

A REMOTE CART IS WIRELESSLY CONTROLLED BY A COMPUTER JOYSTICK

Eduardo Perez Lobato

Departamento de Ingeniería Industrial-Universidad de Antofagasta

Av.J.Guzmán Errázuriz s/n-Casilla 170-Antofagasta-Chile

email: perezlobato@uantof.cl

Abstract – This paper describes the design and implementation of a system which controls wirelessly a remote cart through handling a computer joystick.

Keywords Wireless control, remote control, Programmable Logic Device, joystick-controlled, computer-controlled

Introduction

The background of this work is to develop a robotic unit suitable to perform either terrestrial or underwater exploration. This paper discloses the development and implementation of a wireless link between a PC and a vehicle, in order to remotely make the robotic unit navigate.

1. CART

The cart has three wheels, two of them are driven by a 1.5 V @ 1A DC motor, along with a 41.7:1 reduction gearbox each, and the third one is a freewheel, as in Figure 1.

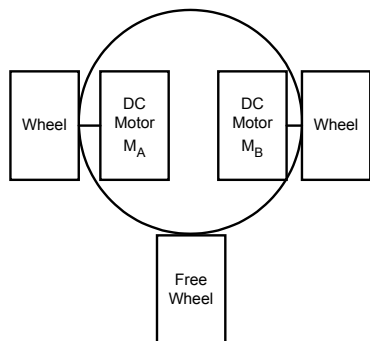


Figure 1 Cart with two motorized wheels and a freewheel

2. GENERATION OF THE MOTIONS OF A SINGLE MOTOR

To generate the three basic motions of a single DC motor, Counter Clock Wise (CCW), Clock Wise (CW) and STOP, a battery and four switches are needed, as in Figure 2. The motions are produced through setting the S₁ to S₄ switches either to an ON or OFF state, as seen in Table 1

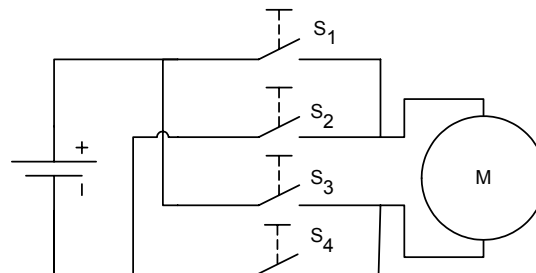


Figure 2 Motor with four switches

S ₁	S ₂	S ₃	S ₄	Motor motion
ON	OFF	OFF	ON	CW
OFF	ON	ON	OFF	CKW
OFF	OFF	OFF	OFF	STOP

Table 1 Generation of the motor motions of a single motor through setting the switches to an ON or OFF state.

In this work, instead of using physical switches, a L293 driver is used, having electronic switches and performing the same function, as depicted in Figure 3.

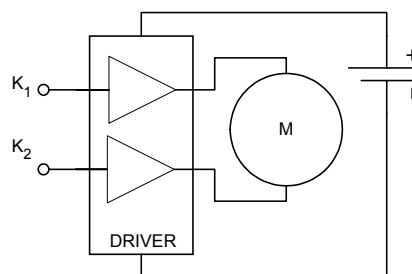


Figure 3 Motor with L293 driver

K₁ and K₂ are the input lines to the driver, so as it is seen, to fully command a single motor with this driver, two input lines are enough. The states of these inputs to generate the three basic motions of a motor are shown in Table 2

K ₁	K ₂	Motor motion
ON	OFF	CW
OFF	ON	CKW
OFF	OFF	STOP

Table 2 Generation of the basic motions of a single motor through using the L293 driver

3. MAKING THE CART GO ANYWHERE

A set of nine commands are needed to make the cart go anywhere. To generate anyone of these commands, the two motors M_A and M_B must be controlled through generating their basic motions, as shown in Table 3

Command	M _A	M _B	Mnemonic
Stop	STOP	STOP	STOP
Forward	CCW	CCW	FWD
Rotates axially CCW	CCW	CW	RCCW
Forward right	CW	STOP	FWR
Rotates axially CW	CW	CCW	RCW
Backward	CW	CW	BWD
Backward right	CW	STOP	BWR
Forward left	STOP	CCW	FWL
Backward left	STOP	CW	BWL

Table 3 Set of nine commands to fully control the direction of movement of the cart

4. JOYSTICK

A joystick connected to the game port of the computer continuously generates the X_J and Y_J planar coordinates, which are read and stored onto a buffer by a software driver.

