# Design and fabrication of robotic welding arm

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**abstract**

A robot is a device works under control system to perform multiple task in several directions. Few areas where robots play important role are mechanical assembly, paints, weldments, pick and drop mechanisms, surgical procedures, evaluation of process parameters to name a few. The famous robot configurations include articulated, S.C.A.R.A (Selective Compliance Assembly Robot Arm), delta robots. As one of the applications of robot is it can perform welding operations**.** The present work enlists the design and fabrication of robotic welding arm incorporating various components, their functions, joining and programming to generate the constrained motion for welding.

***Keywords****:* Robotic arm, SCARA, welding.

**Introduction:**

A robotic arm is a mechanical linkage which can be programmed to perform the functions analogues to human arm functioning. The robotic arm can be mechanism itself or could be a part of more complicated system within a machine [1]. The various rigid links are connected with each other to perform controlled precise motion between them such as rotation, translation or curvilinear motion [2]. The links of robot arm form a kinematic chain which can move in definite directions[3]. The terminus of kinematic linkage is termed as end effector and performs the functions similar to human hand [4].

A robot utilized for welding is also known as Welding Robot. It was designed to gain high accuracy and to reduce security hazards during welding [5,6].

**Working Aspects of the model:** The fabrication of robotic welding arm consists of stages as shown below:

- Design
- Component assembly
- programming

**Design**

Considering the mechanical aspect of the project, it is designed to analyses each step of developing it. constraint were checked to create a virtual model to preview.

Software used: SolidWorks

SolidWorks is a software to model and assemble solid parts using computer added design. It can model solid and analyse the operations based upon model parameters [7].

various features of the SolidWorks program were used to create a full proof model that can sustain the design. The steps included

1. Part Modelling

2. Assembly

3. Rendering

SolidWorks was preferred due to various features it provides for designing as well as its ease to handle [8].

