70(10A): 363-367; 2022. DOI: 10.18311/jmmf/2022/32933

INFORMATICS JOURNALS

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: www.informaticsjournals.com/index.php/jmmf

# Development of IoT Based Pneumatic Punching Machine

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## *Abstract*

*Building effective industrial systems are now possible with the help of the Internet of Things abbreviated as IoT. In nowadays automatic systems are recommended over manual systems. IoT is the latest and rising internet technology. IoT is a developing network of everyday products, from industrial machinery to consumer goods which exchange information and carry out tasks while consumers are attending to other responsibilities. A machine tool is used to punch sheet metals to increase the static stability of the section of the sheet. The movement of the piston in the pneumatic punching machine is from the compressed air which generates high pressure on the piston. The focus of this project is on the development of an IoT-enabled sheet metal punching machine. The main objective of this project is to develop an IoT-based pneumatic punching machine that is capable of monitoring the production parameters of the pneumatic punching machine through an easily manageable web interface. Additionally this technology is innovative in that it allows the control of the punching machine through the Internet of Things as well as the tracking of production data or production values.*

***Keywords:*** *IoT (Internet of Things), Pneumatic Punching Machine, Production monitoring, Arduino.*

## 1.0 Introduction

The punching machine tool is designed to punch metal with the application of pressure. The presses are the quickest and most effective means to shape metal into a completed punched product. They are only designed for mass manufacturing. Thin metals are formed and cut using press tools. The use of press tools is reduced to some basic processes using the punch and a die. A number of different types of presses in the engineering field are present, which are utilized to meet the demands. But the interest shown here is for the introduction of the pneumatic system. Pneumatic power is used primarily by the pneumatic press to shape or cut thin sheets of metal or non-metal. Automation in this period is widely defined as the substitution of mechanical power for manual labour at all levels of automation. The analysis converts the data into waste status knowledge and uses DMUs to determine waste reduction potential using monitoring of real time waste and bench marking analysis on the manufacturing shop floor. An attempt on designing and fabricating a pneumatic punching machine led to the creation of an air-powered punching device that can punch characters on a selected work piece. Pneumatic systems are superior in relation to precision, affordability, and upkeep. According to estimations, the project model will operate at a pressure of 8 bar [1]. It explains the designing and manufacturing a flexible punching system that collaborates the industry robots and unique plier in an experimental study on a versatile punching system employing industrial robots [2]. An experiment was undertaken to assist in the design and execution of a mobile robot for avoidance and obstacle detection in real-time, with the outcome being an extremely productive and cost-effective robot that substitutes human work, reduces human effort, and

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successfully executes checking tasks [3]. A physically smart manufacturing simulation is being used to establish a framework for video based production process monitoring, demonstrating that accuracies of detection of over 90% for personalised objects and also failed positions of the objects can be achieved in the context of industrial research [4]. In a test of a method of IoT enabled process control that uses RFID, sensors, wireless industrial communication. The mean relative error was found to be 1.77, demonstrating the efficiency and feasibility of the PN ACO in solving difficulty with job shop schedule [5]. Both the protocols permit data from the smart box which is to saved and readily monitored via a smartphone application or a computer web interface, as demonstrated in a demo of a smart box for scenarios of Industry 4.0, allowing the data gathering, sensing and monitoring [6]. It was discovered in an analysis of the design and also the development of a structure for RCSS remote monitoring involves the installation of a Wireless Networks for data collection and computer algorithms for anticipatory production that the visual interface of monitoring information will also facilitate by implementation and evolution of AR intuitive in various devices and mobile, as well as displays of head mounted, such as the Oculus Rift [7]. It was discovered in an experimental study of a monitoring system for the shop floor control based on IoT paradigm that it gives new possibilities for the manufacturing organisations to evolve into digital realm and reap benefits which come with it. Furthermore, the suggested monitoring tool has been conceived and developed to be low-cost, reconfigurable, and dependable [8]. The IoT-enabled remote system in assembly of press shop can effectively enhance precision and suitability of detection of abnormality while also lowering the checking of overhead in a normal significance, according to a study the focus on a system of multi user remote that incorporates Raspberry with IoT technology [9]. According to the results of an experimental investigation of the creation of a controller based on a PLC for a pneumatic machine in the manufacture of engine bearings facility, PLC-based automation would improve production time by reducing delays at every level. Second, because a VFD is replaced with the traditional star delta starter, motor will start more smoothly and consume less energy [10]. Using DEA to research comparative effectiveness and percentiles as the method of data classification, Data are converted into information of waste state by analysis and uses DMUs to determine waste reduction potential [11]. In order to illustrate the worth and efficacy of IoT in manufacturing firms, an experimental work is carried out in one of the industrial assembly workstations, with the result that it provides an insight into the other ways of producing value in assembly workstations [12]. Development of a micro punching machine and an examination on the effect of vibration machining in EDM results were carried out in experiments to punch the micro level of holes with the dia of 0.2 and 0.1mm on a ss strip of 0.1mm thickness [13]. There are certain benefits in improving the forming product accuracy and limit in many forming processes utilising step motion, according to research that intends to assess approaches to forming of smart metal by applying IoT and servo press [14]. An organised approach with a randomised storage policy can significantly downs total cost and increase space utilisation, contrasted to the plan that had a specific policy, according to an experimental study of integrated manufacturing strategic and problem of warehouse storage task [15].

