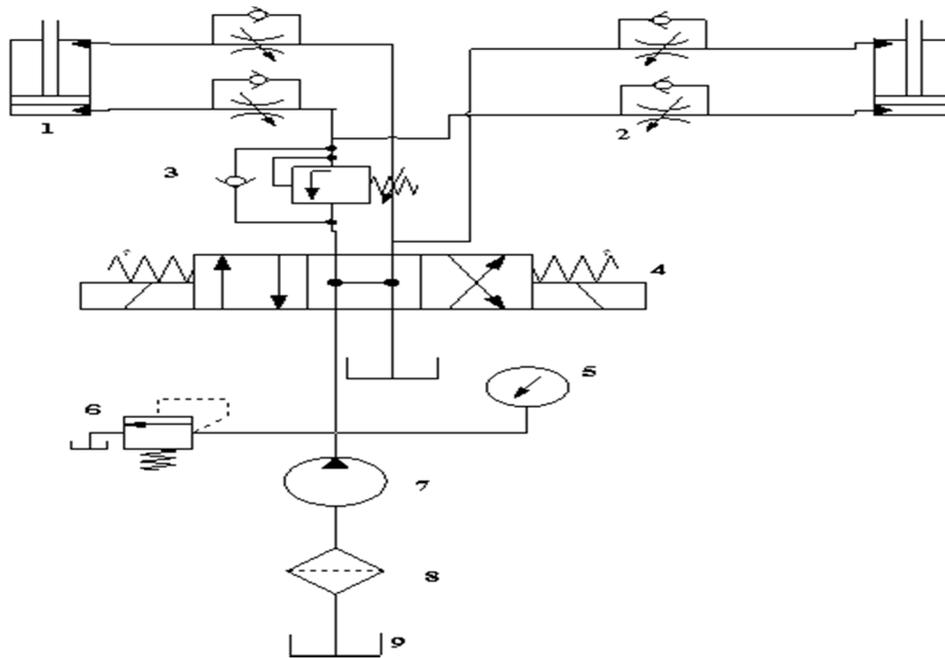


Fig. 4. Hydraulic circuit design by Automation Studio™ software

Components used in the hydraulic circuit design are as follows:

1. two-way cylinder: this type of cylinder move in both directions using the pressure.
2. Hydraulic Flow Control Valve: This valve responsible to regulates the output flow of cylinders.
3. The balance valve: This valve is on the task of maintaining balance during circuit operation after the piston heads.
4. Tap the Route $\frac{3}{4}$ valve: the route tap valve task is to establish flow in the hydraulic circuit.
5. Barometer: calculate pressure level based on the output of the hydraulic pump.
6. Security valve: when the pressure is as high as critical pressure it opens and circuit back the hydraulic flow to the tank.
7. Hydraulic pump: has the duty to provide the required pressure of the circuit.
8. Filters: cleans oil from waste and infected materials.
9. Tank: Reservoir of the required oil for circuit. [7- 8]

2. 6 . Electronic Hardware Design

In this research for the design of electronic hardware that analyze the RTK GPS system sent signals And has proportional reaction to the target device, we need several pieces of electronic mentioned Below and a possible explanation is given about that item.

2 . 6 . 1. Components used in electronic hardware design include:

1. RTK GPS system
2. ATMEGA16 & ATMEGA8 Microcontrollers
3. LCD TS2040
4. IC ULN2003A & IC 7805 & IC 74HCT245
5. Switches and Relays

2 .6 . 2 Electronic hardware usage.

Input voltage (power supply) comes by a 12-volt adapter with the one amp. First, the input voltage goes to IC7805. The task of this component is to maintain a constant voltage circuit. The current and voltage circuits and RTK GPS system is turned on and the receiver is activated and starts to send data.

Data leaves the transmitter unit of the RTK GPS system and entered IC MAX 232. The device operates matching between input voltage and output voltage (input to the microcontroller) of RTK GPS system. After the pieces were removed from the data, they entered the microcontroller ATMEGA8 (hereinafter in abbreviated the microcontroller called «Slave»). In the micro controller accuracy control of transmission data, a good start for getting 445 bytes of data which initiated correctly, data layout would be done . After receiving 445 bytes of information the slave microcontroller ready to send data to ATMEGA16 microcontroller (hereinafter in abbreviated this microcontroller is called «master»). It should be noted that the master microcontroller, choose another microcontroller (which is it's Subaltern and data transferred to the master (which adopted the major commands)). Data transmitted from ATMEGA8 to ATMEGA16 through IC 74HCT245 which is interface between the microcontroller and serves as the key. The master microcontroller processed data and transmitted data is displayed on the LCD and according to the identified position of the different sent data in RTK GPS system, Required information including number of satellites, longitude, latitude and altitude from open sea separated from other data and it is

programmable for any other use. as for intended use of this study that is "the hydraulics operating the vehicle equipped with satellite Finders", data are programmed for this reason that if there is any changes in longitude, latitude and altitude Proportional to Considered slope master microcontroller send a signal to the IC ULN2003A then this IC controls the system relay by strengthening the flow from microcontroller and According to the terms proceed or off the track. Output relay connected to solenoid valve of the hydraulic system and by this way hydraulic system can be controlled by the operator. Figure 5 shows an overview of the components of the electrical circuit.

