VEGA ELECTRONICS

A VEHICLE THAT EXTRACTS THE MAP OF A CLOSED PATH AND CALCULATES THE AREA INSIDE THE CONTOUR

CONCEPTUAL DESIGN REPORT

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ABSTRACT

Vega Electronics knows that Tulip Architecture Company is a very reputable company and successful in paysage works. Our company always examines the projects that are proposed by your company. We believe that the last project “Designing a vehicle that extracts the map of a closed loop and calculates the area inside the contour” announced last month on your website is very suitable to our company. We believe that this vehicle will be very useful when designing and implementing your constructions. The area of the landscape can be calculated very quickly and accurately. Furthermore, mapping of that area by our device will make your interior decoration work easier

In this project, a delicate system which consists of an autonomous vehicle and a certain pathway will be designed and constructed. The ideal designed job for the vehicle is the task of discovery of and tracing an arbitrary path on a certain floor. The map of the closed path that the vehicle should follow will be displayed on the screen of the PC and then the area of the related pathway will also be calculated.

Our company is a very prestigious company. It ensures solving the problem in the most efficient and creative way. In this report we mentioned about statement of the problem, approach to solution, main and alternative solutions for the design, and our weekly plans. Also we will introduce the capability of our company to perform this project in addition to our limitations and cost issues.

1. INTRODUCTION

The subject of the project is to design and manufacture a vehicle extracting the map of a closed path and calculates the area inside the contour. Our aim to design a vehicle which traces a line properly, then draws the map of that line and calculates the area enclosed by that line accurately.

Project is consisted of mainly 3 parts which are design of line follower robot, determination of coordinates of path and calculation of the area. The definite closed pathway is restricted to fit inside 1m x 1m. While floor is white colored, the pathway will be black colored and its width will be 1.1 meter. The line follower robot will detect the black or white color by the virtue of contrast sensor and it will make its movement according to data coming from sensors. This subject is explained in detail in the line follower design part.

There are 2 different solution for determination of coordinates of path. Main solution is ultrasonic distance measurement method. To satisfy this there will be 3 different obstacles which are constituted from absorber and reflector pairs. According to coming signals vehicle will obtain its place and record the coordinates. The alternative solution is that ultrasonic waves will be used for distance measurement. Since three distance information are used for position determining, three ultrasound transmitters will be present in the edges of the setup. These transmitters satisfy the determination of the coordinates by using distance measurement method. These solutions are clearly explained in detail in the solution part.

After the coordinates are determined , the data will be sent to PC via wireless and the path area will be displayed on the screen. Then by using a suitable program , the area of the path will be calculated.

2. PROBLEM STATEMENT

2.1 GOALS

At the end of this project, Vega Electronics aims to design a vehicle which traces a line properly, determine the coordinates with a minimum error, then draws the map of that line and calculates the area enclosed by that line accurately.

2.2 OBJECTIVES

Vega Electronics aims to perform the project with fewer restrictions and in a most accurate way. The most important objective is to correspond Tulip Company's expectations which are :

- The closed path is restricted to fit inside a 1m by 1m square.
- There will be no hardwiring between the vehicle and outside world.
- Every point of the path must be determined within 1 cm accuracy.
- The vehicle will not start its operations on the path.

The project is designed in such a manner that all these expectations are met.

Since all of the solution method choices are chosen according to our objectives, we believe that it is necessary to remind them again.

Accurate	Grade: 8/10
Fast	Grade:7/10
Creative Solution	Grade: 7/10
Adoptable to different working conditions	Grade:7/10
User friendly	Grade:6/10
Environmental Friendly*	Grade:6/10

*By giving a low grade for the environmental friendly requirement, we do not mean that we do not care about the environment. We are already sure that our system will not cause any damage to the nature since we are working on electronic systems. Our purpose in this concept will be just lowering the radiation and noise.

2.3FUNCTIONAL SPECIFICATIONS AND CONSTRAINTS

Project is consisted of mainly 3 parts and all parts have different functional specifications and constraints. All these are listed and explained below part by part.

- **Line follower**:

Functional specifications:

- Includes 5 contrast sensor(CNY70).
- 2 DC motor is used.
- To lessen power consumption and satisfy speed control pwm technology is used.

Constraints:

- Because of vehicle's weight wanted speed level can not be acquired properly.

- **Determination of coordinates:**

Functional specifications:

-For the main solution:

- There will be three absorber and reflector blocks on three corners
- There will be two receiver and transmitter pair on the top of the robot.
- If ultrasonic range finder is used ,it can measure the distance varying from 0 to 765 cm.
- Data readings occur up to every 100 msec.

-For the alternative solution:

- Infrared encoder and decode device is used.
- The transmitter and receiver uses 40kHz frequency.

Constraints:

-For the main solution:

- Because of continous movement there will be a little error

-For the alternative solution:

- Unexpected errors may result because of sound interface from the environment.

➢ **Mapping and wireless data transfer:**

Functional specifications:

- Transmitter an receiver pairs communicates at 433.9 MHz.
- Data is transferred with minimum 0.3 kbit/sec and maximum 2.4 kbit/sec data rates.

Constraints:

- Transmitter can work between -10 ºC and +55 ºC
- Any metal layers in the environment between transmitter and receiver block the wireless signal.
- If there is an another wireless signal at the same frequency and bandwidth in the environment, distortion can occur.

The detailed information about functional specifications are also included in the solution part.

3. SOLUTION APPROACH

3.1 Design Requirements

Line follower:

- Black line will be drawn on the white floor.
- 2 cm line thickness.
- Area should be flat.
- Path must not include any crossing points.

Environment:

- Area of the operation will be 1m x 1m.
- Sound noise level will be low.

Wireless communication:

- There should be computer to draw the area of the path.
- There will be no metal material between transmitter and receiver.
- The receiver-transmitter pairs will use 433.92 MHz frequency range.

Finding coordinates:

- For the main solution there will be three obstacles, two of which will consist of absorber and reflector parts and one of them will consist of only reflector.
- All of the obstacles will be placed on the different corners of the area boundary.
- For the alternative solution three transmitters will be placed as towers so that the receiver can detect their signals.

3.2 DETAILED SOLUTION

Main Sub Blocks of the Design

- Following the line, robot design
- Measuring the distance, finding the position
- Data transfer, mapping and area calculation

3.2.1 Line Follower Robot Design

To design a line follower, first of all, the body of the robot should be designed. The most important thing to choose the body is that it should be lightweight. Generally three types of material are used for the body, which are forex, aluminium and plexiglass. Because the most favored one for the line follower robots is the plexiglass having 3 mm thickness, this type of body will be used. Figure 1 shows the picture of the body. (5TL) Also if the body is longer, it can follow the line more accurately. The reason is that sensors will antecede from vehicles and this provides vehicles prepare to turn, so turns will be smoother.

Figure 1

Shape of the body

A line follower consists of a mechanical part and an electronic part.

Mechanical part:

The aim of the mechanical part is to adjust the movement and velocity of the line follower. For that reason, this part is important for the accuracy. When the velocity is increased the accuracy will decrease, so the speed of the line follower will be adjusted according to accuracy.

For the line follower, 3 wheels will be used. One of them will be free wheel. This provides line follower to turn faster.

According to research it is found that dc motors are more appropriate for line follower’s design because of 5 main reasons:

- It provides the line follower to be faster. After the accuracy is adjusted to satisfy the requirement, the second thing which will be important is velocity. For that reason, dc motors will be appropriate for the design.
- The motors can move to the opposite direction. This feature can be useful if robot steps out of line. When this situation occurs, by the virtue of this feature robot can go back and find the line.
- It provides continuous movement.
- Speed control is made with pulse width modulation. Pwm is a technique for reducing the amount of power delivered to a DC motor. Pwm provides different velocities for the two vehicles. For example, one of them turns right fast, other one will not stop. It will turn also with it, but it will be slower. This will be satisfied by pwm.
- It is cheap, small and has high energy output.

According to data which is sent from PIC, there will be high or lower voltage which satisfies motors to move and turn. PIC16F628 will be used as a microcontroller because it has a single output for the pwm, it does not require an additional circuit thanks to interior oscillator and it has a large capacity. Its schema is shown in the Figure 2.

