

# Drilling Deviation Detection System Using Laser Beams

Mostafa Atashpoosh, and Alimorad Khajehzadeh, *Department of Mechatronics Engineering, Faculty of Engineering, University of Islamic Azad, Kerman Branch, Kerman, Iran.*

**Abstract—** Considering the extraordinary importance of retrofitting of historic and residential buildings without strength, the key to the role of drilling in columns and walls is clearly visible in this technique. Factors such as aggregates, alloy, and the quality of drilling equipment and human error can cause deviation in the drill path. Previous researches in this area each have certain weaknesses, such as inefficiency in magnetism environments. In this research, we have tried to use laser beams in addition to detecting possible deflection, the amount and direction of it to inform the system operator and design the system in such a way that the limitation of use in magnetism environments completely removed and the relationship of parts Rotating and fixed through radio waves and fsk modulation.

**Index Terms—** Drill deflection, laser, retrofitting, radio waves, fsk modulation.

## I. INTRODUCTION

THE country of Iran is one of the oldest civilizations in the world, and in terms of architecture and engineering of the building, both in the pre-Islamic period, especially in the Sassanid era and after Islam, there have been masterpieces, some of which remain today. It is one of the most valuable cultural heritage of our country and it is important to preserve these works from the natural disasters, especially earthquakes. The strength of ancient monuments against earthquakes is not easily estimated, and it is not possible to obtain a certain degree of certainty in this regard.

Given the great cultural importance of ancient monuments and the unconditional certainty of being treated during an earthquake, it is necessary to strengthen them. Reinforcement is applied to prefabricated buildings. Essentially, for buildings under construction, it is necessary to observe the technical rules and regulations, and retrofitting does not have any particular meaning.

The use of the old nuclear augmentation method has also been considered by civil engineers. Using available drilling tools, they built drill holes in the body and carried out the next steps. Due to the historical and religious significance of these buildings, the slightest error in retrofitting these buildings is by no means accepted.

For this reason, the urgent need is for a system that is able to detect possible deviations in such drills. In addition to

detecting the system deviation, it must be able to determine the direction and the amount of deviation at the moment. During the research phase, we have tried to examine the practical and yet simple way of designing and constructing the system.

## II. INTRODUCTION TO BASIC CONCEPTS

In this section, we first discuss the stages of retrofitting the historical works and then introduce the nuclear reinforcement method, and then discuss the advantages of using this method, the implementation and the existing systems for detecting the deviation that is being used.

### A. Steps to perform retrofitting in historic buildings

- Collection of construction site information: includes information on bed and foundation.
- Collection of information about the building: Information about nearby buildings such as the survey of the presence of common members and the pathology of adjacent structures.
- Collecting information about the structure: Material information, barrier walls, system mechanisms, slabs, joints of joints, joints of non-structural members. [1-2]
- Proper and accurate analysis to determine practical solutions.
- Provide retrofit design.
- Estimated Costs.
- Implementation of the rehabilitation plan.

### B. Nuclear reinforcement implementation method

In this way, the locations identified for the application of the element with special drills are perforated in the form of vertical holes, and the element made of GFRP or CFRP bars is inserted into the cavity. The diameter of these holes is about 10 cm and the diameter of the FRP bars is about 8 mm. These holes extend to the inside. After inserting these rods into the holes, the rods are closed from a cavity plate and the rods are closed by using special expansion joints. It is then injected into the cavity using a cement injection molding machine. Mortar infusion continues until the mortar overflows and exits all empty spaces within the member. [3]

#### B.1. What is FRP products

Fiber reinforced polymeric fibers (Fiber Reinforced Polymer / Plastics) can be used to repair, enhance and improve various types of concrete structures with surface mounting (slabs, beams, columns, walls, fences and foundations) and in

residential, office and commercial buildings. Industrial buildings, car parks and heavy facilities, water structures such as dam, canal, calvert, etc., bridges and railways, reservoirs and water and liquids, silos, and cooling towers. [4]

### B.2. Composite Fittings (FRP BAR)

FRP fittings or reinforcement are similar in appearance to similar shapes (Fig. 1), but in their production, instead of steel, they are made of special polymeric resins and fibers (typically these fibers are made of glass and carbon and have more resistance than steel Are used). It can be considered as a good alternative to steel bars in the role of a concrete weapon, and there are many projects that have been using this product. [5]



Fig. 1. Composite fittings.

