Design and Implementation of Driverless Car using Machine Learning

[1]SHRIDHAR J A, [2]SHUBHAMANGALA K, [3]SMRUTHI P, [4]SWATHI P, [5]POORNIMA B

Asst. Prof., Dept of Electronics and Communication Engineering, ATRIA INSTITUTE OF TECHNOLOGY, Bangalore, Karnataka, India.

***

Abstract - *Autonomous driving has been a big fuss among companies because of the entanglement of the problem which has endless applications. Companies like Google, Tesla and Uber have applied algorithms to commercial cars and had some success. These algorithms varies from traditional control to machine learning. In this paper we will use one of the Machine learning techniques SVM (Support Vector Machines) with the goal of navigating the driverless car with maintaining traffic rules and avoiding accident. This technique mainly detects sign boards, classifies it and takes decision accordingly. This paper mainly includes object recognition and zone based control using different types of sensors. It also has live video streaming which is used for monitoring purposes.*

Key Terms - **Driverless car, machine learning, support vector machines (SVMs), ultrasonic sensors, automation**

I. INTRODUCTION

In the present growing world, technology is emerging day by day and it has become a hot topic in the development of automated vehicles. The already proposed automated vehicles has certain restrictions applicable only to specific areas which have well-built roads with lane markings and road signs which leads to a huge development cost. This automated vehicle is implemented using stereoscopic vision. This model can be used as a reference to overcome the issues of existing systems, by improving the accuracy and efficiency of autonomous vehicle for better safety.

The smart automobile/ the autonomous car is one step towards smart city and is applicable for all the handicap people especially blind people and is suitable for all day to day transport activities. The motive behind the whole concept of the driverless car was to avoid accidents that take place now days in large numbers. According to the statistics of 2014, the death rate of people due to accidents in the US was around 32,000 each year. In India itself, the count was around 13,976. Use of these Smart Automobiles on the roads could reduce at least half of these accidents, it could save up to 16,000 lives each year.

Also, the handicapped and older public can avail to long distance transport without relying on a third person say, a driver.

This project also has an aim to control the speed of any vehicles automatically in cities and also in restricted areas such schools, parks, hospitals and in speed limited areas etc. Nowadays in an exceedingly fast paced world all the peoples don't seem to be have self-control. Such peoples square measure driving vehicles in an exceedingly high speed so the police don't seem to be able to monitor all those things. This paper provides how for the way to manage the speed while not harming others. In this project we have a tendency to mistreatment RF for indicating the regulation areas it's placed front and back of the restricted zones. RF receiver is placed inside the vehicle. Speed is nonheritable by the assistance of speed indicator within the vehicle.

II. COMPONENT DESCRIPTION

A. Arduino Uno Microcontroller:

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

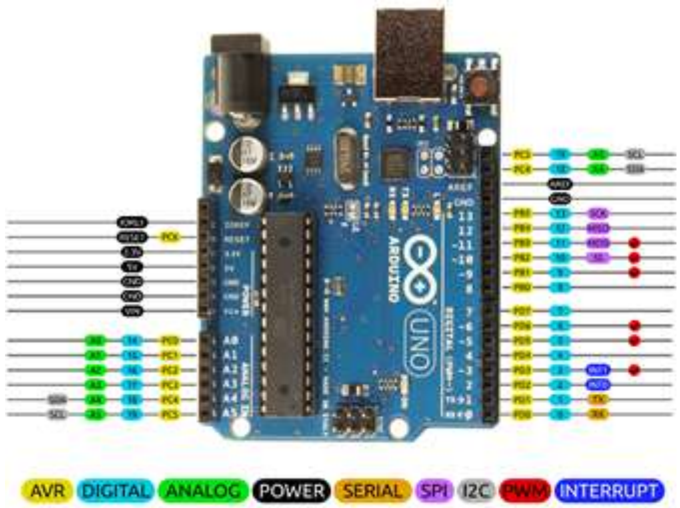

Figure 1: Arduino Uno

B. ARM7 (LPC2148) Micro controller

The LPC2148 is a 16 bit or 32 bit ARM7 family based microcontroller and available in a small LQFP64 package. ISP (in system programming) or IAP (in application programming) using on-chip boot loader software. On-chip static RAM is 8 kB-40 kB, on-chip flash memory is 32 kB-512 kB, the wide interface is 128 bit, or accelerator allows 60 MHz high-speed operation. It takes 400 milliseconds time for erasing the data in full chip and 1 millisecond time for 256 bytes of programming.