## 2. Experimental Setup

### 2.1 The Working Principle of a Pneumatic Punching Machine

The solenoid valve contains one input and two outputs. The solenoid DCV (direction control valve) is actuated with the control timing unit. Air is compressed and at the pressure of 5-7 bar, of air is passed from the compressor through the pipes to the one valve of the solenoid with one input. Air that enters in input exits from two outputs after the actuation of the timing control unit. The air pressure above the piston is lesser than the pressure below the piston and this is because of the high pressure of air at bottom of the piston. So, this moves the piston upward which is tilted by the control unit. This force is passed on to punch and also moves in the downward direction. A fixed punch guide directs the punch in such a way that it is directed to die. Materials are sandwiched between die and punch. Therefore, when the punch or rivet descends, the components are sheared to the proper shape, and the blank is lowered by the clearance of the die. The exhaust valve is opened when the piston reaches the limit of its stock length, allowing pressured air to enter at the top of the piston and drive it downward. As a result, the

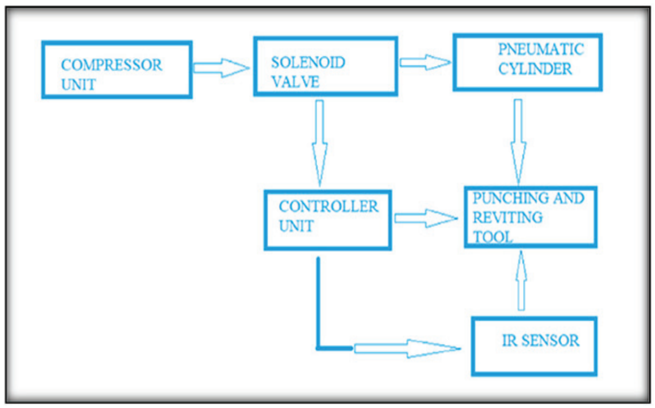


**Figure 1:** Flow chart of a Pneumatic Punching Machine

air is being dragged downward on one side while being raised upward on the other. Therefore, the punch is drawn up from the die.

## 2.2 Fabrication of Pneumatic System of Punching Machine

The construction of a pneumatic punching machine is shown in the above figure. The structure of the machine is constructed out of mild steel. The mild steel is a hollow tube measuring 1 inch square. Here, double acting cylinder is in working. In the pneumatic cylinder, which is attached to the mild steel frame, air is pressurised. The gate valve in the pneumatic cylinder aids in the flow of air, and a pressure gauge is fixed to show the cylinder's pressure. The sheet metal is held in place on a flatbed that is attached to the frame and the die is attached to the piston of the double acting cylinder. Lathe is used to complete the job on the die and bed.