### B.3. Some Advantages of Nuclear Enhancement

- The core of the member is strengthened so that the worn out mortar is replaced without proper destruction and removal from the inside with a suitable mortar.
- Increase the resistance of the building walls against internal forces and external forces.
- The decorative features and appearance of the member architecture are preserved.
- The amount of destruction in the building will be much less than other methods. [6, 3]

### C. Use the Measurement and Measurement Tool called Devy Shot

This is a commercial product manufactured by Devico (Figure 2). Due to the commerciality of the above plan, there is not much information on how it works in the researchers. The function of the system is that a spring-loaded tube with a sensor that passes through the cavity after digging. Information is transmitted and the signals obtained through Bluetooth technology are transmitted to a specific receiver that is similar to a mobile phone. [7-9]

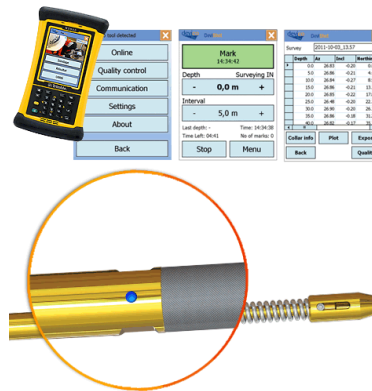


Fig. 2. Measurement and Measurement Tool called Devy Shot.

The use of the system also has major constraints, which in some cases makes it impossible to use it. One of the most important ones is the ineffectiveness of magnetism. If most of the sites that need to be retrofitted are adjacent to one of the magnetism elements (Fig. 3). The tool is designed in such a way that it is possible to use it after drilling operations; in other words, it cannot be determined before the cavity is created or probable deviation occurs. The existence of this defect is severely compromised, which in no way is likely to lead to a deviation in the structure.



Fig. 3. Magnetism elements.

### D. The main components of a drilling system with automatic deviation detection capabilities

#### D.1. Supply Force Operator

The required force is usually provided by electromotors or hydromotors (Fig. 4). Hydraulic motors or hydraulic motors are one rotary device. Hydraulics have the ability to increase power during transmission and change direction fast. Because the hydraulic transmission of energy is carried out with the aid of a hydraulic fluid, the fluids are generally flexible and can be passed through arbitrary paths. [10-11]

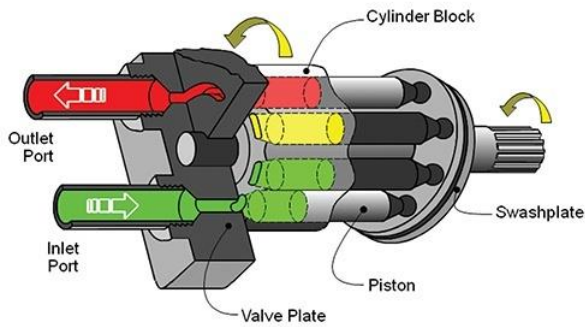


Fig. 4. Hydromotors.

D.2. Rotary force operator to drill

The force generated by rotating operators must in some way be transmitted to the tip of the drill, which is the final operator of the system. Hollow metal pipes called rads can be used for this purpose. Rads have the task of transferring rotational force around the axis from the output of the power converter to the main part. [12]

III. E. MATERIALS AND METHODS

The design and construction of the above system are divided into three parts. Each section has a schematic map, a PCB map, and two sections with a separate program. All sections on the side lead to the correct operation of the system. [13].

A. Installed section at drill tip

This part (Fig. 5) contains a customizable adjustable laser diode supplied by a lithium polymer battery. This PCB fiberboard should be designed in such a way that the laser beam is focused precisely on the center of the radians.



Fig. 5. Section at drill tip.

B. Section Installed in Primary Rod

This section is designed to detect deviations with the aid of 15 \* 15mm square laser receivers that cover the cross-section of the radial mosaic. The output of the laser receivers is converted to digital values by analogue to digital converters, in this section information is transmitted through radio waves out of the rad (Fig. 6). This fiberboard design has been designed in such a way that two separate circuits are connected to the socket.