Embedded Trace interfaces and Embedded ICE RT offers real-time debugging with high-speed tracing of instruction execution and on-chip Real Monitor software. It has 2 kB of endpoint RAM and USB 2.0 full speed device controller. Furthermore, this microcontroller offers 8kB on-chip RAM nearby to USB with DMA. One or two 10-bit ADCs offer 6 or 14 analogs i/ps with low conversion time as 2.44 μs/ channel.

Only 10 bit DAC offers changeable analog o/p. External event counter/32 bit timers-2, PWM unit, & watchdog. Low power RTC (real time clock) & 32 kHz clock input. Several serial interfaces like two 16C550 UARTs, two I2C-buses with 400 kbit/s speed. 5 volts tolerant quick general purpose Input/output pins in a small LQFP64 package. Outside interrupt pins-21. 60 MHz of utmost CPU CLK-clock obtainable from the programmable-on-chip phase locked loop by resolving time is 100 μs. The incorporated oscillator on the chip will work by an exterior crystal that ranges from 1 MHz-25 MHz The modes for power-conserving mainly comprise idle & power down. For extra power optimization, there are individual enable or disable of peripheral functions and peripheral CLK scaling.

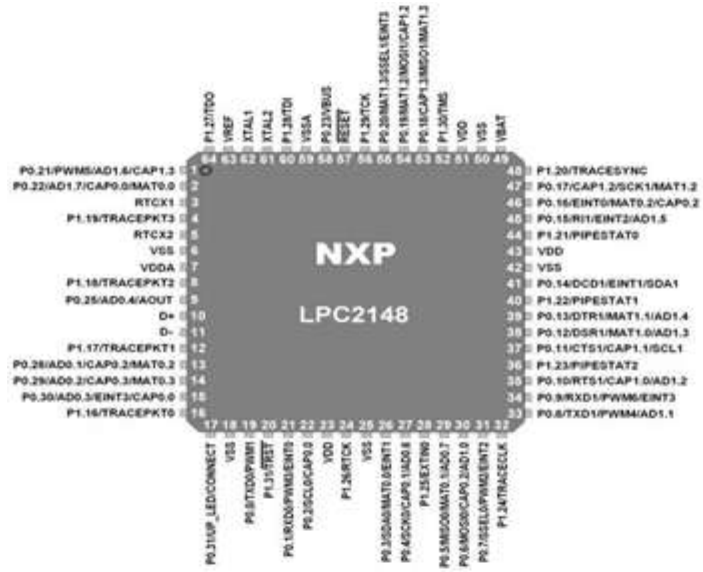

Figure 2: ARM7 (LPC2148) Micro controller

C. Ultrasonic Sensor

Ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception. An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

Figure 3: Ultrasonic Sensor (HC-SR04)

The distance can be calculated with the following formula:

Distance L = 1/2 × T × C

where L is the distance, T is the time between the emission and reception, and C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.)

D. *IR Sensor*

An Infrared light emitting diode (IR LED) is a special purpose LED emitting infrared rays ranging from 700 nm to 1 mm wavelength. Different IR LEDs may produce infrared light of differing wavelengths, just like different LEDs produce light of different colors. IR LEDs are usually made of gallium arsenide or aluminium gallium arsenide. In complement with IR receivers, these are commonly used as sensors. An IR sensor consists of two parts, the emitter circuit and the receiver circuit. This is collectively known as a photo-coupler or an optocoupler.

The emitter is an IR LED and the detector is an IR photodiode. The IR phototdiode is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor. The type of incidence can be direct incidence or indirect incidence. In direct incidence, the IR LED is placed in front of a photodiode with no obstacle in between. In indirect incidence, both the diodes are placed side by side with an opaque object in front of the sensor. The light from the IR LED hits the opaque surface and reflects back to the photodiode.

Figure 4: IR Sensor

E. *RF Transreceiver*

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The RF module is often used alongwith a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

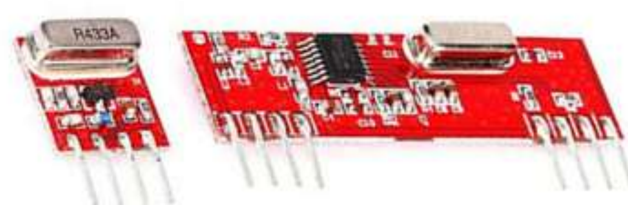

Figure 5: RF Transreceiver

III. DESCRIPTION OF THE SYSTEM

The main focus was on Following Vehicle, which detects and avoids obstacles, coordinate with live video streaming, follow the route. For another application, it checks vehicles around and automatically moves slowly behind the traffic until it gets out of traffic jam situation. When the vehicle enters in the normal area it speed does not decrease and it goes normally no action is performed. When the vehicle enters into the restricted areas that means it enters into the speed limiting. Whenever it enters the transmitter module just send an information that contains how much speed a vehicle can go inside the speed limited region. Then the signal or information is received by the receiver and the signal acquired from the speed meter is also given to the controller. The signal is basically analog in nature that will be converted into digital so only the micro controller able to process the signal.