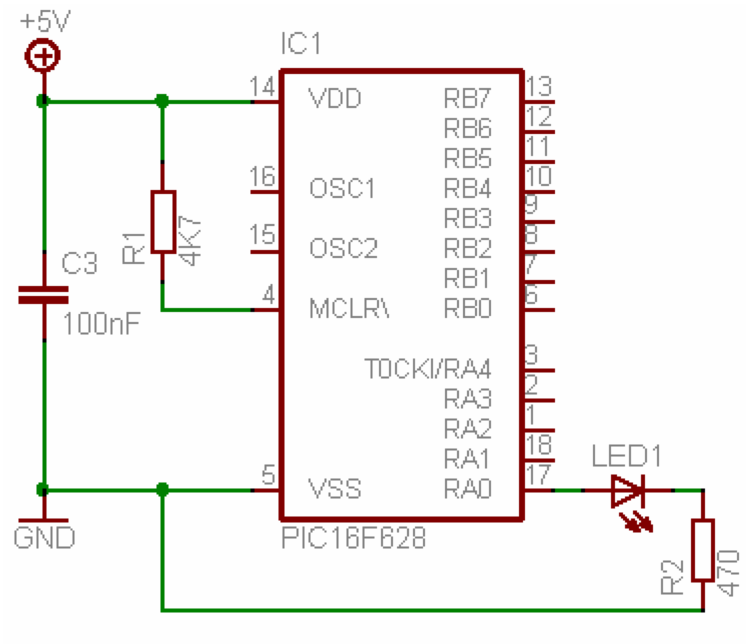
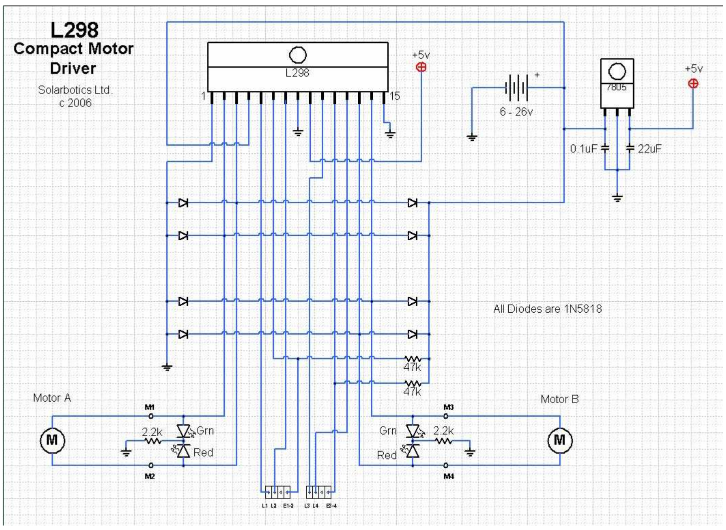


Figure 2

The schematic of the PIC16F628

There should be also a motor driver in order to increase driving current to energize motors. To drive motors the most widely used and effective motor drivers are L293D and L298, so one of these motor drivers can be used. The schema of L293D and L298 are shown in the Figure3. Also 2 capacitors will be used to lower the vibrations.



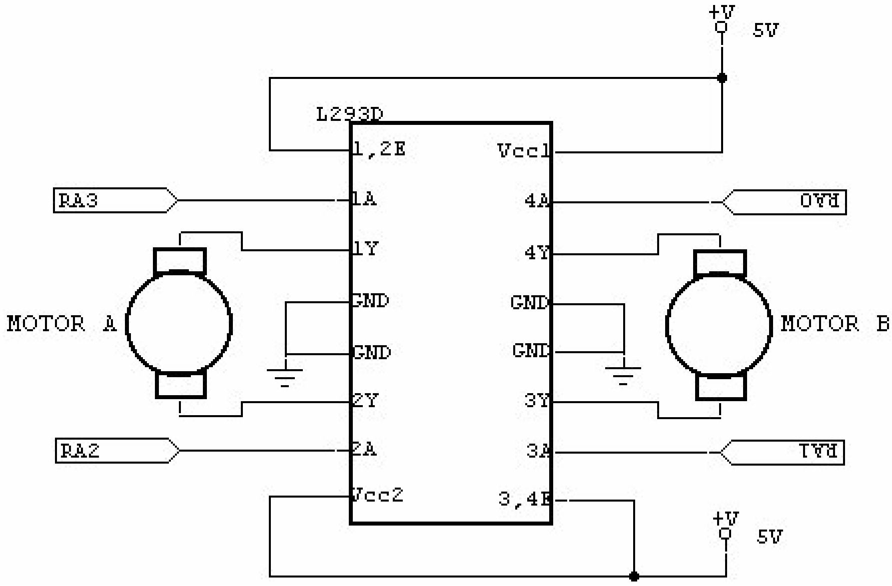


Figure 3

The schematic of L293D and L298

Electronic part:

The definite closed pathway is restricted to fit inside 1m x 1m. While floor is white colored, the pathway will be black colored and its width will be 1.1 meter. The line follower robot will detect the black or white color due to contrast sensor CNY70 and it will make its movement according to data coming from sensors. There will be 5 sensors which are alligned such that the middle one will detect black color and other 4 sensors will detect white color. Two of the sensors which are near the middle will be on the border that black line and white floor come together. If the left sensor detects black line, motors will be driven to change vehicle’s position to left. If the right sensor detects black line the exact opposite situation occurs. The other 2 sensors will be placed near the right and left sensors. The reason why these two sensors are needed is to reduce the error. When these two sensors detect the black color motors are driven as illustrated above, however the voltage level will be higher to drive motors.

The sensor alignment will be as in the Figure 4.

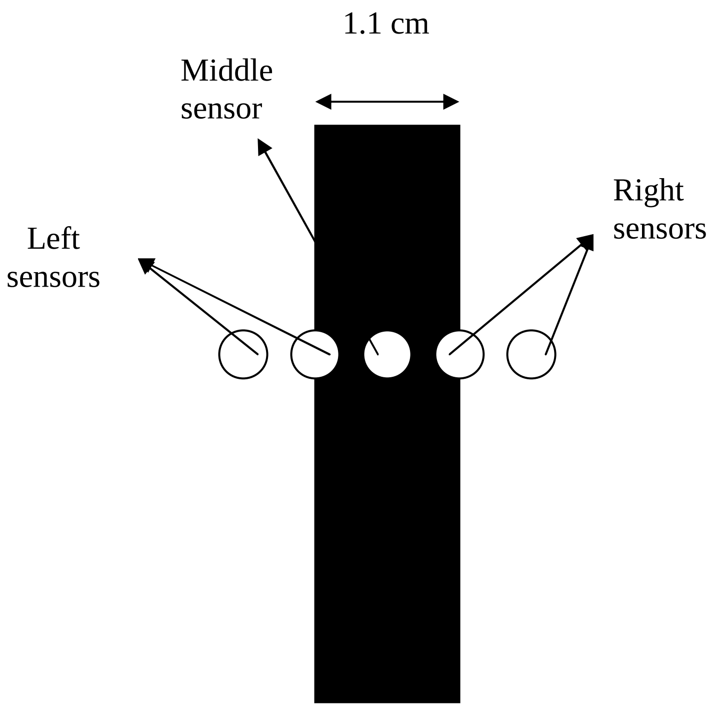


Figure 4

Alignment of sensors

3.2.2 Measuring the Distance, Finding the Position

- <u>Main Solution Approach</u>

Ultrasonic Distance Measuring

Receiver and the transmitter are placed on the robot.

The voice signal that will be transmitted will be 40 KHz which is out of the range that the human ear can hear. (Human can hear signals having the frequencies between 20 Hz to 20 KHz.) Therefore, the signal we will use is called ultrasonic not audible. So, our robot will not disturb the user with its sound.

- **Ultrasonic Sensor Choices:**

1) URM04 v2.0 Ultrasonic Sensor

Properties:

- Detectable ranges from 4cm to 500cm
- Module using RS485 bus communication
- 1 cm resolution
- Input voltage: 5V DC
- Dimensions: 34mm x 51mm
- Weight: 30g

Price: 28 Dollar

We are working on a 1m*1m plane. In case that the closed path is drawn very close to corners of that plane, we will put the reflector-absorber pairs outside the plane. Since the minimum range measured by the ultrasonic sensor is 4 cm, it will be enough to put the sensor 4-5 cm (in x and y direction) outside the plane. However, it required that the path will be mapped as how it looks like on the $1m^2$ area. Therefore, using this sensor will create an extra work to us.

2) Ultrasonic Range Finder –XL-Maxsonar EZ1

Properties:

- Object detection includes 0 range objects.
- Readings occur up to every 100 ms.
- Operates at 42 KHz.
- Can be powered between 3.3 V to 5V.
- Triggered operation provides the range reading as desired.
- Free run operation can continually measure and output range information.
- Calibrated beam angle.
- Real time auto calibration and noise rejection for every ranging cycle.
- Range 0 to 765 cm.

