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Novel Approach to Soldering with Smart Solder Gun

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Abstract: The paper discusses the design of a smart solder gun whichwill be an improved and modified versionof the existing soldering iron [1]. Here, the reel of lead is mounted on one end of the gunusing a shaft. This shaft is removable. The tip is placed on the other end of the gun.The solder material is fed into the gun using an L shaped motor. The motor is used toimplement a roller mechanism using which lead is transmitted from one end of thegun till the tip. The heating element is electrically heated and is kept in direct contactwith the tip. The solder lead is fed to the heating element through a heat resistivetubing to avoid the melting of solder before it touches the tip. The heat resistivetubing is made of materials having very high melting point. The solder reaches thetip only when the switch is pressed. As long as the switch is pressed, the lead isdriven by continuous rotation of the motor. The rotation of motor is programmed ina microcontroller. The components are placed and arranged inside the body of a hotglue gun.

Keywords: Embedded system, soldering, DC motor, Microcontroller.

I. INTRODUCTION

A soldering iron is a hand tool used in soldering. Soldering is a process in which two or more items are joined together by melting and putting a filler material (solder) into the joint, the filler material having a lower melting point than the adjoining metal [2]. It consists of a heated metal tip and an insulated handle. Electronic soldering connects electrical wiring and electronic components to printed circuit boards (PCBs).

The commonly used soft soldering makes use of a soldering iron having a metal tip which is electrically heated to high temperatures sufficient enough to melt the solder material. The parts to be joined are placed in closest possible contact with each other. Excessive amount of solder must not be used. The strength of soldered joint is greatest when the minimum solder is used.

II. COMMON SOLDERING PROBLEMS

Most of the soldering for small PCBs is done manually with hand held soldering iron. This requires a certain amount of skill and is a very inefficient method and not suited for beginners who have no experience in soldering. Some of the problems [3] associated with the current soldering system are

- Disturbed joints: When a joint is moved as the solder hardens you end up with a disturbed solder joint. This can be prevented by stabilizing the work.
- Excess solder: This results in an unreliable electrical connection. A blob of solder may not wet the pin.
- Non sticky iron tip: Solder, at times does not stick to the tip of the soldering iron. The solder melts and rolls itself like a ball and doesn't stick to the tip of the iron.
- Pits in solder stream: If the metal is not clean or if the solder joint receives too much heat, irregularities in solder stream is observed.

In this work, we have proposed the development of a smart solder gun which is an improvement from the existing soldering iron. The proposed design is not only easier to use but also will be optimized for low power consumption and less lead usage. It will be a single portable hand held device that will have a heating mechanism and a lead feeder. This will make the whole process of soldering less cumbersome and convenient. In contrast to the conventional system, the lead feed will be controlled and hence the problem of excess solder can be overcome. Also, the proposed system ensures a steady rate of solder feed making the joint look better. The plan is to design the system in such a way that it will be compact and also not very costly.

III.SMART SOLDER GUN

As stated above, the smart solder gun is an improved and modified version of the existing soldering iron. A block diagram of the operation of the system is as shown in Fig 1.

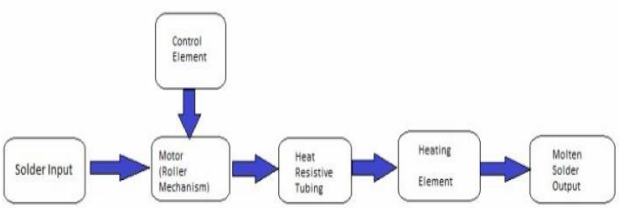

Fig.1 Block diagram of Smart Solder Gun

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Here, the reel of lead is mounted on one end of the gun using a shaft. The tip is placed on the other end of the gun. The solder material is fed into the gun having heating element internally by means of a motor. The motor is used to implement a roller mechanism using which lead is transmitted along the gun till the tip. The heating element is electrically heated and is in direct contact with the tip. The solder lead is fed to the heating element through a heat resistive tubing to avoid the melting of solder before it touches the tip. The molten solder flows out only when the input switch is pressed and accordingly the motor is driven. The rotation of motor is controlled by a microcontroller using an H bridge. The heating element is enclosed so that it doesn't come in contact with the user and so can prevent accidents. This model overcomes the few disadvantages found in the current soldering method. It is safer, the amount of filler material can be easily controlled and a more stable work can be done

A. Motor (Roller Mechanism)
The motor is used in order to drive the solder lead till the tip. A roller mechanism is also used for this purpose. DC motor is used with L shaped shaft for ease of mounting.

