International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 22 No. 2 Apr. 2016, pp. 375-383

http://www.ijisr.issr-journals.org/

Fabrication of Fire Fighting Robot

Sunil Mathew[1], Gaikwad Sushanth[1], KR Vishnu[1], V. Vishnu Nair[1], and G. Vinoth Kumar[2]

[1]UG scholar, Department of Mechanical Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

[2]Assistant Professor, Department of Mechanical Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India

ABSTRACT: In today's commercial, industrial and domestic world, Automation plays an important role, it is actually an arrangement of different elements in order to regulate, direct, sense and command itself to achieve a desired result. "Automatic Fire Fighting Robot" project employs the electrical thermostat technology for the controlling the fire 24 hrs. Robotics has gained popularity due to the advancement of many technologies of computing and nano technologies. So, we proposed to design something that can make humans life easier and comfortable. There are many possibilities a fire can start in an industry or in any remote area. For example, in cotton mills, garments, fuel storages, etc., electric leakages can lead to huge damage. Also it's a worst-case scenario, causing heavy losses not only financially but also destroying areas surrounding it. Robotics is the emerging solution to protect human lives and their wealth and surroundings. The aim here is to design a FIRE FIGHTING ROBOT using Arduino system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal case and as a fire extinguisher in emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The project will help generate interests as well as innovations in the fields of robotics while working towards a practical and obtainable solution to save lives and mitigate the risk of property damage.

KEYWORDS: DC Motor, Relay, Arduino Board, Motor Drive, Flame Sensor.

1 INTRODUCTION

Robotics is one of the fastest growing engineering fields of today. Robots are designed to remove the human factor from labor intensive or dangerous work and also to act in inaccessible environment [1].

The use of robots is more common today than ever before and it is no longer exclusively used by the heavy production industries. The need Fire extinguisher Robot that can detect and extinguish a fire on its own is long past due. With the invention of such a device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire. Our task as engineers was to design and build a prototype system that could autonomously detect and extinguish a fire. Also aims at minimizing air pollution. It is the Robot that can move through a model structure, find a lit candle and then extinguish it with help of a fire extinguisher. Our research paper describes the design of a small autonomous Fire Fighting Robot. We have worked on the same project at our college presenting a synopsis showing its basic construction and working [2].

The Fire Fighting Robot is designed to search for a fire in a small floor plan of a house of the specific dimensions, extinguish the fire with the help of the fire extinguisher, and then return to the front of the house. The fire detection to be put into use is relatively free of false alarms, it is anticipated that it will not overreact in nonfire simulations. This mission is divided into smaller tasks, and each task is implemented in the most efficient manner such as self-autonomous start of the robot, navigation of the robot in every room step by step, finds the fire in a specific room, approaches the fire at a very fixed distance, extinguishes it and finally returning to the front of the house.

Corresponding Author: Sunil Mathew

2 LITERATURE SURVEY

J. Reinhart V. Khandwala (2003) was et all discussed about design and the implementation of the fire-fighting robot. The key design elements of the robot to be discussed include: the assembly and construction of the robot hardware, the processing algorithm based on the sensors response, and the navigation algorithm that will enable the robot to find an efficient path in and out of the house model [1]

Lynette Miller Daniel Rodriguez (2003) was et all discusses the development of each component of the robot that is designed to find a small fire represented by a light emitting diode in a model home and extinguish it. This paper will talk about each component of the robot from the start signal to the robot platform to the line following and room finding and finishing with the fire detection [2].

Sahil S.Shah (2013) was et all discussed about design a FIRE FIGHTING ROBOT using embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal case and as a fire extinguisher in emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The result shows that higher efficiency is indeed achieved using the embedded system [3].

U.Jyostna Sai Prasanna, M.V.D.Prasad (2013) was design the fire detection system using four flame sensors in the firefighting robot, and program the fire detection and fighting procedure using sensor based method. The firefighting robot is equipped with four thermistors/flame sensors that continuously monitor the temperature. If the temperature increases beyond the predetermined threshold value, buzzer sounds to intimate the occurrence of fire accident and a warning message will be sent to the respective personnel in the industry and to nearby fire station with the GSM module provided to it [4].

Swati A. Deshmukh (2015) was et all discussed about the fire detection system using sensors in the system, and program the fire detection and fighting procedure using sensor based method [5].