Price: 49.95 Dollars

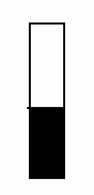
Compared to the first one, the second one has a higher price. However, it has many advantages over the first sensor. Its range, calibrated beam angle, triggered or continuous operation properties are very feasible to our project and satisfy our requirements. Since we are working on a 1m2 area and the path can be drawn anywhere, the lower range limit is important for us. If the path is drawn very close to the corners the first sensor will give inaccurate results.

After searching both of the sensors and comparing their capabilities and our requirements, we decided to use the second sensor, Ultrasonic Range Finder –XL-Maxsonar EZ1. We believe that although we will give more money to this range finder, it will make our project result much better. (Accurate and fast)

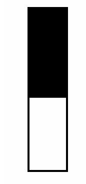
- **Distance measurement and finding the coordinates**

It is planned to put three reflector-absorber blocks on three corners. Sound absorbing foam will be used for absorbers and for reflection we have many choices to use like cardboards, woods etc.

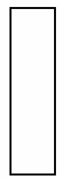
These three blocks will be designed in a way that, we will be able to distinguish to which block the coming echo signal refers to.



Reflector at the top,
Absorber at the bottom



Reflector at the bottom,
absorber at the top



Only reflector
no absorber

There will be one receiver-transmitter pair placed on the top of the robot and one placed at the bottom of the robot. For example when the bottom receiver reading is 0 V and the upper receiver reading is 5V then, it is sensed by the program written by us that the distance measured is from the 1st block. The similar analysis can be done for the other configuration of the blocks. Then, the data pairs: the distance-ith block, three circles will be drawn. For this purpose, we will assign coordinates to the blocks. For instance the first block will be placed to (0,0). Then, the location of the other blocks will be (100,0) and (100,100) or (0,100). We have the three distances measured from each of these coordinates. Now, we have enough data to draw three circles. (The radius and the center point)

$(x-a)^2+(y-b)^2=r^2$ Center point (a,b) Radius:r

In fact, two absorber-emitter blocks is enough because the intersection of the two circles is already 2 points one of which will be outside 1m*1m area. It is possible to exclude that point in our program. However, since the accuracy is ranked the first in our requirements, we will use three absorber-emitter blocks. By this way, position measurements will be more accurate.

Receiver transmitter pairs will rotate and after the receiver detects the first signal, second signal and third signal respectively. There is no need to reference point when compared to other alternatives. So, there is no waste of time for alignment.

- **Another solution to find the coordinates in the same configuration**

Instead of intersecting three circles, the distance and the angle can give the position. In this method also, we have to place the receiver-transmitter on top of the robot and rotate it in order to find the angle. Although it seems quite feasible, at the end of every cycle, we have to align it to the reference plane. This will make the process slow and extra components such as a system like a compass will be added.

Therefore, we decided to intersect three circles in order to find the position. If this method does not give accurate results during test procedure we will consider this method.

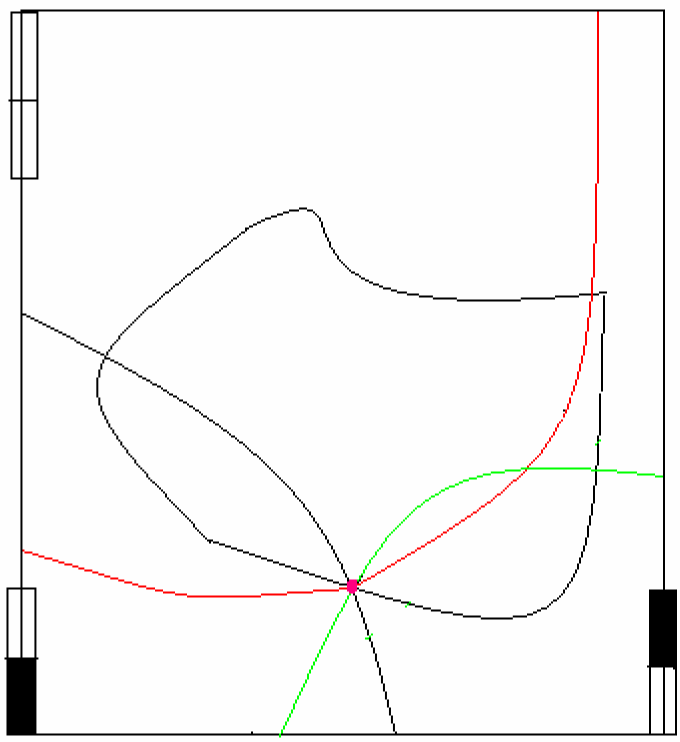


Figure 5

Final Decision for the distance measurement technique and configuration

- <u>The Other Solution Approach</u>

In this method, ultrasonic waves will be used for distance measurement. Since three distance information are used for position determining, three ultrasound transmitters will be present in the edges of the setup. There will be a single wide-range receiver on the line follower. There will also be infrared encoder/decoder devices on these components to obtain synchronization.

The system will use a method known as time-of-flight method. When the line-follower requests for distance measurement, a signal will activate an IR LED via an IR encoder/decoder and start a counter. The desired transmitter will be stimulated by the IR signal using the coding mechanism. Then it will transmit a 40 kHz ultrasound wave almost simultaneously with the counter start. The receiver on the line-follower will detect the ultrasound signal and stop the counter. Then the time-of-flight of the sound signal will be calculated using the counter value and the clock period of the counter. After multiplying this time interval with speed of sound in air, distance to the related transmitter will be calculated. These steps will then be repeated for the other two transmitters. Knowing the distance to each transmitter and intersecting the solution spheres in the computer, the robot's position will be uniquely determined. Figure 6 shows the general block diagram.

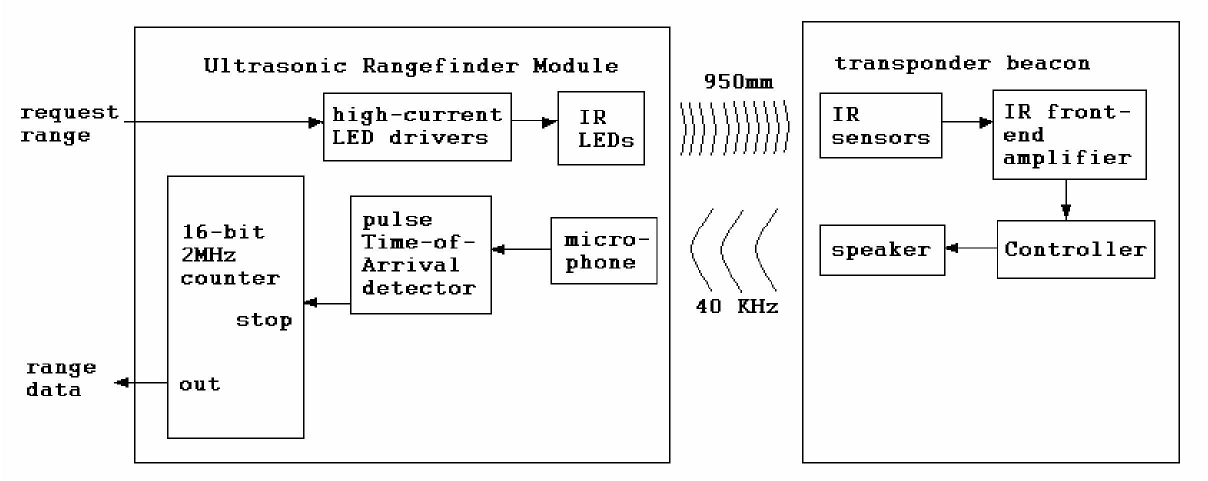


Figure 6

General block diagram

For encoding purpose, MCP2120 infrared encoder/decoder is planned to be used. The data received from a standard UART is encoded (modulated) and output as electrical pulses to the IR Transceiver. The IR Transceiver also receives data which it outputs as electrical pulses. The MCP2120 decodes (demodulates) these electrical pulses and then the data is transmitted by the MCP2120 ART. This modulation and demodulation method is performed in accordance with the IrDA standard. Typically a microcontroller interfaces to the IR encoder/ decoder. Figure 7 shows its block diagram and Figure 8 shows the dimensions of the device. This device costs approximately $1.1 each and 4 devices will be sufficient.