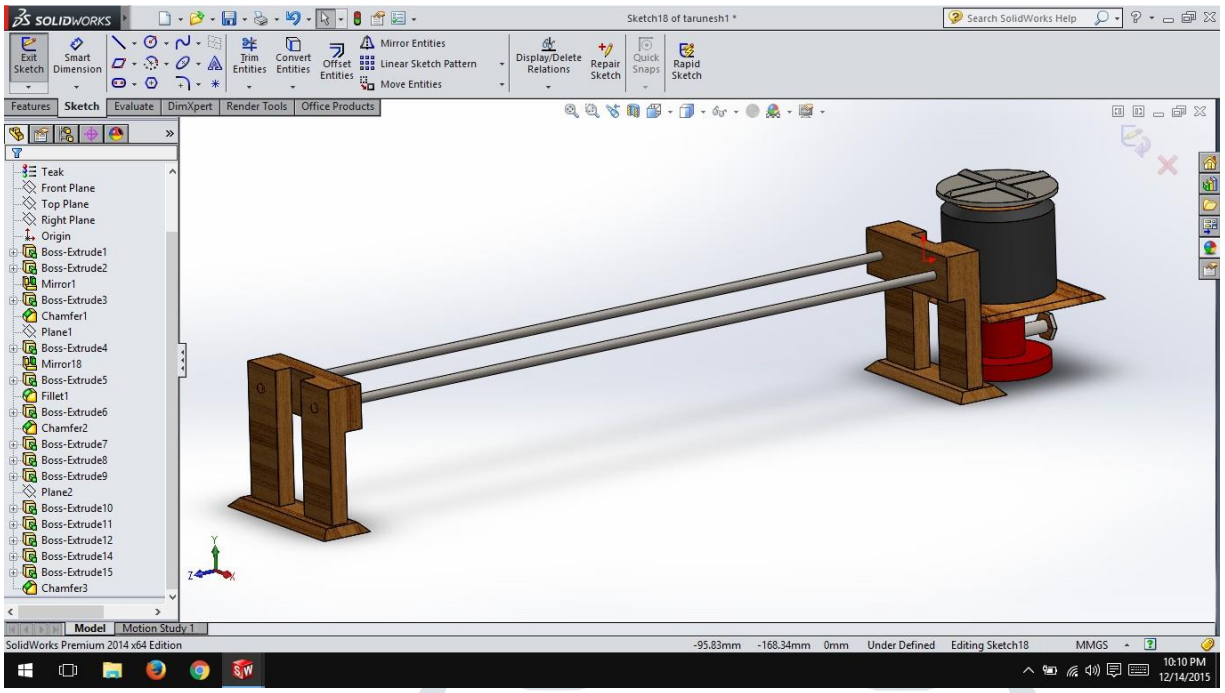


***Figure 1:*** Assembled robotic arm in software interface

**Part modeling** consists set of principles for mathematical and computer modeling of three-dimensional solids. Rendering consist of developing an image from models with help of a program code. A scene file comprises of model features in coded language such as geometry, views surface features, shade dimensioning to name a few [9].

**Mechanical Components and Assembly**

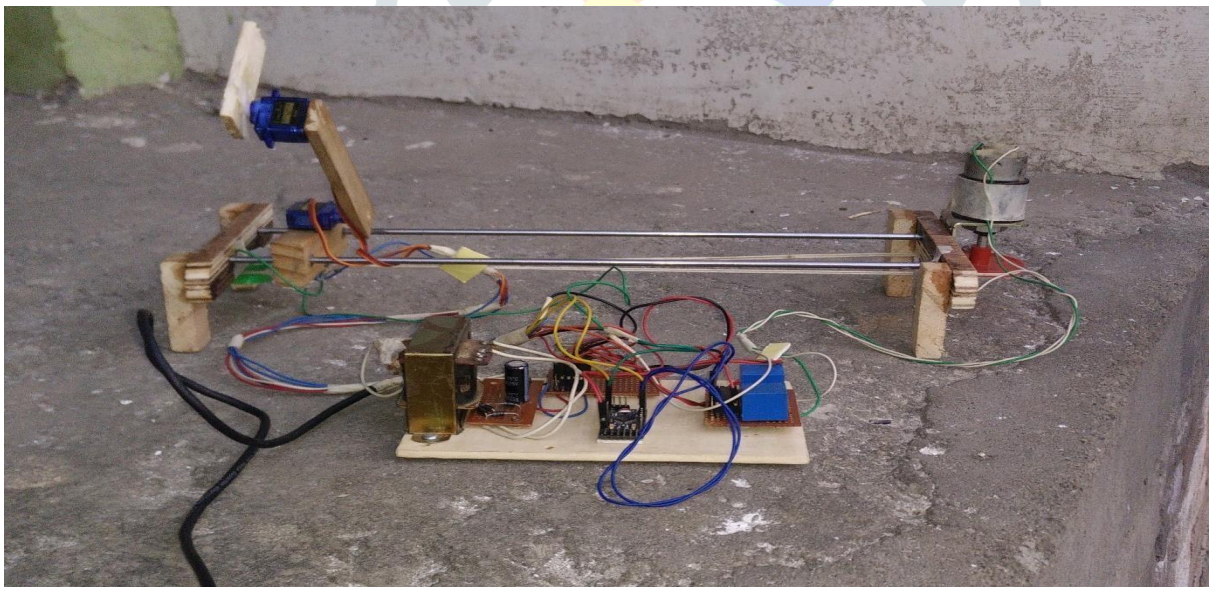

***Figure 2:*** Actual Assembled robotic arm.

**Wooden platform**

Made of typical conrnus wood. It is used to create a working space for the robot. Two standing planks to support parallel arranged steel rod.

**Two thin steel rods**

Steel rods to provide base for movement of slider. Smooth surface promotes easy sliding.

**Wooden slider**

It has two holes through which each steel rod goes. Now clearance between rod and holes helps in the movement of slider. Another end of the slider is connected to wooden arm controlled by a stepper motor.

**Two wooden arms**

Wooden arms are used for welding action. Lower arm is connected to slider with a stepper motor. Upper arm is connected to lower one with another stepper motor. This provides two-dimensional free motion.

**Rope**

It is used to drive motor and pulley to pull slider on the platform.

**Pulley**

Retains rotatry motion of the motor. Helps in sliding of the arrangement.