To classify the surrounding objects and act based on that data we use Machine Learning algorithm SVM. Support Vector Machines (SVMs) are one of the most effective tools for tackling classification and regression problems in complex, nonlinear data distributions. Indeed, SVM has been recently successfully applied to the fuzzy methodology. The training of SVMs is characterized by convex optimization problem; thus local minima can be avoided by using polynomial complexity Quadratic Programming (QP) methods. Besides, kernel-based representations allow SVMs to handle arbitrary distributions that may not be linearly separable in the data space. The ability to handle huge masses of data is indeed an important feature.

The following flowchart gives a brief description of the flow of control through the system:

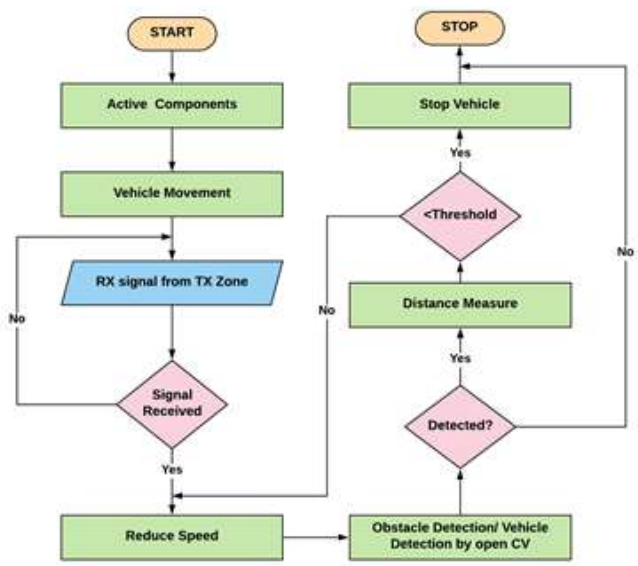

Figure 6: Transmission Unit

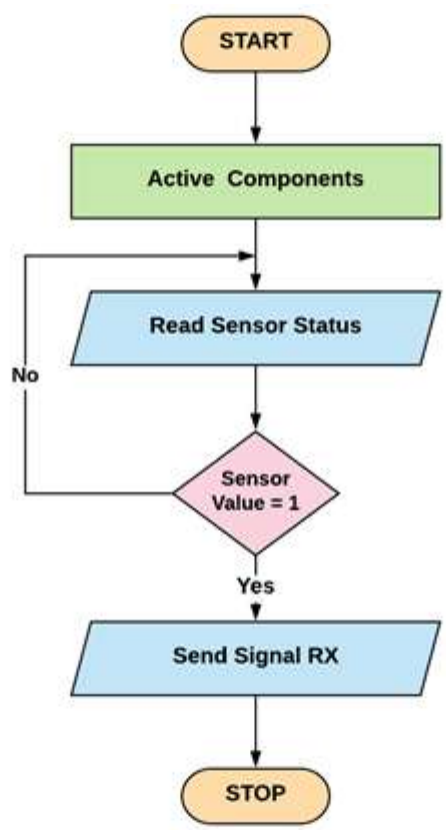

Figure 7: Vehicle Unit

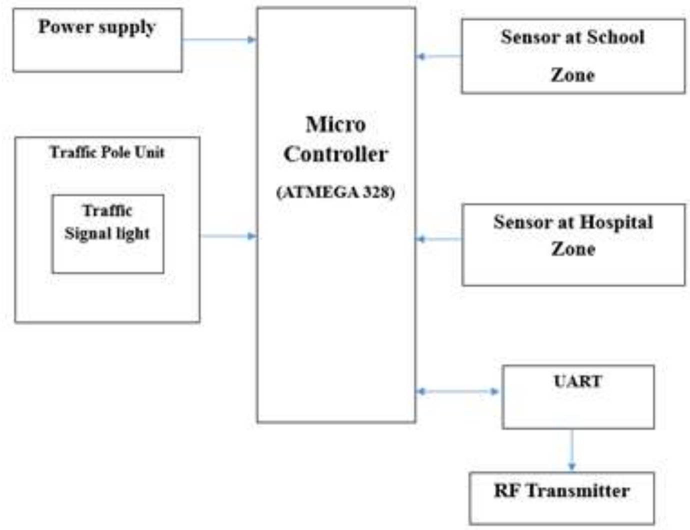

Figure 8:Block Diagram of Transmission Unit

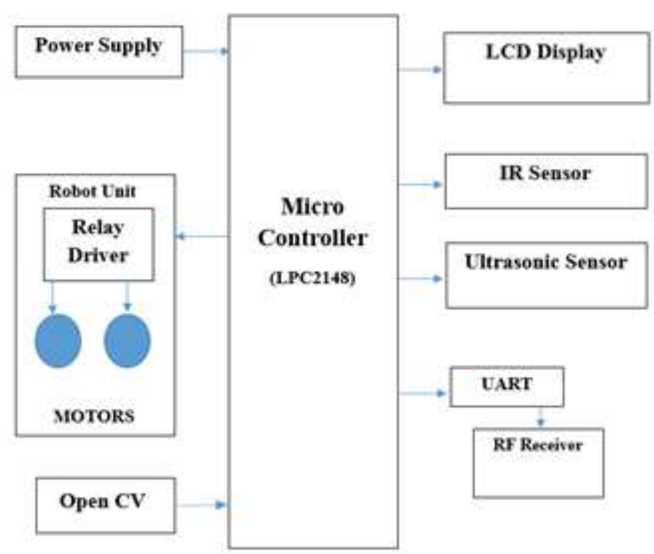

Figure 9: Block Diagram of Vehicle Unit

IV. ALGORITHM OF THE SYSTEM

Algorithm 1: Transmission Unit

1. START
2. Active all the components
3. Read the status of the sensor
    a. If the sensor status is 1 Rx signal is transmitted.
    b. Else wait for the sensor status to get high.
4. STOP

Algorithm 2: Vehicle Unit

1. START

2. Active all the components
3. Vehicle starts moving