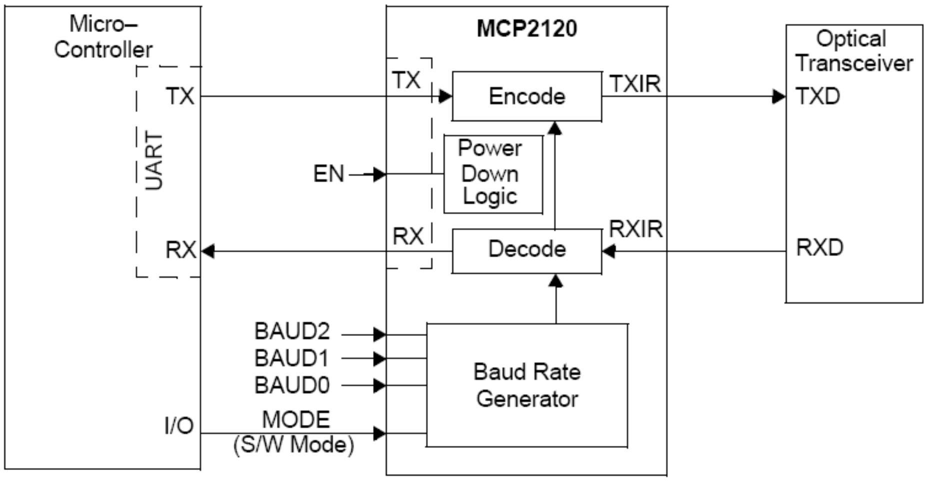
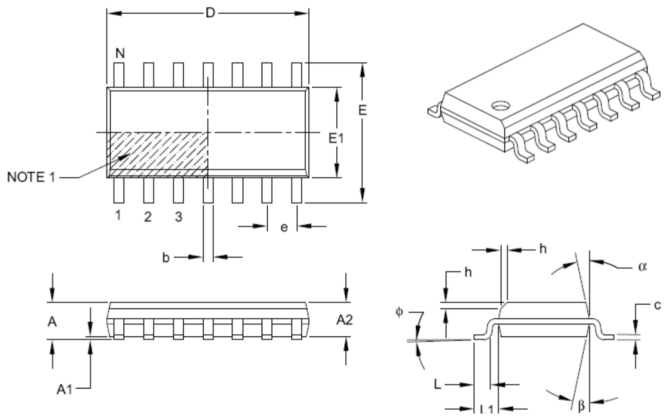


Figure 7

Block diagram for MCP2120



Units		MILLMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	14		
Pitch	e	1.27 BSC		
Overall Height	A	–	–	1.75
Molded Package Thickness	A2	1.25	–	–
Standoff §	A1	0.10	–	0.25
Overall Width	E	6.00 BSC		
Molded Package Width	E1	3.90 BSC		
Overall Length	D	8.65 BSC		
Chamfer (optional)	h	0.25	–	0.50
Foot Length	L	0.40	–	1.27
Footprint	L1	1.04 REF		
Foot Angle	ϕ	0°	–	8°
Lead Thickness	c	0.17	–	0.25
Lead Width	b	0.31	–	0.51
Mold Draft Angle Top	α	5°	–	15°
Mold Draft Angle Bottom	β	5°	–	15°

Figure 8

Dimensions for MCP2120

As ultrasonic transmitter, US40KT-01 40kHz Omni-Directional Ultrasound Transmitter will be used. Figures 9-11 show the dimensions, frequency characteristics and beam directivities of this device. The transmitters will be placed to three towers surrounding the area which will be assigned to a specific coordinate.