**Assembly**

Steel rods were attached to wooden platform. Now wooden slider is attached to steel rod and connected to a pulley with rope. Pulley is driven by motor which created rotatory motion upon which slider moves in translation motion, back and forth. The slider is connected to wooden arms arrangement which works as hand work while welding. To ensure reach to the welding point with exact dimension two programmed motors are attached at the end of each arm. Theses motors help arm to reach to the welding spot.

**Electronic components and Assembly**

**Transformer**

A **transformer** is a device used to transmit electricity between two or more stations through electromagnetic induction. Often the transformers are termed as step up or step down depending upon increase or decrease of the output voltage. Here transformer is connected to direct electricity supply of 220 V. it is used to convert this 220 V into 15-20 V which can be supplied to other electronic components [10].

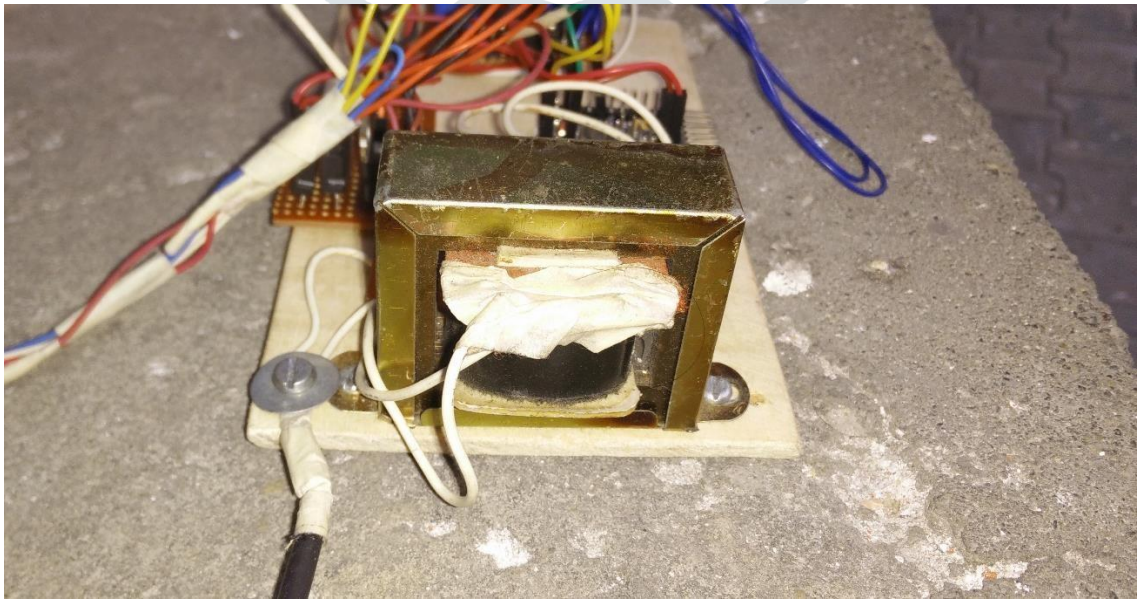

***Figure 3:*** transformer

### Transistor

**A transistor** is a kind of semiconductor device which can modulate or divert electric/electronic signal. It consists of three terminals made of semiconductor material. It sometimes works as a voltage regulator [8].

Present work used 7805 and 7812. Both belong to the voltage regulator ICs. These are used in circuit needing regulated power supply. 7805 produces 5 V while 7812 produces 12 V. we have used two 7805 to connect to steppe motors while one 7812 to connect to 12 V DC motor.