    a. If RX signal is received speed is reduced.
    b. Else the vehicle moves in normal speed.
4. Obstacle and Vehicle detection
    a. If obstacle is detected measure the distance.
        I. If the distance is lesser than the threshold the vehicle stops.
        II. Else the speed is regulated.
    b. Else Normal speed.
5. STOP

V. RESULTS OBTAINED

Figure 11: Vehicle moving at green signal

Figure 12: Obstacle detection

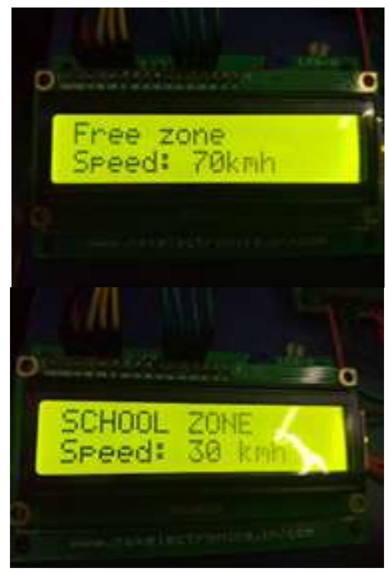

Figure 13: Zone Based Speed Control

VI. ADVANTAGES & DISADVANTAGES

The advantages of using this system is as follows:

- Without the need for a driver.
- Travelers would be able to journey overnight and sleep for the duration.
- Traffic could be coordinated more easily in urban areas to prevent long tailbacks at busy times. Commute times could be reduced drastically.
- Speed limits could be increased to reflect the safer driving, shortening journey times.
- Sensory technology could potentially perceive the environment better than human senses, seeing farther ahead, better in poor visibility, detecting

smaller and subtler obstacles, more reasons for less traffic accidents.

The disadvantages of using this system is as follows:

- It only works better in an environment where all the cars are autonomous.
- Unexpected obstacles are not detected efficiently.
- Cannot detect stationary object at highway speeds.
- Implementing such vehicles in real time involves many complexities.