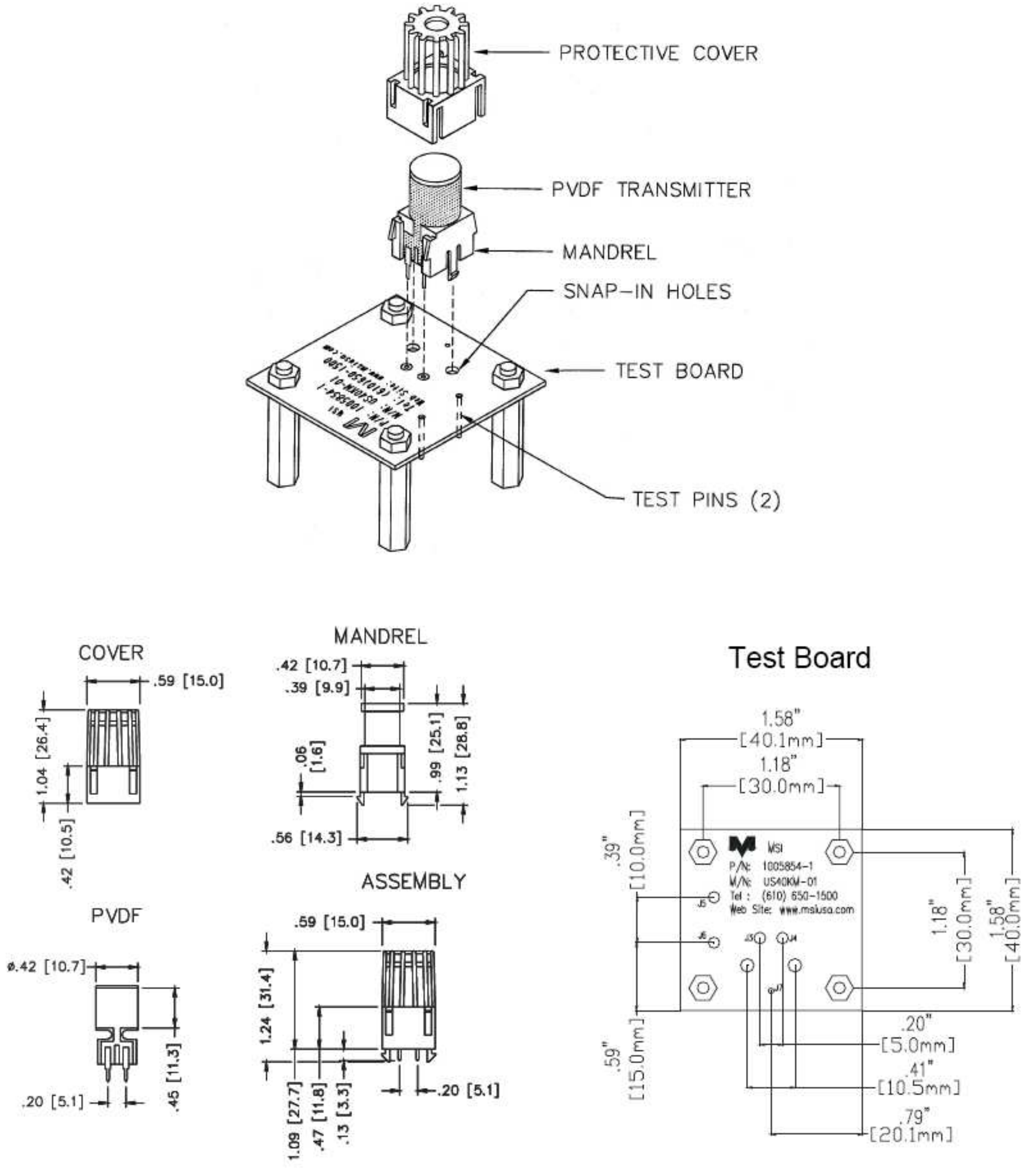


Figure 9

Dimensions of ultrasonic transmitter

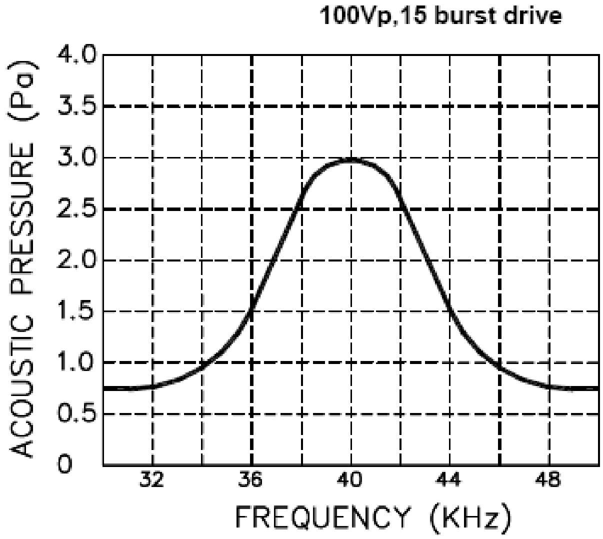


Figure 10

Frequency characteristics of ultrasonic transmitter

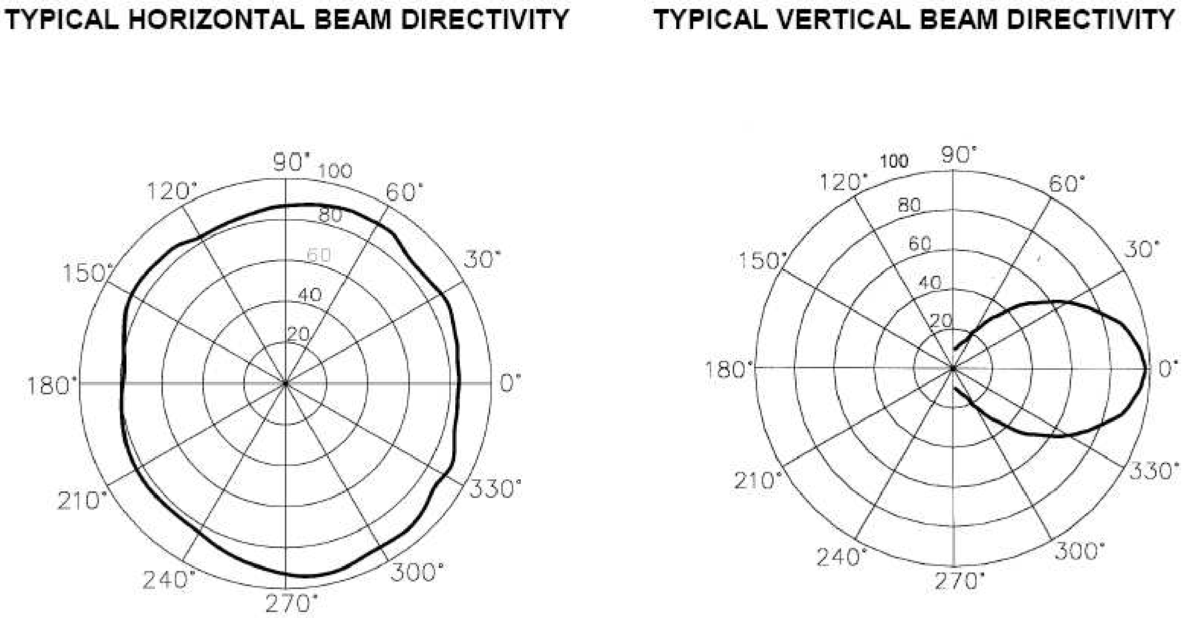


Figure 11

Beam directivity graphics of ultrasonic transmitter

As ultrasonic receiver, US40KR-01 40kHz Wide Angle Ultrasound Receiver will be used. Figures 12-15 show the dimensions, frequency characteristics and beam directivities of this device. The transmitters will be placed to three towers surrounding the area which will be assigned to a specific coordinate. The receiver will be placed on the line-following robot.

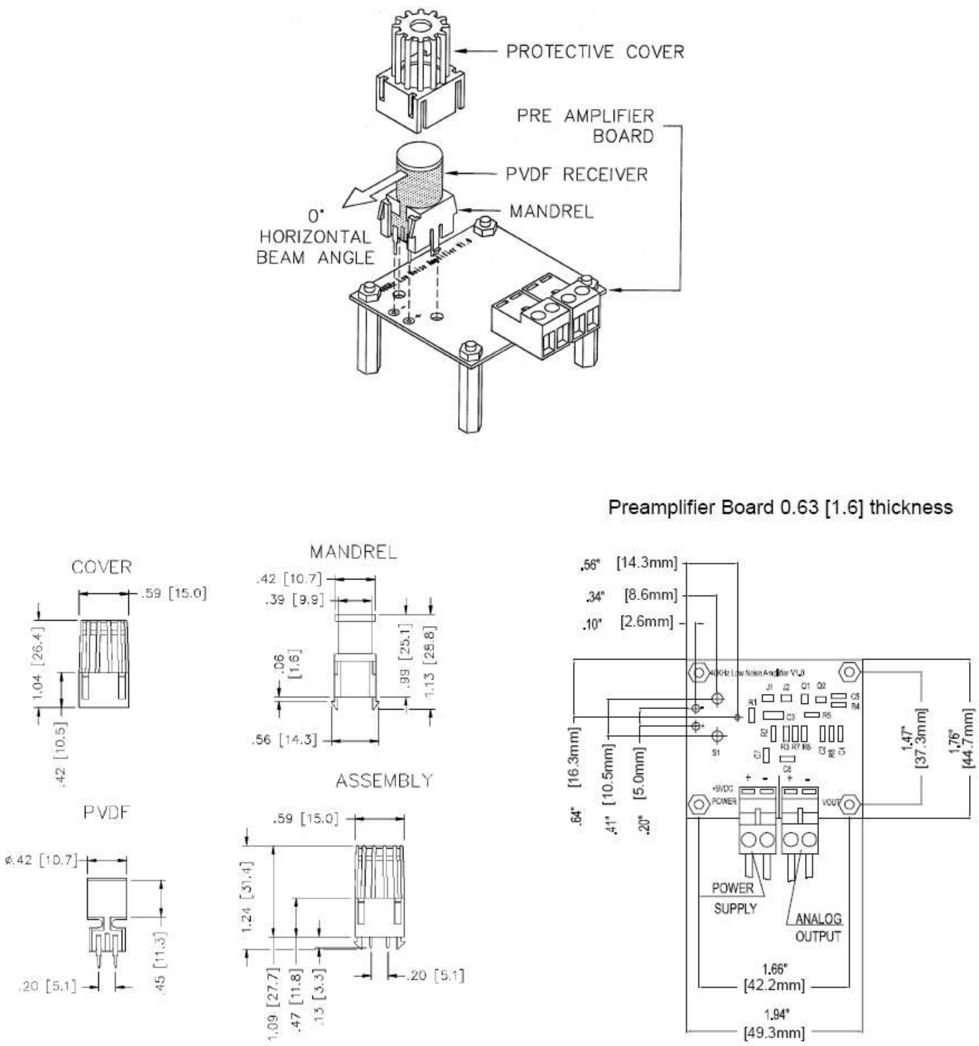


Figure 12

Dimensions of ultrasonic receiver

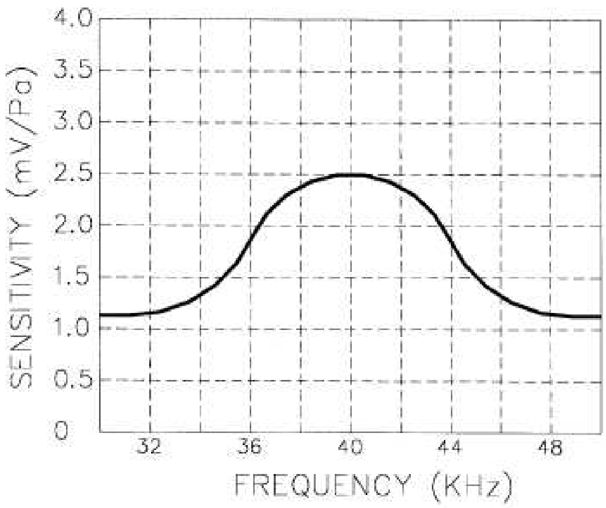


Figure 13

Frequency characteristics of ultrasonic receiver

TYPICAL HORIZONTAL BEAM DIRECTIVITY **TYPICAL VERTICAL BEAM DIRECTIVITY**

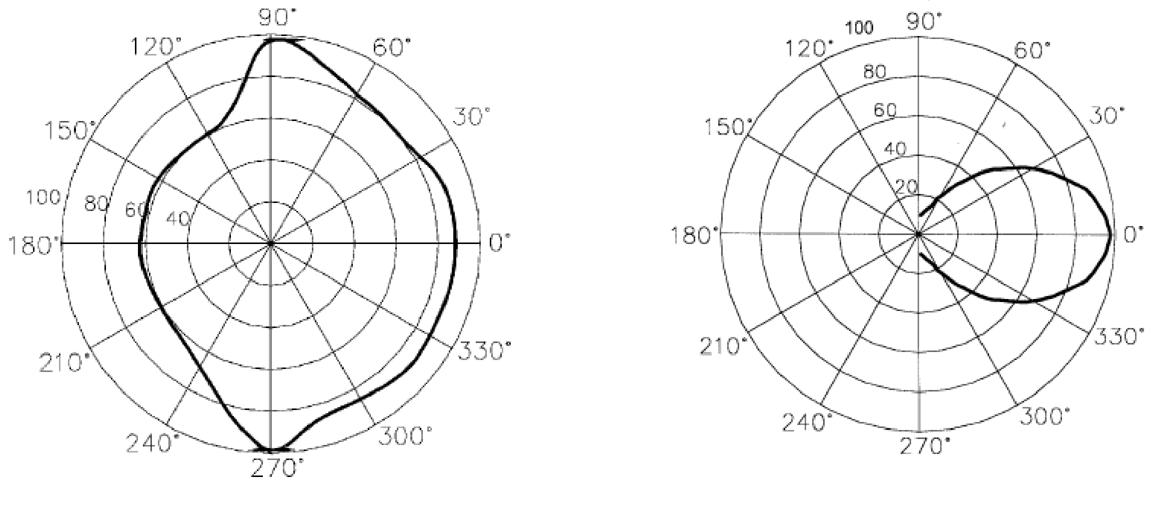


Figure 14

Beam directivity graphics of ultrasonic transmitter

The transmitters and the receiver will cost approximately $7 each. Three transmitters and one receiver will be needed in the setup. The beam directivities can be adjusted using different lenses.