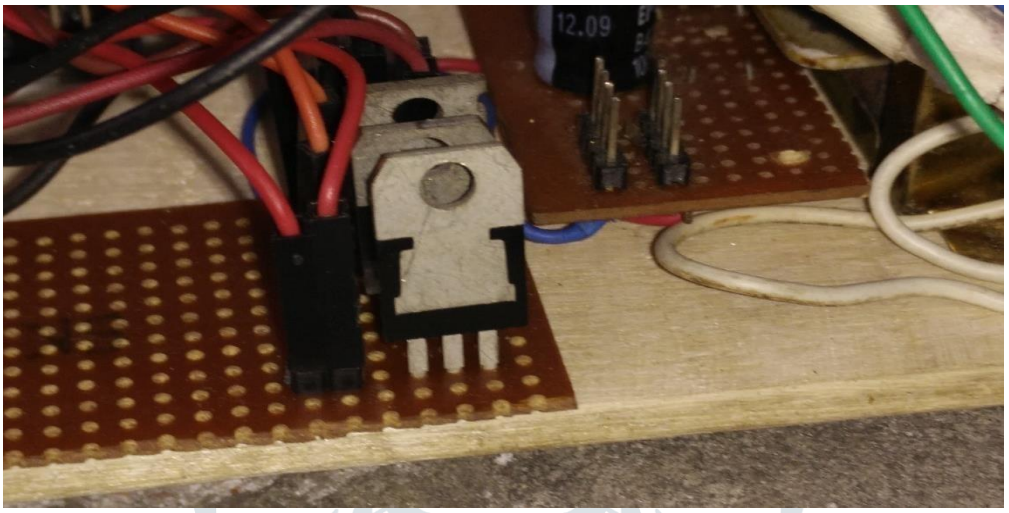


***Figure 4:*** transistor

### Capacitor

A capacitor is energy storing device consist of two conductors separated through insulator layer.
the present work used a capacitor of 25 V, 200 microfarad which is connected to transformer on one end while to transistors and resistors on other. It stores charge from transformer to ensure regular supply to transistor so as to power the motors.

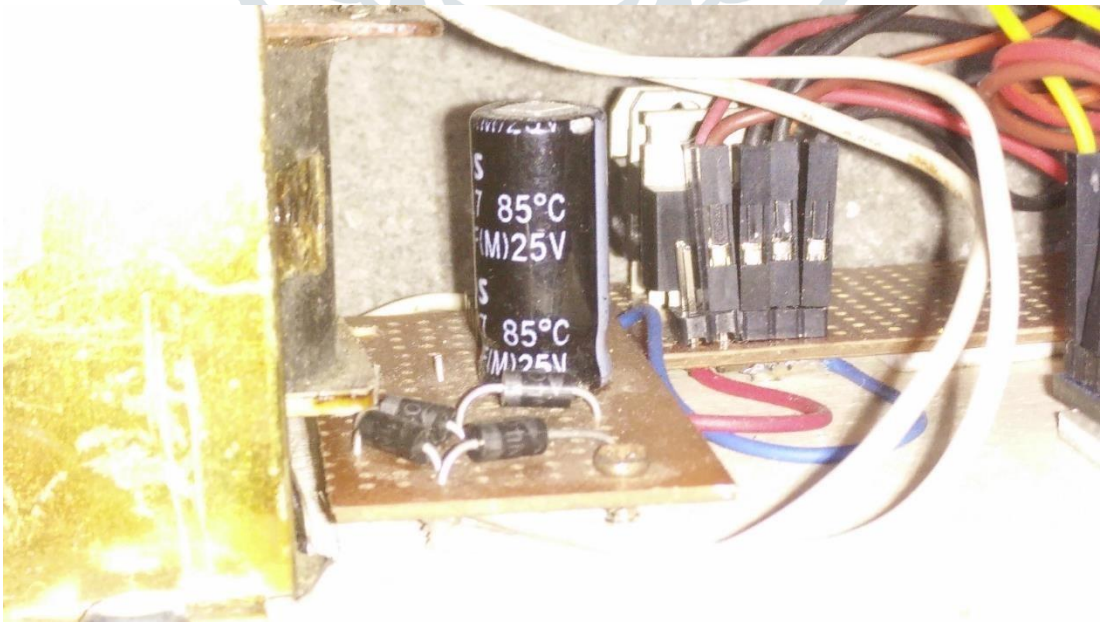


***Figure 5:*** Capacitor

**Resistors**

A resistor consists of two passive terminals used for resistance to flow of electricity. They can be used to control the flow of current within limits.

Resistors were being used to lower the voltage coming from capacitor and transformer. Four resisters each of 5 ohms are used to compensate the flow of the current.