B. Control Element
A microcontroller is used for controlling the motor, which in turn controls the flow of lead to the heating element. A soldering switch is provided in the gun. If the switch is pressed, the motor rotates. The duration of rotation of the motor is controlled using the microcontroller. It is programmed such that as long as the switch is pressed, the motor rotates continuously. Once the switch is released, the motor rotates in the opposite duration for a very short period of time so that no excess lead comes in contact with the heated tip. L293D motor driver IC is used for driving the DC motor.

C. Heat Resistive Tubing
The solder lead is fed to the heating element through heat resistive tubing. Heat resistive tubing is made of ceramic material. In this project, we propose use of Zirconium Dioxide (ZrO_2) pellets that can be joined using an adhesive.

D. Heating Element
We have proposed the use of Nichrome wire element for designing the heating element. If 230 V is applied to Nichrome wire, it starts heating. The melting point of Nichrome is $1400^{O}C$ [4]

E. Solder Tip
We have used the removable tip from existing iron. As a provision for molten solder output, a 1mm hole was drilled through the centre of this tip. The length of the tip was reduced to the possibility of lead solidifying in the tip itself.

IV. DESIGN IMPLEMENTATION AND TESTING

We have planned the design of the system in two stages. The first stage involved the selection of components for the project. The next stage would be the development of the heating element and solder tip. Once the rate of solder is decided, then the next stage will be the development of the lead dispenser system, with the motor and the roller mechanism. The next stage is the mounting of the entire system into a housing that will provide adequate mechanical support and strength to the solder gun. Such a system will need elaborate testing before it can be used. For the prototype we have decided to do some tests and so the final stage will be testing of the system for its reliability, rate of soldering and whether or not the tip gets blocked due to hardened lead. The prototype, once completed will look as shown in Fig 2.

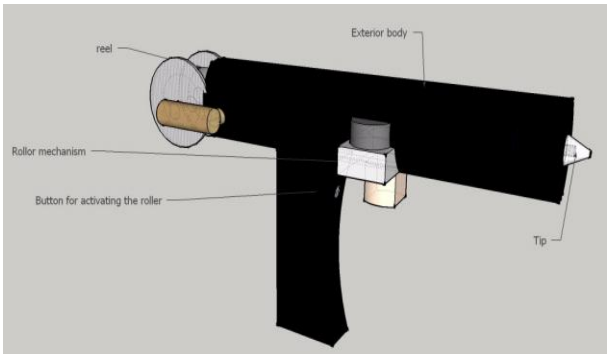

Fig. 2 Smart Solder Gun prototype design

V. COST ESTIMATION

The smart solder gun that we have proposed has to be developed at a low cost. An estimate of the cost that may be incurred was prepared as given in Table 1 below.

TABLE I COST ESTITMATE

Sl. No.	Component	Specification	Quantity	Cost (Rs)
1	PIC Microcontroller	16F883	1	200
2	Motor Driver IC	L293D	1	40
3	Voltage Regulator	L7805	1	20
4	Crystal Oscillator	4MHz	1	10
5	Capacitor	22pF	2	2
6	Resistor	1K	2	2
		330	2	2
7	Motor	DC, Geared 12V 60 rpm	1	50

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8	Heating Element	Nichrome	1	25
9	Metallic tip	Iron, 1mm dia hole drilled	1	20
10	Ceramic Pellets	6mm dia	15	15
	Total			**386**

As seen here, the overall cost of the components for the prototype proposed is less than Rs. 400/-. The estimate given above does not include the PCB fabrication cost, mechanical housing, etc, which will be obtained later only after the design is over. We are expecting to complete the design in less than Rs. 500/- with the housing and the mechanical assembly. This will be a good improvement over the conventional design which requires good skill in operation and also is less efficient. This is the estimate for a minimal system. Any more features can be incorporated into the current system, but at a higher cost. The usage of a PIC microcontroller can extend the functionality of the smart solder gun by a great deal. A protection circuit and a temperature control system can also be incorporated by measuring the soldering temperature and giving a feedback to the user. This will need additional circuitry and components and in turn will increase the cost of the system.

VI. CONCLUSION

Compared with the existing soldering iron, Smart solder gun helps in stable work,no excess solder and faster soldering.The Smart Solder Gun has a simple structure, easy to operate, easy to obtain rawmaterials, manufacturing equipment simple process. It has control functions, and is lesssusceptible to interference, high reliability, ease of use, can make products with highperformance and low cost. The product is suitable for large, medium and small soldering works.

The Smart Solder Gun can be used in large scale and small scale PCB fabrication. Itcan also be used in technical laboratories and home.

Once the prototype is completed, we are planning to extend the work and add additional features into the system so that it becomes a complete solution for soldering needs. A temperature controlled soldering station can be realized in this platform as the system already has a microcontroller in it. Another improvement that can be brought about is the addition of a safety circuit that will protect the soldering gun from over current or over voltage conditions. Also, over heating protection also can be incorporated into the system

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