Saravanan P (2015) discussed about the Design and Implementation of this project is mainly based on control of Semi - Autonomous mobile robot (SA-BOT). The system controls four DC Geared motors which is powered by the Atmega2560 and controlled autonomously by Navigation system which comprises of integrated ultrasonic and infra-red sensors. The bot is outfitted with wireless camera which captures the video and transmits it to the base station. The fire detection system comprises of LDR and temperature sensor, if there is a fire, the sensors detects it and the bot will be moved to the source and starts extinguishing it. The Extinguishing System comprises of a BLDC motor with water container. The SABOT can also be operated manually for extreme conditions. We have provided a GUI support through which the bot can controlled from the base station [6].

Swati A. Deshmukh (2015) was et all discussed about the fire detection system using sensors in the system, and program the fire detection and fighting procedure using sensor based method [7].

Abhilash Dhumatkar, Sumit Bhiogade (2015) was et all Automatic Fire Fighting Robot" project employs the electrical thermostat technology for the controlling the fire 24 hrs. The system is cost effective, has a wide applications which when implement can show good and effective result. Synchronization of various equipment involve in the system i.e Thermostat Sensor, water jet, wireless remote and wireless android device WiFi enabled Camera. This is mean to simulate the real world operation of Robot performing a fire extinguishing function. Fuzzy logic provided an appropriate solution to the otherwise complex task of mathematically deriving an exact model for the non-linear control system upon which conventional control techniques could then be applied [8].

By review the various studies show that firefighting robot **usingarduino system** is not yet studied.so the aim present work is firefighting robot **usingarduino system** has been performed, and theproject is designed by following blocks fire sensor, Arduino board, line tracking sensor , Motor with driver circuit , Robot model, and Driver circuit with relay and Fire extinguisher.

3 EXPERIMENTAL METHODOLOGY

A. FIRE FIGHTING ROBOT PROCESS

It is a robot that autonomously detect and extinguish fire. It use flame sensor for detection and arduino board for processing. Fire extinguisher along with electronic valve (actuator) is used to extinguish the detected fire. The robot rotates

while actively scanning for fire. This scanning is performed by sensors placed on the sides. When a fire is detected, itmoves in the direction of fire an stops 30 cm in front of it and trigger the extinguisher to turn out the fire [1].

B. COMPONENT DETAILS

1) DC Motor: In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion [1]. The dc motor show in Fig 1.

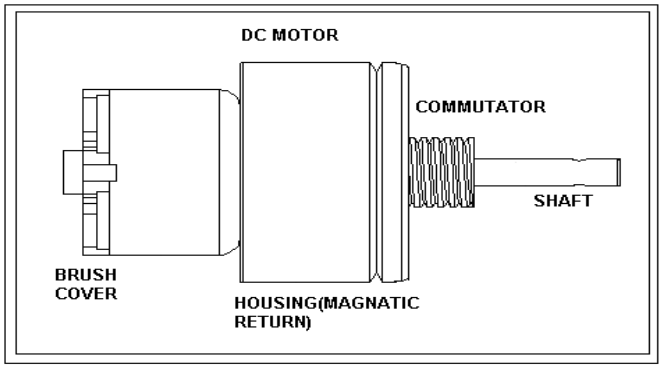

Fig. 1 DC motor

2) Relay; A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts as show in Fig2. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. Relay circuit as show in Fig 3. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical [2].

Fig. 2.Relay

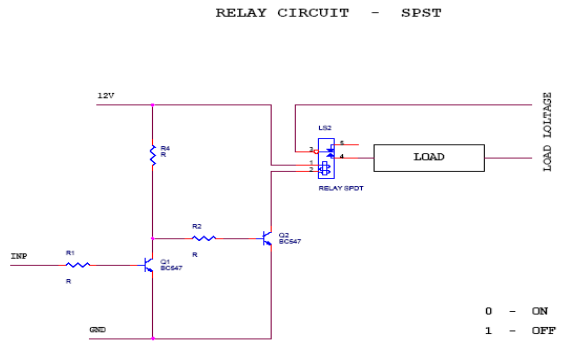

Fig. 3.Relay circuit

3) Arduino Board; An Arduino board historically consists of an Atmel 8-,16-or32-bit. AVR microcontroller AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation into other circuits. it's shown in Fig 4. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU board to a variety of interchangeable add-on modules known as *shields*. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus—so many shields can be stacked and used in parallel. Prior to 2015 Official Arduinos had used the Atmel mega AVR series of chips, specifically, the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560 and in 2015 units by other manufacturers were added. A handful of other processors have also been used by Arduino compatible devices. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants), although some designs such as the Lily Pad run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, optiboot loader is the default boot loader installed on Arduino UNO

At a conceptual level, when using the Arduino integrated development environment, all boards are programmed over a serial connection. Its implementation varies with the hardware version. Some serial Arduino boards contain a level shifter circuit to convert between RS-232logic levels and TTL-level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR ISP programming is used.