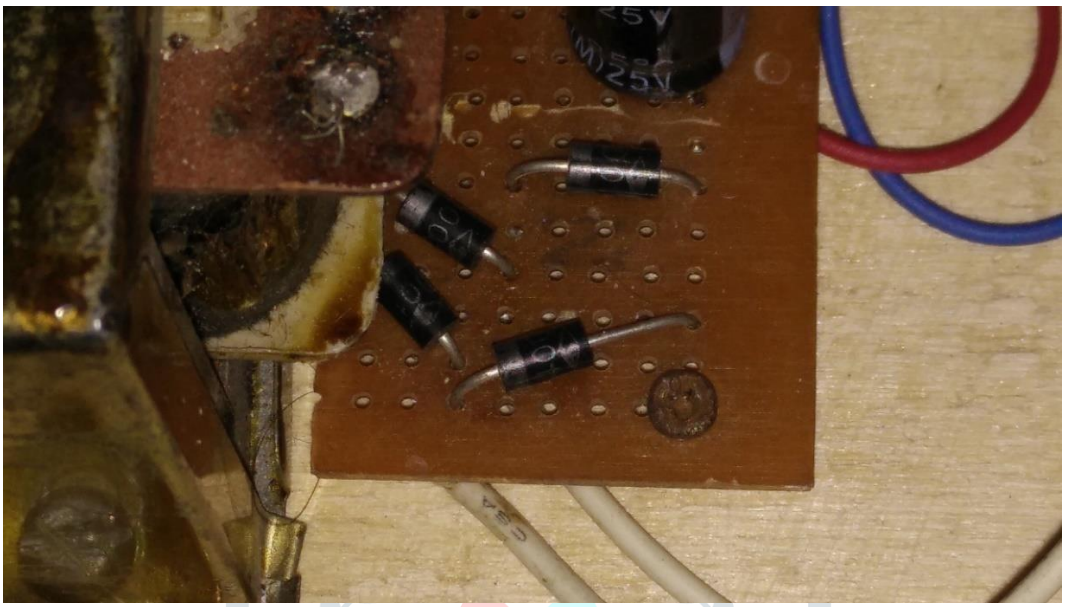

***Figure 6:*** Resistor

**Darlington Transistors (ULN2003A)**

It consists of seven NPN DT with capacities of 500 mA, 50V. it can produce high current amplitudes using two transistors in DC couplings.

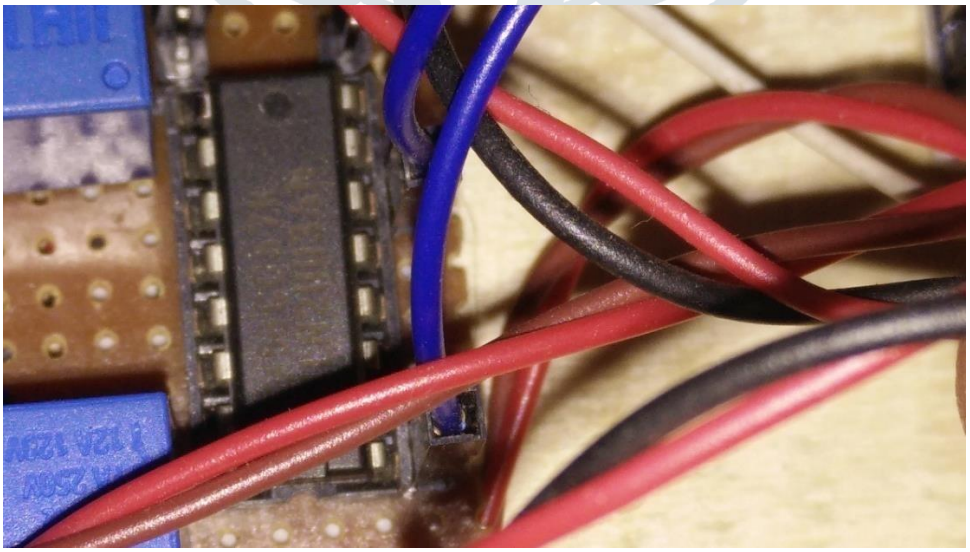

***Figure 7:*** Darlington transistor

Here it is interfaced with relay to amplify initial voltage in each cycle.

**SSR (Solid State Relay)**

A solid-state relay (SSR) work as an electric switch for on/off operation by applying small voltage across its terminals. SSRs comprises of a sensor acted upon by input signal. It supplies power to load circuit and mechanism to activate the entire operation. AC or DC voltage can be regulated using SSR.

relay is used to provide bidirectional motion of the motor. Two relays are applied to switch voltages up and down in alternate orders. This way slider can move back and forth on the platform.