**Figure 2:** Fabrication of Pneumatic punching machine

## 2.3 IoT Embedded System

The above picture shows the circuit of the IoT system. The microcontroller, regulator, relay and IR sensor are the components used in the circuit. This circuit system connected to the frame helps in the working of a pneumatic punching machine. This microprocessor supports an RTOS and has a configurable clock frequency band of 80 MHz to 160 MHz. Due to its powerful CPU, integrated Bluetooth and WIFI, and support for deep sleep operating, it is perfect for IoT projects. The Arduino IoT Cloud is used to programme the Node MCU ESP8266. The Node MCU Microcontroller Board may be easily programmed using the Arduino IoT cloud, which is easy to

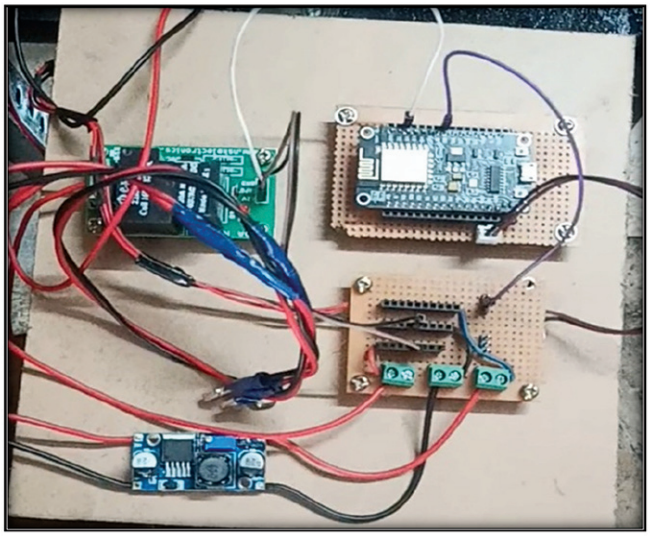

**Figure 3:** IoT embedded system

use. Infrared LEDs provide light in this frequency range. We cannot see infrared light because its wavelength (700 nm to 1 mm) is substantially greater than that of visible light. In electronics, relays are the most used type of switching device. There are two important parameters of relay, Trigger Voltage and Load Voltage and Current. The Arduino IoT Cloud is a system that provides the development of Internet of Things (IoT) applications. It has an intuitive user interface and offers one stop shopping for installation, coding, uploading, and monitoring.