Every time the joystick is moved, its planar coordinates X_J and Y_J are changed. The X_J coordinates varies its value between 0 and 640 and the Y_J coordinate varies its value between 0 and 480. The home (0,0) and the end (640,480) points of the plane, also called a map, are respectively set up in the upper left corner and the lower right corner position of the joystick.

The position of the joystick is defined in such a way that is directly related with the direction where the operator of the joystick wishes the cart to go. To do so, the most frequent commands were mapped onto the 640x480 plane, as depicted in Figure 4, allowing the operator to run them

with the joystick fire button released. The specific coordinate sets which delimits anyone of the cart directions are shown in Table 4

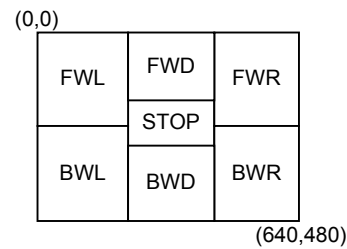


Figure 4 640x480 map with fire button released

Mnemonic	Coordinate sets
STOP	(210,200) - (420,280)
FWD	(210,000) - (420,200)
FWR	(420,000) - (640,240)
BWD	(210,280) - (420,480)
BWR	(420,240) - (640,480)
FWL	(000,000) - (210,240)
BWL	(000,240) - (210,480)

Table 4 Coordinate sets with fire button released

Whenever the operator wishes the cart rotate either clockwise or counterclockwise, then a second 640x480 map is required. To create a second map, the operator must press the joystick fire button. On keeping the joystick fire button pressed, the related motions are mapped, as depicted in Figure 5, and the specific coordinate sets which delimits anyone of the motions are shown in Table 5

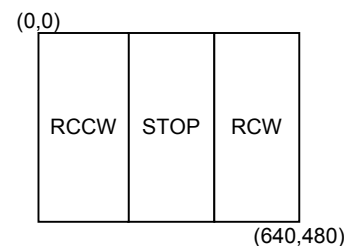


Figure 5 640x480 map with fire button pressed

Mnemonic	Coordinate sets
RCW	(000,000) - (210,480)
RCCW	(420,000) - (640,480)
STOP	(210,000) - (420,480)

Table 5 Coordinate sets with fire button pressed

As shown before, two tables were needed in order make the operator handle the joystick in an easier fashion.

5. COMMAND TRANSMITTER

A 4-bit word will be enough to encode the 9 commands needed to move the cart anywhere, as depicted in Table 6

Mnemonic	D ₃ D ₂ D ₁ D ₀
FWD	"1001"
FWR	"1011"
BWD	"1101"
BWR	"1110"
FWL	"1111"
BWL	"1000"
RCW	"1100"
RCCW	"1010"
STOP	"0xxx"

Table 6 Commands and their code

Everytime the operator at the computer site changes the position of the joystick in order to move the remote cart to a new direction, the software reads from the joystick driver the new X_J and Y_J coordinates, along with the state of the fire button, and then locate them onto one of the two 640x 480 maps, thus getting the command to be run and its related 4-bit word. Afterwards, the 4-bit word is taken out from the computer through the DB-25 parallel port D₀-D₃ output pins to the MC-145026 communication encoder, where it is registered. The communication encoder secures the wireless transmission through combining the D₀-D₃ bits with the A₁-A₅ bits, which is its local address. This combination makes up a single communication word out of the 2⁹ communication words, and it is sent twice to the AM-RT4-418 Radio Frequency transmitter. The transmitter modulates the communication word with a 418 MHz frequency carrier and broadcasts it through the air, as depicted in Figure 6