VII. FUTURE SCOPE

The following improvements can be made in order to improve the system:

- We can include LIDAR sensors which effectively detects the edges of the roads and lane markings.
- We can also include radar sensors for better monitoring the position and state of the car.
- Once cars are driverless, it not only end collisions, but promote fuel efficient traffic flow

VIII. CONCLUSION

As describe throughout the paper, many technologies exist to detect obstacles and classify between objects for a driverless car. This paper tries to look at the emerging technologies and determine the best approaches for accident avoidance by following traffic rules. The reason for a driverless car is, compared to human eyes sensor data are more accurate. In this paper SVM (Support Vector Machine) based driverless car has been established simulated and the implementation of the autonomous vehicle has been done. Using machine learning technique sign boards on the road has been classified and hence it follows the traffic rules which mainly avoids accidents. This autonomous vehicle successfully detects the obstacles and overcomes it using the sensor like Ultrasonic sensor.

REFERENCES

[1] "*An Ultrasonic Sensor for Distance Measurement in Automotive Applications*". Alessio Carullo and Marco Parvis, IEEE SENSORS JOURNAL, VOL. 1, NO. 2, AUGUST 2001

[2] "*Autonomous Decision Making for a Driver-less Car*". Nicolas Gallardo, Student Member, IEEE, Nicholas Gamez, Student Member, IEEE, Paul Rad, and Mo Jamshidi Fellow, IEEE

[3] "*Design of Collision Detection System for Smart Car Using Li-Fi and Ultrasonic Sensor* ". Prabu Krishnan, DOI: 10.1109/TVT.2018.2870995, Volume: 67 , Issue: 12 , Dec. 2018

[4] "*Behavioral cloning for driverless cars using transfer learning* ". Xin Zhang, Maolin Chen, Xingqun Zhan School of Aeronautics and Astronautics, Shanghai Jiao Tong University, Shanghai, China,2018 IEEE

[5] "*Autonomous electric vehicle using Ultrasonic sensor skirt approach*". Kunal Khade, Harshal Patil, Vinod Gadget and Shrikant Velankar, 2018 3rd International Conference for Convergence in Technology (I2CT). The Gateway Hotel, XION Complex, Wakad Road, Pune, India. Apr 06-08, 2018

[6] "*A study on driver fatigue notification system*", Mohammed Hayyan Alsibai and Sulastri Abdul Manapl ARPN Journal of Engineering and Applied Sciences VOL. 11, NO. 18, SEPTEMBER 2011

[7] "*An Unbalanced Dataset Classification Approach Based on ν -Support Vector Machine*". Yinggang Zhao, Qinming He, Proceedings of the 6th World Congress on Intelligent Control and Automation, June 21 - 23, 2006, Dalian, China

[8] "*Drowsiness Detection Systems Using Different Feature Extraction Algorithms.*", Kamalpreet Kaur, International Journal of Engineering Technology Science and Research. Volume 4, Issue 6 June 2017

[9] "*Legal aspects of autonomous vehicles*" Viktória Ilková and Adrian Ilka
International Conference on Process Control ,Štrbské Pleso, Slovakia,
June 6 – 9, pp. 428-433.

[10] Sheikh Azid, Krishneel Kumar, Darrel Lal and Bibhya Sharma "*Lyapunov Based Driverless Vehicle in Obstacle Free Environment*", 2nd International Conference on Control and Robotics Engineering, 2017

[11] "*Efficient implementation of SVM training on Embedded Electronic Systems*". Paolo Gastaldo, Giovanni Parodi, Sergio Decherchi and Rodolfo Zunino, Part of the Lecture Notes in Computer Science book series (LNCS, volume 4578)

[12] "*Autonomous Campus Mobility Services Using Driverless Taxi*". Seong-Woo Kim, Member, IEEE, Gi-Poong Gwon, Woo-Sol Hur, Daejin Hyeon, Dae-Young Kim IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, VOL. 18, NO. 12, DECEMBER 2017

[13] Akhil Soin and Manisha Chahande "*Moving Vehicle Detection Using Deep Neural Network*" DOI: 10.1109/ICETCCT.2017.8280336

[14] "*A Prototype of Autonomous Vehicle Using Stereoscopic Vision*" Sumit Aher et al, International Journal of Computer Science and Mobile Computing, Vol.6 Issue.4, April- 2017, pg. 228-233

[15] "*An Embedded Support Vector Machine*", Rasmus Pedersen and Martin Schoeberl, An Embedded Support Vector Machine. In Proceedings of the Fourth Workshop on Intelligent Solutions in Embedded Systems (WISES 2006) (pp. 79-89)

[16] "*Incremental Training of Support Vector Machines*". Alistair Shilton, M. Palaniswami, IEEE TRANSACTIONS ON NEURAL NETWORKS, VOL. 16, NO. 1, JANUARY 2005