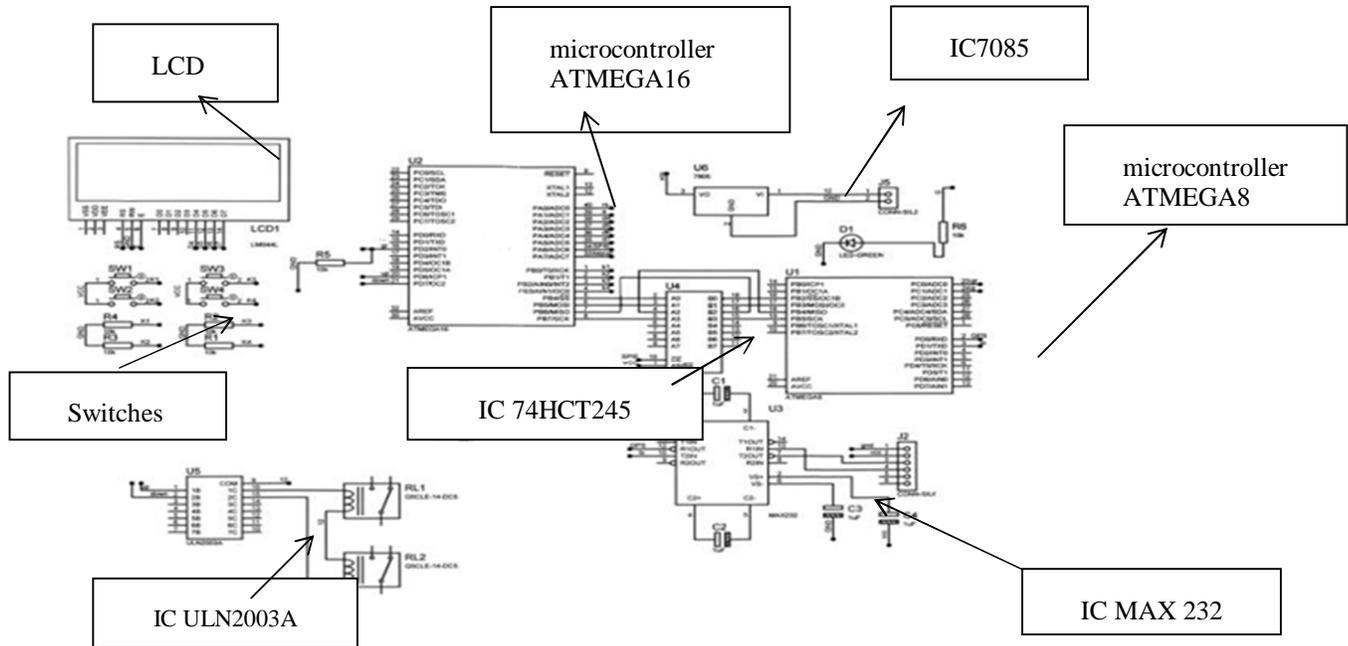


Fig. 5. Designed electrical circuit for system

3 . Conclusions

This project shows that should be moved forward with World Science and Technology and traditional methods and acts and also machine controlling manually which usually does not have good Efficiency and quality should be dismissed . In order to use RTK GPS system Telecommunications infrastructure which is poor should be strengthened to Use of this system for such a large operation in the field of large operation be possible because use of such systems require the use of satellite signals error-control stations, (DGPS) . Another result that can be mentioned are:

1. The results, analysis and software analysis and practical test that was conducted on laboratory models shows that the intelligent control of such vehicles by using satellite positioning is possible.
2. By Using satellite positioning systems at any time of day or night hydraulic systems could be precisely control And this technology can be used in other fields.
3. By producing machines equipped with advanced equipment, Construction and agricultural projects could be very good in terms of quality and upgrade its industries to localize.
4. With more research in the field of "machine control by using satellite positioning signals " localization of this that Few countries have the it technical knowledge could be done and make it Available in the country.

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