## 2.4 An Assembly of Pneumatic Punching Machine and IoT Embedded System

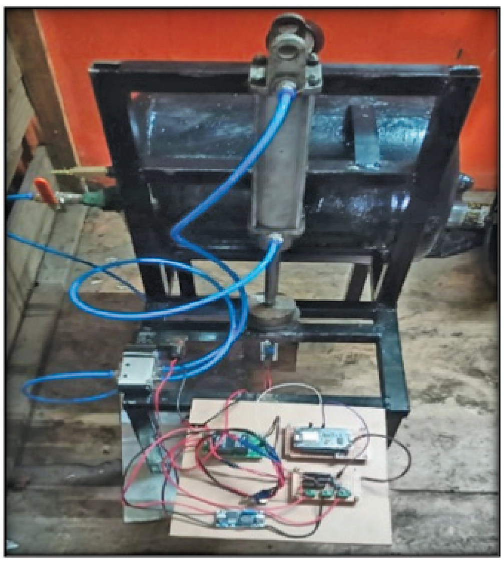

**Figure 4:** IoT enabled pneumatic punching machine

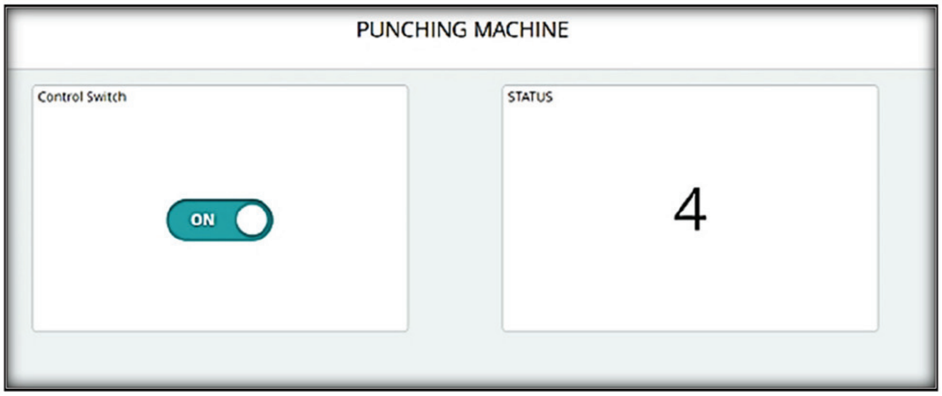


**Figure 5:** The web view of the control switch and production value


**Figure 6:** The mobile view of the control switch and production value

An assembly of a pneumatic punching machine with an embedded IoT system is shown in Fig.4. Compressed air from the cylinder connected to the gate valve is permitted to flow through a solenoid valve to the double-acting cylinder. The direction of airflow in and out of the cylinder is regulated by a solenoid valve. The die attached to the piston of the double-acting cylinder punches the sheet metal that is laid on the bed because of the high-pressure compressed air. The number of sheet metals inserted or punched on the bed is detected through an IR sensor that is connected to the frame. The microcontroller receives the sensed data immediately and uses a cloud system to send the production data via email or straight to a phone.

## 3.0 Results and Discussions

The web view and the mobile view of the control switch and the production value are shown in the Figs.5 and 6 respectively. The notification received through email is shown in the Fig 7. The fourth metal sheet that is undergoing the process is shown in each of the below-displayed pictures. The number of sheet metals or the production value is recorded. The recorded data is received through the mail and cell phone. For the notification to be received through the mail, a Gmail is directly fed and for the phone, a hotspot name and its password is set into the programme. The Arduino IoT cloud is used to write the programme and set the Gmail account and hotspot to which the email is received to that mail and phone application respectively. The mobile application used is Arduino IoT cloud. While operating, mobile data and hotspot are turned on so that the IoT embedded system accesses the internet and the notification is received.

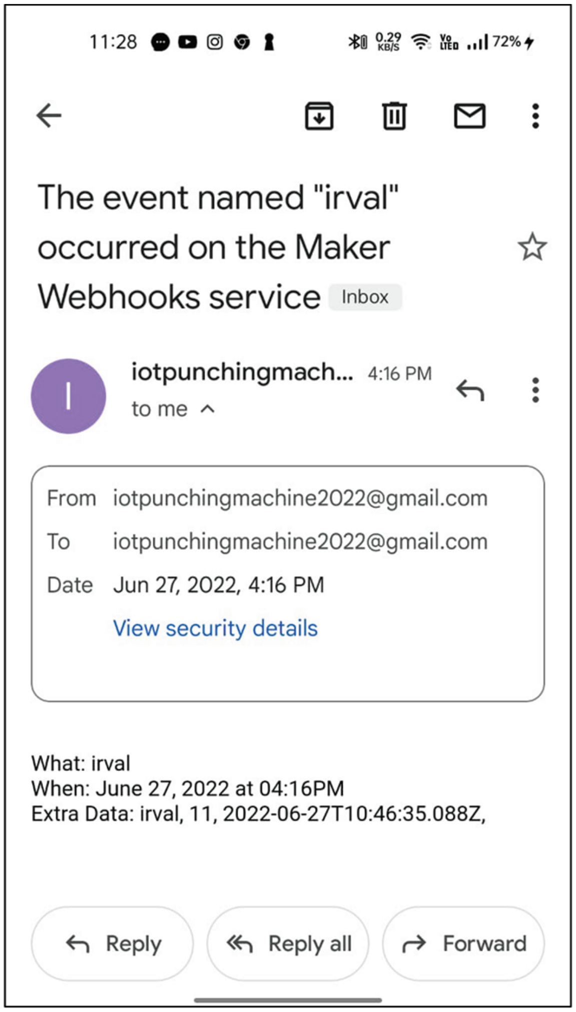


**Figure 7:** A notification of production value is received through E mail

## 4.0 Conclusion

A development of an IoT-enabled sheet metal punching machine is carried out. The main aim of this project is to develop an IoT-based pneumatic punching machine that is capable of monitoring the production parameters of the pneumatic punching machine through an easily manageable web interface. The sheet metals are punched by the piston of the double-acting cylinder and the IoT embedded system receives the data from the IR sensor and transfers it through mail or phone accessing the internet. The data received from the IR sensor is received by the microcontroller in binary form and that is converted to digital form to mail and mobile application through the cloud. This helps in monitoring the production value in real-time and also helps in increasing the storage capacity.

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