Encoder must be followed by an infrared transceiver. A pair of transceivers must be present for each ultrasonic transmitter tower. For this step TFDS4500 could be used as IR transceiver, which costs approximately $1,50. Its dimensions are 9.7 x 4.7 x 4.0 mm. The circuit connections are shown in Figure 15.

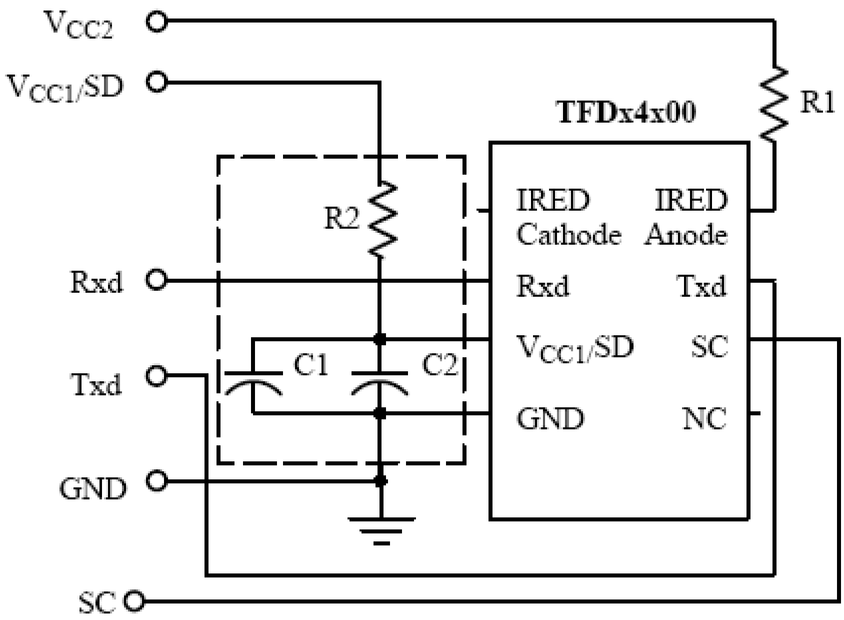


Figure 15- Connection for TFDS4500

The major advantages of this method are its immunity to electrical and magnetic interference due to the use of sound waves and suitability to use in short distances. Also it is preferable considering cost and portability issues. However unexpected errors may result due to sound interference from the surroundings. Moreover the design complexity can cause interfacing problems and error accumulations. Since this method requires synchronization using IR, it is not preferable compared to the main solution.

Grading Our Main and Alternative Solutions

The fast issue depends on the sensors data taking time, the speed of the robot, robot's line following ability. In the main design, since the system does not have to align to a reference at each cycle, this will make the system faster. When comparing the main solution and the other solution, we will consider only the design differences in them. We give 7 out of 10 for fast objective.

Also, in order to separate the three readings from each other, obstacles are designed in a creative way. Synchronization has to be considered very carefully. In the other solution approach, the synchronization problem is solved in a more complex way. Therefore, for the creative solution objective, we give 7 out of 10.

For the accuracy issue, the sensors play a big role. The resolution and the data range are important. The sensor comparison is done in the previous parts. The accuracy of the first one is better because in the second method there is a possibility that the three signals interfere with each other. In the main solution approach, all three distances are taken one by one. So, for the accuracy issue, the main solution approach receives 8 out of 10. The alternative solution receives 7/10 since there may be errors due to synchronization and beam directivities.

If we consider the adaptability to different working conditions, both of them are successful and needs the same requirements. (Like obstacles placed on corners) We give 8.5 to main solution approach for this issue. The alternative solution receives 8/10 since it uses two kinds of signals and it will be affected by the constraints for both signals.

Since the second method uses rf, it creates some radiation. The first one just uses ultrasound which will not create any electromagnetic radiation. The main solution is advantageous over the alternative solution. Main solution receives 9/10 while the alternative receives 8/10.

Both of the methods are user friendly. The difference of them will just be the work load on the programmer and designer. The alternative solution needs more work. There is no difference in user friendly issue between the two solutions. Therefore, both of them receive 9 out of 10.

3.2.3Data Transfer, Mapping, Area Calculation

After defining robot, the position data needed to be sent to the computer. That transfer begins with the control unit which includes PIC16F628. RF transmitter part is to be connected to control unit that prepares the coordinate knowledge to send transmitter. RF receiver part is positioned beside the computer. A serial interfacing circuitry helps to transfer the receiver data to PC.

Why PIC16F628 Instead of other PIC Types?

PIC16F628 gives faster operation, has larger memory and capability of working with an internal oscillator. Also PIC16F628 has serial communication feature, analog voltage comparison feature and PWM part. USART(RX) pin is also available for synchorone communication. Control unit with PIC converts our position data to digital coordinate data.

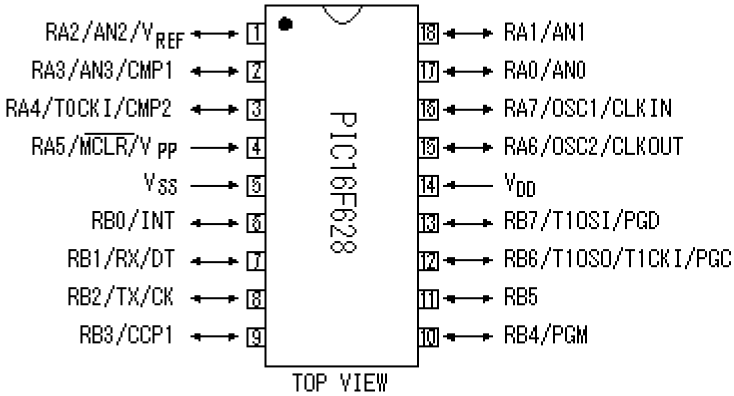


Figure-16 PIC16F628 Pin Diagram

ATX-34 and ARX-34 transmitter receiver pair

Digital coordinate data should be transferred to PC by transmitter receiver pair. Since we use high frequencies for modulation and demodulation, implementing RF frequency circuitry on a board will give some error because of the capacitance of conducting layers. Transmitter and receiver modules give more accurate results. For easy finding, low pDrice, accuracy in high frequency and low power consumption advantage, we prefer using ATX-34 and ARX-34 from UDEA. These modules are used without any other RF component while PCB implementation which is an important concern, easy to implement. A regulator circuitry is needed with these transmitter and receivers since they don't have internal protection for improper voltages. An antenna connection can be made by a simple cable. The receiver has same quality and both transmitter and receiver has data in or out pins directly.

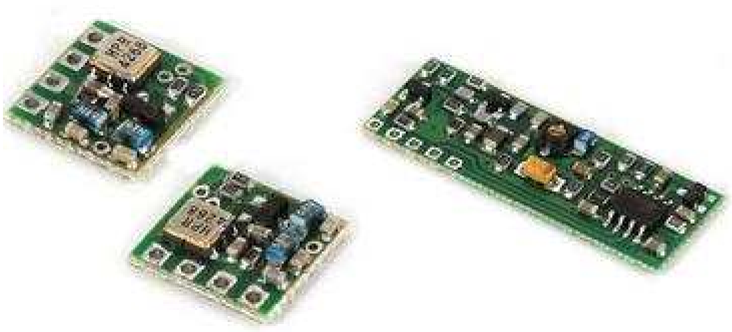
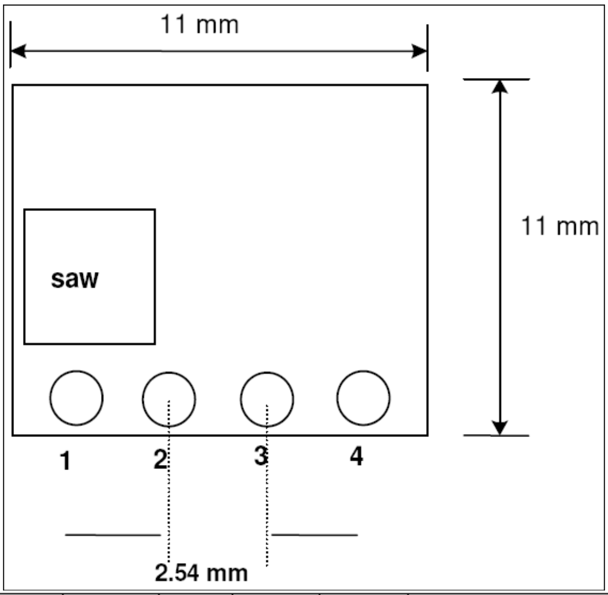
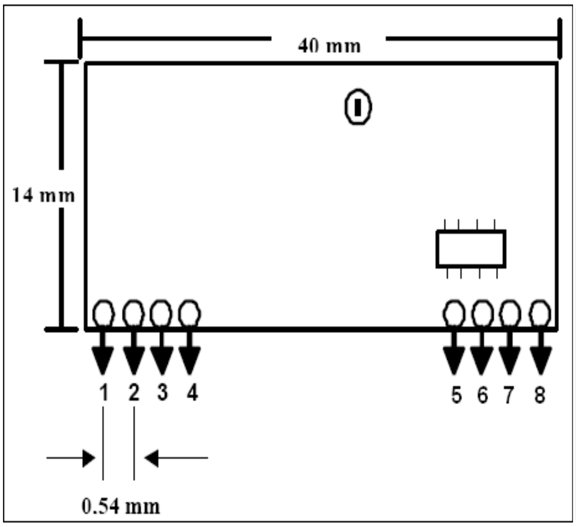