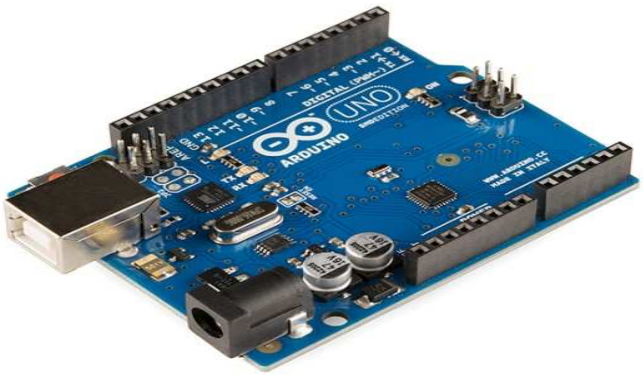

Fig. 4. Arduino board

4) Motor driver: A motor driver IC is an integrated circuit chip(Fig 5) which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors in robots and the motors in the robot. The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. For this tutorial we will be referring the motor driver IC as L293D only The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors. The L293D switches it output signal according to the input received from the microprocessor [4].Motor driver as show in Fig 6.

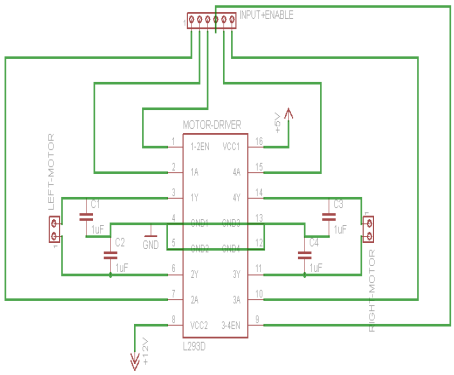

Fig. 5 motor driver chip

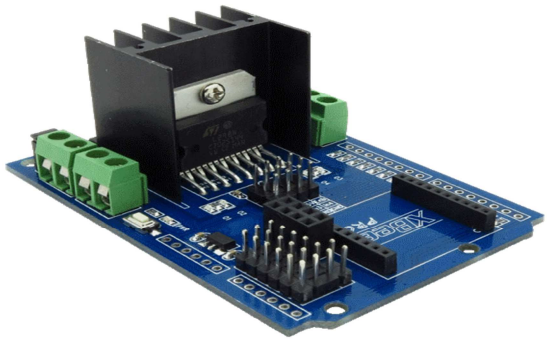

Fig. 6 motor driver

5) Flame sensor: The flame sensor (Fig8) is used to detect the flame occurrence. When the sensor detects the fire then it became short-circuit show in Fig 7. When there is no fire the sensor become open circuit. The flame sensor is connected with resistor. This connection formed the voltage divider network which is connected with inverting input terminal of the comparator. The reference voltage is given to non inverting input terminal. The comparator is constructed with LM 741 operational amplifier. When there is no fire, the flame sensor became open circuit. So the inverting input terminal voltage is greater than non inverting input terminal (reference voltage). Now the comparator output is -12V which is given to the base of the switching transistor BC547. So the transistor is cutoff region. The 5v is given to 7404 IC. The 7404 is the hex inverter with buffer. Hence zero voltage is given to microcontroller [5].

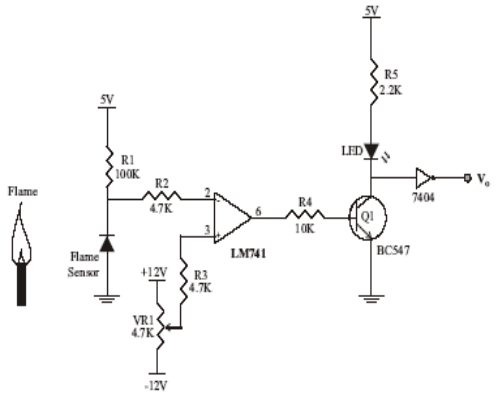

Fig.7 Flame sensor circuit

When there is fire occurred, the flame sensor became short circuit. So the inverting input terminal voltage is less than non inverting input terminal (reference voltage). Now the comparator output is +12V which is given to the base of the switching transistor BC547. So the transistor is turned ON. The zero voltage is given to 7404 IC. Hence +5v voltage is given to microcontroller[10,11]. In the microcontroller we can detect the fire with the help of software