It is also connected to microcontroller to ensure the movement according to the program fed in the microcontroller.

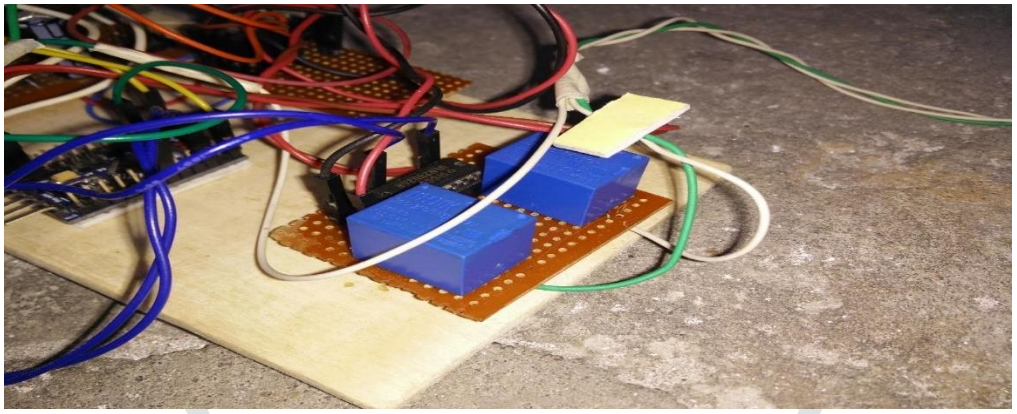

***Figure 8:*** Solid State Relay

12 V DC motor is used in the project, which drives the ropes to translate slider on the platform. The motor has an rpm of 3000.

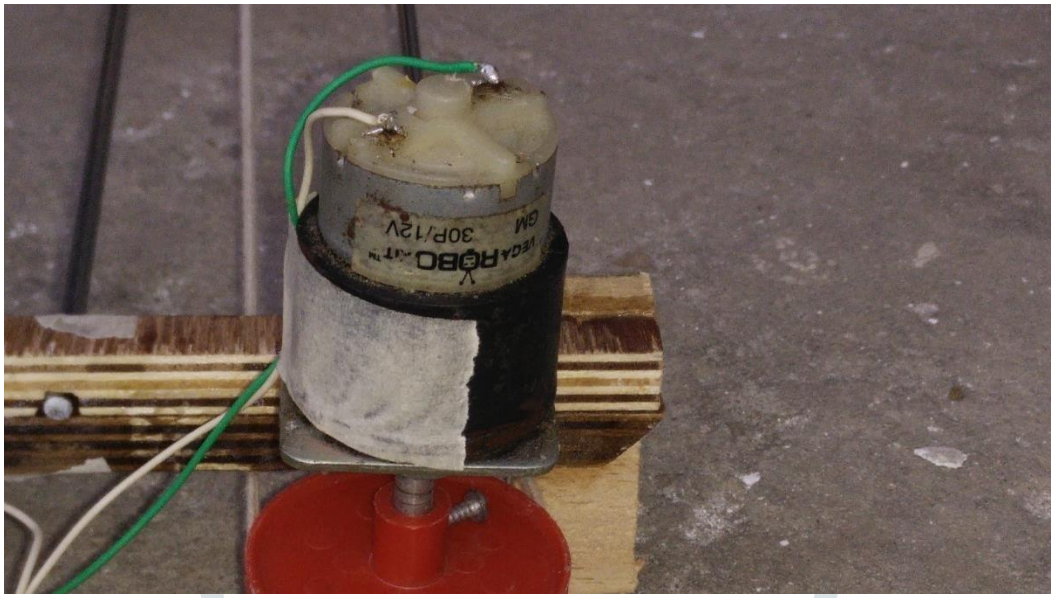

***Figure 9:*** 12 V DC motor

**Stepper Motor**

A stepper motor converts electric pulse into controlled and interrupted mechanical motion.

two stepper motors were used to control movement of the arm of the robot. They work on the standard 5 V supply.