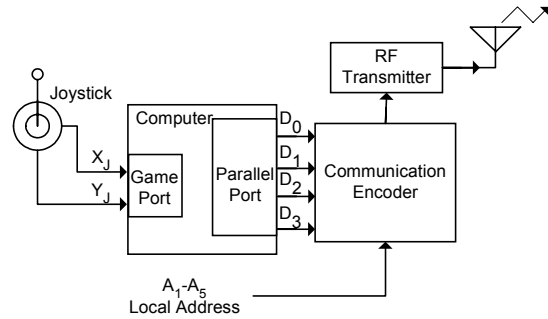
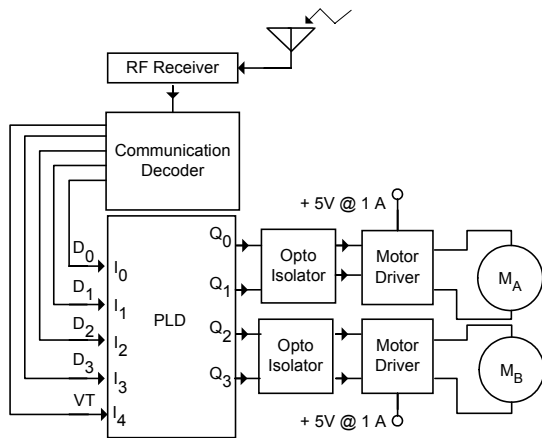


Figure 6 Command transmitter layout

6. COMMAND RECEIVER

The AM-HRR3-418 RF receiver continuously picks up the broadcasted communication words, demodulates and passes them to the MC-145027 communication decoder. The communication decoder checks the last communication word twice, thus discarding it if the communication word has been destroyed because transmission corruption, and keeping the Valid Transmission (VT) bit low.

On successful transmission, the decoder sets the VT bit high, thus enabling the Programmable Logic Device (PLD), and then the 4-bit word is extracted out from the valid communication word and gated into the PLD, where one out of the nine commands is decoded and the related signals to the motor drivers are generated, thus making the cart go to the desired direction. It is noteworthy to point out that the back electromagnetic noise generated by the electrical motors makes the RF receiver work erroneously and the clock of the PLD tilt, thus meaning the computer randomly losses control over the remote vehicle. So in order to fix this problem, an ISQ-204 optoelectronic isolation stage was set between in the controller and the motor drivers, thus filtering the electromagnetic interference out. The command receiver layout is depicted in Figure 7



T.Hongo, H.Arakawa, G.Sugimoto, K.Tange and Y.Yamaoto, "An Automatic Guidance System of a Self-Controlled Vehicle," IEEE Trans. on Indus. Elect. Vol. IE-34, No. 1, 1987.

Figure 7 Command receiver layout

CONCLUSIONS

This cart was tested over a 30 sight feet range, proven to be satisfactory. Due this vehicle does not generate feedback signaling, it means the human operator must be watching to make the vehicle avoid obstacles, so further work will be focused in add some feedback to the operator, which it means instead of having a single way transmission, a two way transmission will be set, as seen in (K.Z.Karam et al., 1998; R.M.DeSantis, 1995). Besides it is possible to record the full sequence of operations of the joystick into the computer, thus retrieving it later in order to automate the working sequence of the cart, as seen in (Z.Shiller, 1991; T.Hongo et al., 1987)

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REFERENCES

- K.Z.Karam and A.Albagul, "Dynamic Modelling and Control Issues for a Three Wheeled Vehicle," Proc.5th Int. Con. on Control, Automation, Robotics and Vision, Singapore, 1998.
- R.M.DeSantis, "Modeling and Path-tracking Control of a mobile Wheeled Robot with a Differential Drive," Robotica, Vol. 13, 1995.
- Z.Shiller, "Dynamics Motion Planning of Autonomous Vehicles," IEEE Trans. On Robotics and Automation, Vol. 7, No. 2, 1991.