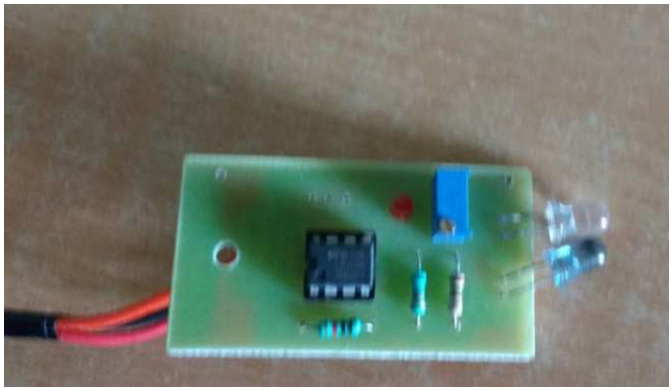

Fig.8 Flame sensor

6) Fire extinguisher: A fire extinguisher, or extinguisher(Fig 9), is an active fire protection device used to extinguish or control small fires, often in emergency situations. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the expertise of a fire department. Typically, a fire extinguisher consists of a hand-held cylindricalpressure vessel containing an agent which can be discharged to extinguish a fire.

Fig. 9 fire extinguisher

There are two main types of fire extinguishers: stored-pressure and cartridge-operated. In stored pressure units, the expellant is stored in the same chamber as the firefighting agent itself. Depending on the agent used, different propellants are used. With dry chemical extinguishers, nitrogen is typically used; water and foam extinguishers typically use air. Stored pressure fire extinguishers are the most common type. Cartridge-operated extinguishers contain the expellant gas in a separate cartridge that is punctured prior to discharge, exposing the propellant to the extinguishing agent. This type is not as common, used primarily in areas such as industrial facilities, where they receive higher-than-average use. They have the advantage of simple and prompt recharge, allowing an operator to discharge the extinguisher, recharge it, and return to the fire in a reasonable amount of time. Unlike stored pressure types, these extinguishers use compressed carbon dioxide instead of nitrogen, although nitrogen cartridges are used on low temperature (-60 rated) models. Cartridge operated extinguishers are available in dry chemical and dry powder types in the U.S. and in water, wetting agent, foam, dry chemical (classes ABC and B.C.), and dry powder (class D) types in the rest of the world[12].

4 DESIGN OF THE ROBOT

Many technical concepts from different areas like mechanical, electric, electronic and pneumatic systems were used to project a build the robot.

A. BLOCK DIAGRAM

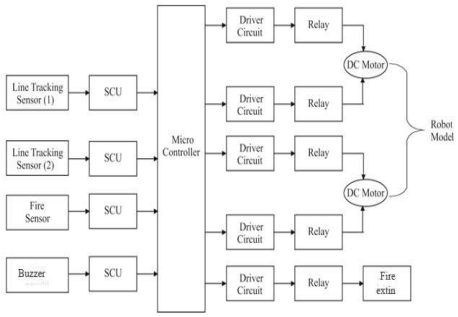

Fig.10Block Diagram

B. SYSTEM WORKING

The project is designed by following blocks fire sensor, Arduino board, line tracking sensor (2nos), Motor with driver circuit (2), Robot model, and Driver circuit with relay and Fire extinguisher.

The flame sensor is used here to sense the fire. The flame sensor output is very low voltage so we give that signals to signal conditioning unit. The signal conditioning unit gives the signal to Arduino board. The Arduino board used is flash type reprogrammable controller. Therefore, it receives the signal from signal conditioning unit and activates corresponding driver circuit.

If the fire is sensed by the sensor it gives the signal to Arduino board. By which the robot movement is controlled artificially, the Arduino board activates the alarm driver circuits. So the alarm makes sound for indication of fire. And at the same time Arduino board activates driver circuit for fire extinguisher. The keypad is used here to control the robot movements like as forward and reverse direction and left and direction control. The line tracking sensor is used to sense the line just below the robot model. There are two sensors kept at the front of the robot model at a certain distance. The two sensors are used to sense the left or right directions for further move of the robot model.