Figure 17- ATX-34 and ARX-34 transmiter and receiver



	Min.	Type	Max	Unit	Not
Çalışma Frekansı		433.9		MHz	±200 KHz
Data Rate	0.3		2.4	Kbit/s	
Output RF Power		10		dBm	5V & CW Power
Besleme Voltajı	5		12	Vcc	Regüle edilmiş voltaj kaynağı kullanılmalıdır. Max. Riple 100 mV
Akım Sarfiyatı		6,5		mA	5V
Logic "0" DI voltaj	0		0.1xVcc	Vdc	
Logic "1" DI voltaj	0.8xVcc		Vcc	Vdc	
Çalışma Sıcaklığı	-10		+55	°C	ETSI 300 220

Figure 18-ATX-34 transmitter dimensions and specifications



	Min.	Type	Max	Unit	Not
Çalışma Frekansı		433.9		MHz	±200 KHz
Band Genişliği		±2		MHz	
Data Rate	0.3		2.4	Kbit/s	
Duyarlılık		-108		dBm	
Besleme Voltajı	4,9		5,1	Vcc	Regüle edilmiş voltaj kaynağı kullanılmalıdır. Max. Riple 100 mV
Logic "0" DOUT voltaj	0		0.1xVcc	Vdc	
Logic "1" DOUT voltaj	0.8xVcc		Vcc	Vdc	Max. 5 mA current source
RX on time		10		ms	

Figure 19-ARX-34 receiver dimensions and specifications

After receiving our datas, voltage level transmission is performed by MAX232. It is needed because serial interface components work with -12 and 12 V voltage range for transmitting across long distances.

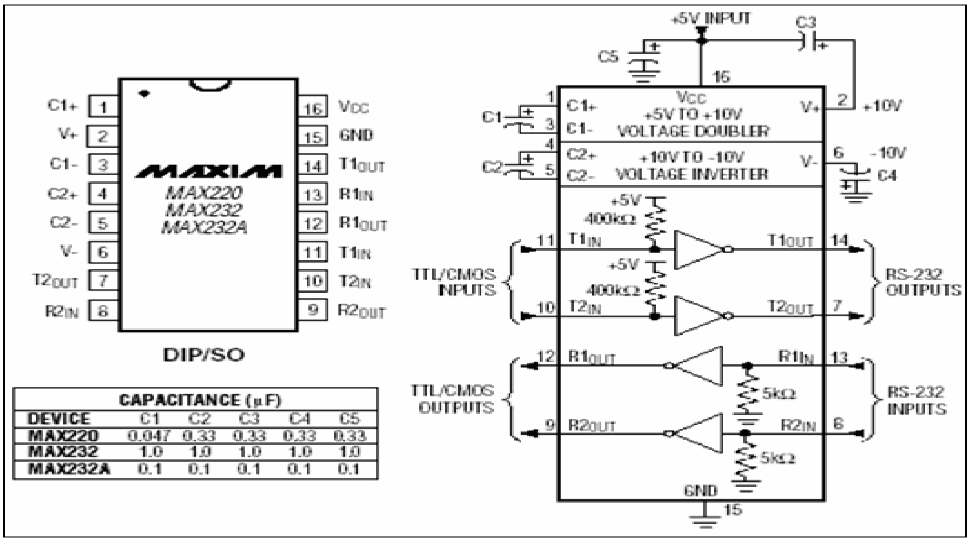


Figure 20-MAX232 internal connections and shape

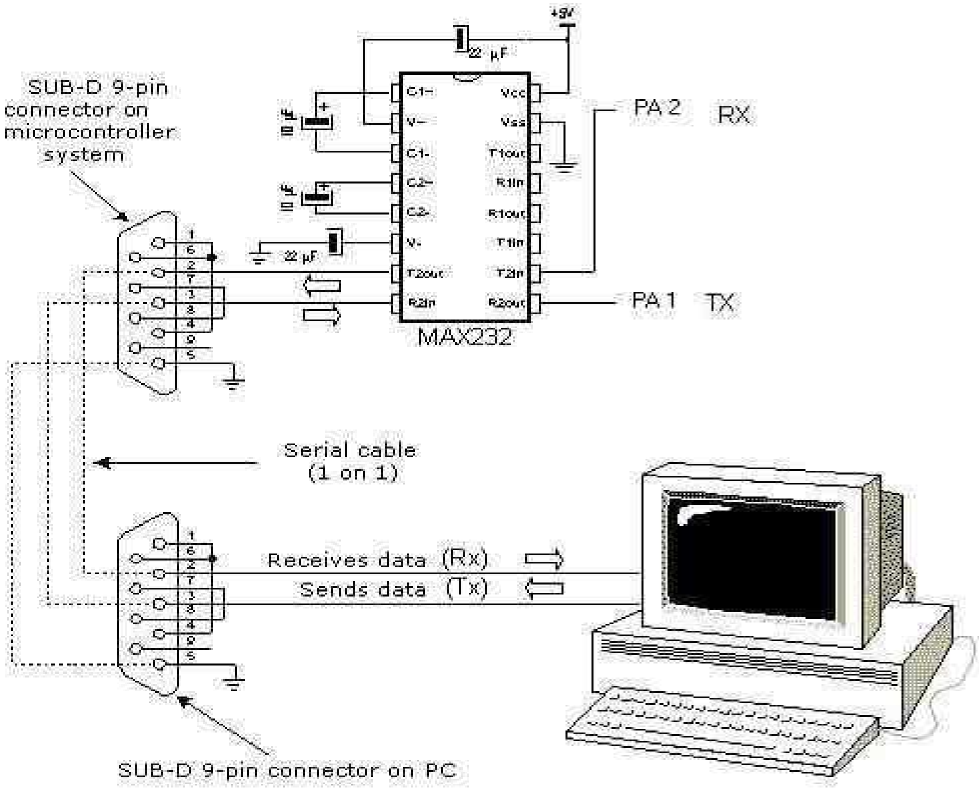
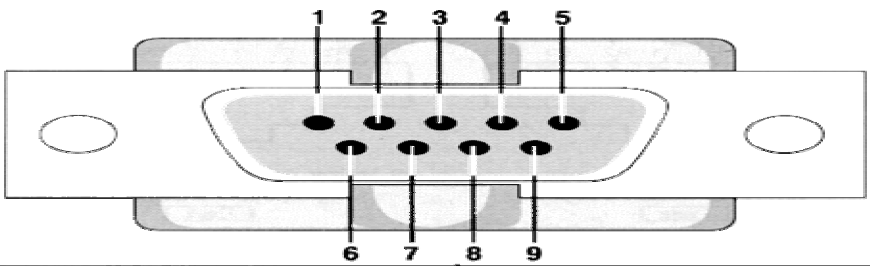


Figure 21-MAX232 connections to RS232 and computer

RS232 is a standard for serial I/O interface according to some protocols.



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

Figure 22-RS232 pin diagram

Alternative solution:

Using a microprocessor directly connected to an LCD can be a solution for mapping. According to coordinate information, the related pixel will flash. Each coordinate, the program should check all the points one by one. So, our program will be complex and all this conversion will take some time. The program complexity since GLCD don't use serial port directly, importability and former reasons define these solution to be the second.

Area Calculation

According to first and second coordinate's position, the distance can easily be calculated without any error in our project because of the flat shape of the surface. Any feedback mechanism is not needed.

Visual basic is our first choice because of its user friendly computer language and its advanced graphical interface. We can collect map in different scales as an extra feature.

The spectral frequency (or linement density) calculation can be made also.

Area calculation is a requirement for us. In most cases, we will face an irregular outline for map.