***Figure 10:*** Stepper motor

**Microcontroller**

A microcontroller is a mini computer in integrated circuit comprises of core, memory and an interface for programming. Program memory can be of N.O.R. flash, ferroelectric-RAM often available with chip. Microcontroller acts as the brain of robotic arm which give commands to individual elements and to control their motions.

Atmel 328p was used for the fabrication of robotic arm for our robot. This microcontroller is used in our project to control the motion of motors and relay.

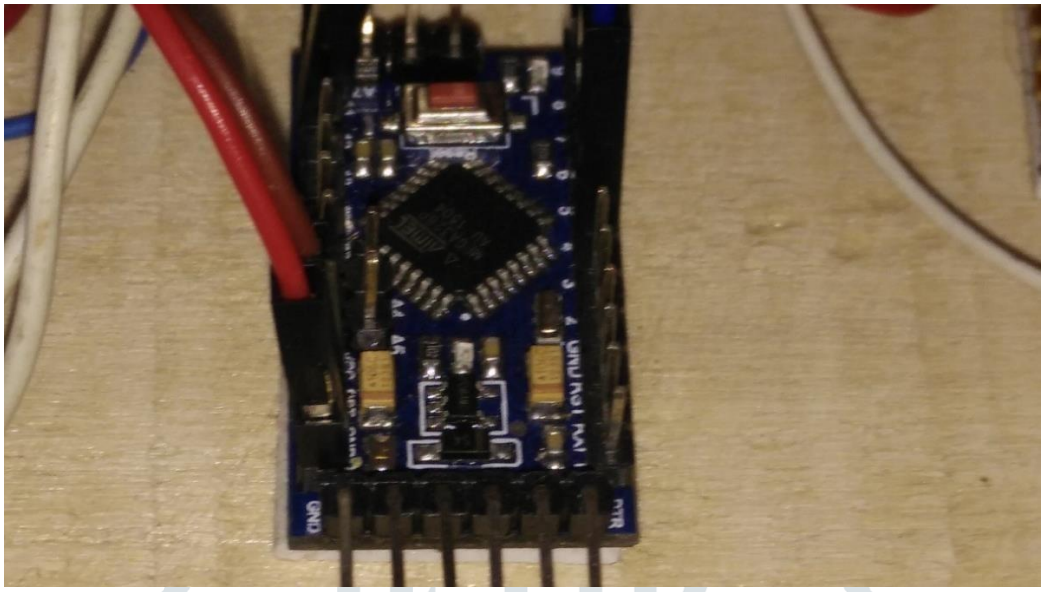

***Figure 11:*** Micro controller

**working:**

The working of the robot can be classified into two categories

- current flow
- instruction flow

**Current Flow**

When robot is connected to 220V, the current is supplied to transformer which converts it to 15-20 V. This current now goes into the capacitors and is reduced by resistors in between. From capacitor stored charge is supplied to voltage regulator ICs which converts it to currents of 5 V and 12 V. the 5 V current goes to the two-stepper motor while 12 V current goes into the dc motor. This way both motors are powered. Also, 5V continuous current is supplied to the microcontroller too. Another 5V supply is given to ULN to operate the relays.

**Instruction flow**

Instructions are generated in the microcontroller by feeding the program. This program helps in the movement of the arms and the slider as well as feeds instruction to the relay to work on the timing of the movement. Whenever programs start its first instruction it rotates the controlled rpm dc motor to a particular degree of rotation, so as to cover the translation movement of slider across the two-rod arrangement. Simultaneously it orders the first stepper motor to go down to the particular distance where workspace is kept. Both motors are programmed in such a way that distance of arm can be adjusted according to need of the weld. Now when in forward stroke weld is completed, it travels back by the action of the relay which moves the dc motor in opposite direction. The timing of movement is controlled by the fed program in the microcontroller.

**Program**

The programming was done in Ruby to feed instruction to motor and relay.

**Conclusions**

the present paper discussed the design and fabrication of robotic welding arm. The design was prepared using solid works and based upon the design outcomes, mechanical and electronic components were assembled and integrated through processing unit. Operating program was prepared in Ruby to feed the instructions to motor and relay to impart the desired motion. The robotic welding arm generated correct and controlled motion for applications where precise work is of prime requirement as compared to manual operations of welding.

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