C. ASSEMBLY OF WORKING MODEL

The fig.11 shows that assembly of robot model.The robot was made designed for extinguishing the fire by detecting the flame with the help of flame sensor which are attached in robot body. when the sensor get the signal its send singal to the micro controller after receiving the signal the micro controller (adruino) activated the motor drive, which help robot to reach the area where fire is outcome. After reaching that area the robot activated the cam system so that it can push the fire extinguisher nozzle and thus fire is extinguished. The project carried out by us made an impressing task in the field of automobile department.

Fig .11 assembled robot

This project will reduce the cost involved in the concern. Project has been designed to perform the entire requirement task at the shortest time available.

D. FUTURE SCOPE

This project has been motivated by the desire to design a system that can detect fires and intervention. In thepresent condition it can extinguish fire only in the wayand not in all the rooms. It can be extended to a real fireextinguisher by increasing robot size and configurations. This provides us the opportunity to pass on to robots tasks that traditionally humans had to do but were inherently life threatening. Fire-fighting is an obvious candidate for such automation. Given the number of lives lost regularly in firefighting, the system we envision is crying for adoption. Of course, this project has only scratched

the surface. As in the design simplifications and the implementation constraintsin suggest, our project is very much a proof-of-concept. In particular, a practical autonomous fire-fighting system must include a collection of robots, communicating and cooperating in the mission; furthermore, such a system requires facilities for going through obstacles in the presence of fire, and ability to receive instructions on the fly during an operation. All such concerns were outside the scope of this project. However, there has been research on many of these pieces in different contexts.

5 CONCLUSION

The conclusion is to provide security of home, laboratory, office, factory and building which is important to human life. We develop an intelligent multisensory based security system that contains firefighting system in our daily life. We design the fire detection system using sensors in the system, and program the fire detection and fighting procedure using sensor based method.The system is cost effective, has a wide applications which when implement can show good and effective result. It can be use deliberately in industrial applications, commercial and in domestic sectors where the requirement of automatic work demands

REFERENCES

[1] David J. Ahlgren FIRE-FIGHTING ROBOTS AND FIRST-YEAR ENGINEERING DESIGN: TRINITY COLLEGE EXPERIENCE. 31st ASEE/IEEE Frontiers in Education Conference S2E-6 October 10 - 13, 2001

[2] Taiser T. T. Barros, Walter Fetter Lages Development of a Firefighting Robot for Educational Competitions 3rd International Conference on Robotics in Education (2003)

[3] U.Jyostna Sai Prasanna, M.V.D.Prasad Automatic Fire Sensing and Extinguishig Robot Embedded With GSM Modem International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013

[4] Sahil S.Shah , Vaibhav K.Shah, Prithvish Mamtora and Mohit Hapani FIRE FIGHTING ROBOT nternational Journal of Emerging Trends & Technology in Computer Science (IJETTCS) Volume 2, Issue 4, July – August 2013 ISSN 2278-6856

[5] Saravanan P Design and Development of Integrated Semi - Autonomous Fire Fighting Mobile Robot International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 4, Issue 2, March 2015

[6] Swati A. Deshmukh , Karishma A. Matte and Rashmi A. Pandhare Wireless Fire Fighting Robot INTERNATIONAL JOURNAL FOR RESEARCH IN EMERGING SCIENCE AND TECHNOLOGY E-ISSN: 2349-7610 VOLUME-2, SPECIAL ISSUE-1, MARCH-2015

[7] Abhilash Dhumatkar, Sumit Bhiogade, Shashank Rajpal, Datta Renge,Prof. V. Kale Automatic Fire Fighting Robot nternational Journal of Recent Research in Mathematics Computer Science and Information Technology Vol. 2, Issue 1, pp: (42-46), Month: April 2015 – September 2015

[8] www.wikipedia.com, Firefighter robot, its benefits and its recent developments.

[9] National robotics challenge," NRC, 2012, <http://www.nationalroboticschallenge.org/joomla/>.

[10] L. A. Bryan and E. A. Bryan, *Programmable Controllers, Theory andImplementation*, 2nd ed. USA: Industrial Text, 1997, pp. 8–10.

[11] *S7-1200 Programmable controller - System Manual*, Siemens, 2012, http://support.automation.siemens.com/BR/view/en/36932465>.

[12] *AN822 - Stepper Motor Microstepping with PIC18C452*, Microchip, 2012, <http://ww1.microchip.com/downloads/en/appnotes/00822a.pdf>.