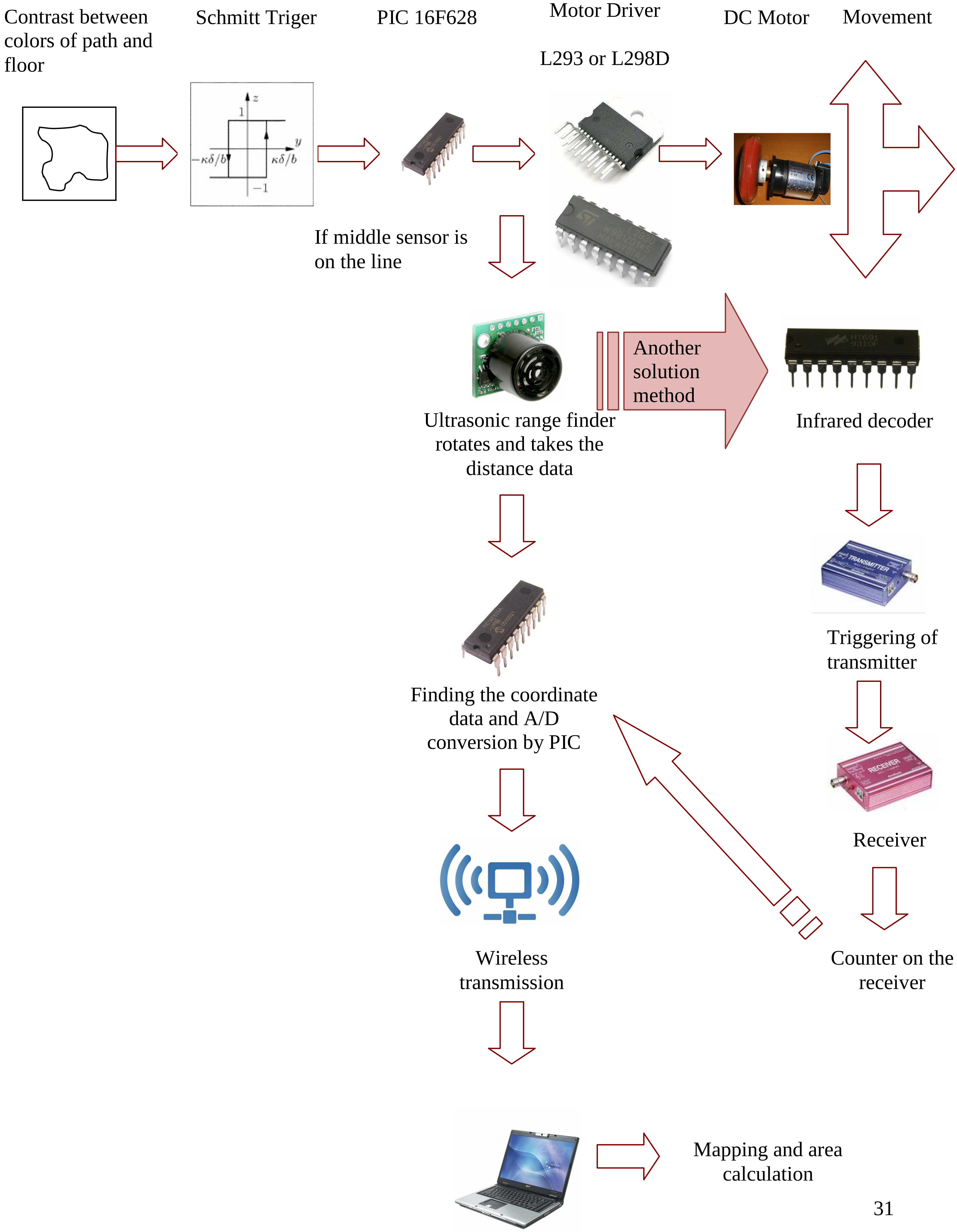
While calculating this area, the user can decide the outer points as reference; the enclosed area can be calculated.

A final display window summarizes the datas and saves to a text file.

Another Method for Area Calculation

Since the operation field is purely flat, area calculation method could be very simple. Instead of using Visual Basic, MATLAB will be an alternative. Using 'contour' function, the map will be drawn. The area will be calculated by segmenting it into non-overlapping triangles and adding the area of each triangle.

3.2.4 Flow Chart



3.3 TESTING METHODS

Firstly, the picture of the field will be taken using an overhead camera. Then the image will be sent to the PC. On the PC the picture can be compared to the drawn map pixel by pixel. To test the calculated area, the black-white image will first be fulfilled and the number of colored pixels will be calculated. Then the number will be scaled to real dimensions and the area will be calculated to compare with the found one.

3.4 PROJECT MANAGEMENT

3.4.1 COST ANALYSIS

PRODUCT	COST
2 x PIC 16F628	20$
L293D	1.88$
URM 04V20 Ultrasonic sensor	28$
Ultrasonic Range Finder	49.95$
*4 x MCP2120 ART infrared encoder/decoder	4.4 $
*Transmitter-receiver	7$
*TFDS4500 IR transceiver	1.5$
ATX34-ARX34	20$
MAX 232	10$
RS 232	3$

TOTAL: 132.83$

It is expected that the total cost will be 165$ when the project is finished.

*These are cost of products for the alternative solution. Total cost includes only the cost of the products for the main solution.

3.4.2 GANNT CHART

Task	Start	End	Duration
Presentation preparation	28/12/2009	4/1/2010	7
Presentations	4/1/2010	8/1/2010	4
Detailed design	8/1/2010	31/1/2010	23
Detailed design	25/1/2010	14/2/2010	21
Supply and market research	3/2/2010	10/2/2010	7
Material purchase	10/2/2010	14/2/2010	4
Implementation	15/2/2010	28/2/2010	14
Improvement of the project	15/2/2010	7/3/2010	20
Creative solutions research	22/2/2010	7/3/2010	13
Modification	8/3/2010	15/3/2010	8
Test	15/3/2010	22/3/2010	7
Modification	22/3/2010	28/3/2010	6
Test	29/3/2010	4/4/2010	7
Modification	4/4/2010	18/4/2010	14
Implementation of creative solutions	8/4/2010	18/4/2010	10
Final modifications and test	19/4/2010	25/4/2010	7
Construct	25/4/2010	9/5/2010	14
Final presentation preparation	10/5/2010	23/5/2010	14
Presentations	23/5/2010	30/5/2010	7

3.4.3 CONTINGENCY PLAN

During testing and implementation there are some risks we can encountered. These are:

- Accuracy may not be obtained as expected. If this occurs , another sensor can be used. If it does not work, we should find another solution for the design.
- PIC can burn. It should be programmed again.
- If our main solution for the determination of the coordinates, we will use alternative solution.
- For the line follower, if the alignment of the sensors can pose a problem , we can change alignment. For example, the alignment can be V shaped.

3.5 TEAM ORGANIZATION

Before the conceptual design period, each team member is allocated to a different part of the project considering their qualifications. Gizem Kuzucu examined possible solutions about the mechanical and electronic structure of the line follower based on her interest and background in control area. She considered different possible selections of the line width, sensor number and arrangement as well as the motor driving mechanism. Ayşe Özpehlivan, based on her interest in transmission and computer area, did research on the transmission of related data to the device on which the shape will be displayed, which may be a PC or an LCD display. She also considered the area calculation methods and testing methods. Aslı Ülgen and Gonca Suna shared the research on position determining solutions, considering their interest in microwaves area. Also, Aslı and Gonca made the comparison of the two solutions considering the company’s objectives. Aslı Ülgen examined the solution in which the position is determined using the sensor(s) on the device and several barriers placed in the surroundings of the operation field. Gonca Suna examined the solution which determines the position using several transmitters around the area whose signals will be received by the device.

4. CONCLUSION

When the main steps of the design is considered, three main building stones draws the attention. The arbitrary line should be traced firstly. Significant effort is spent on the sensor ordering to ensure accuracy limitations in first step. We designed a software and organized the sensor alignment to control velocity of both wheels precisely for smooth returns and following line with minimum error. While the vehicle traces the line, it will take position data when the middle sensor is on the line only. This aspect maximizes our accurate position data.

The position determination is our second step and we spent more time on sensor types for taking correct data. Besides accuracy, we eliminated many possible solution for complexity of data. The simpler and easy implemented solution will be more suitable for us. The range finder and reflector-absorber pair is very creative solution across similar products which lessen our cost.

The last step is determining coordinates, wireless transmission of data and mapping using a Visual basic interface, area calculation on PC. Wireless data transfer provides less weight for the vehicle for next steps.

All the parts of the project are designed considering cost, accuracy, error and easy to implementation. We ensure that in the end of the project all restrictions and expectations of the Tulip Company will be corresponded.

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