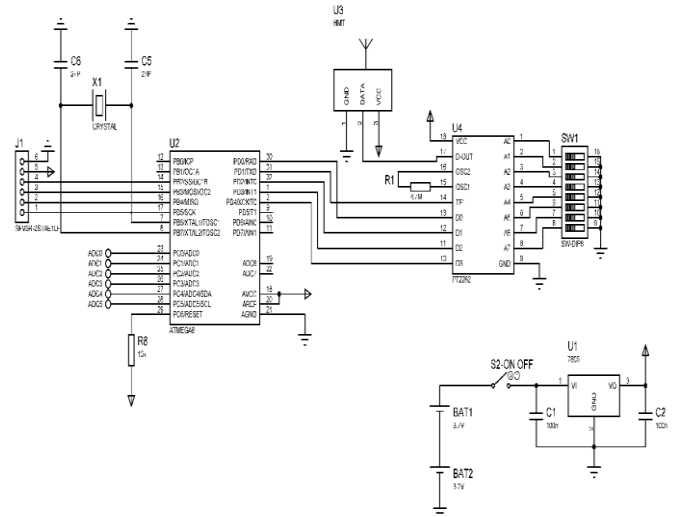


Fig. 6. Section Installed in Primary Rod.

In order to communicate one-way radio with the environment outside the HM-T telecommunication module. Sending a signal in this way is carried out in such a way that with 12 position status addresses, the system is able to send 531443 separate channels of information.

C. The main part of the system

This section can be referred to as the main section of the system, this part is installed outside of the rails and receives the signal sent from the primary radius, and after transferring to the processor of this section and processing the information, the amount of deviation and its direction also The display is shown to the user. The information received in this section is received by the HM-R module. The receiver's encoding codes must be exactly the same as the sender's side so radio communication is established (Figures 6 and 7).

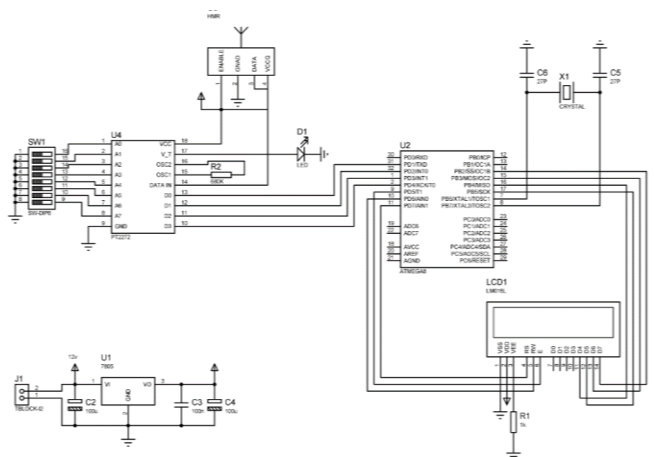


Fig. 7. Main part of the system.

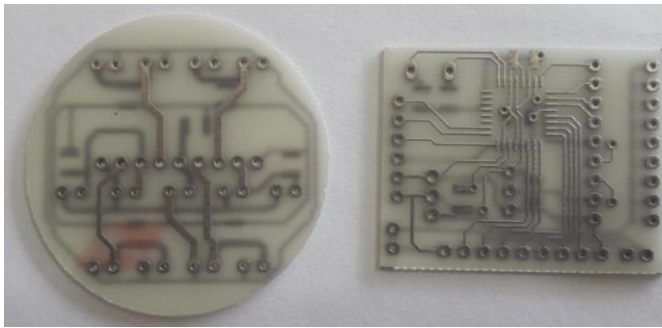


Fig. 8. Main PCB of the system.

#### IV. CONCLUSION

Taking into account the background of the design and similar items, a new system has been designed and constructed that in addition to detecting the deviation, the rate and direction of the drilling path using simple and inexpensive techniques can be the biggest fault of previous systems, which inefficiencies in magnetism environments to be completely eliminated. Because of the insertion of the system into drill rods, it can also be used in tight span holes (Fig. 8).

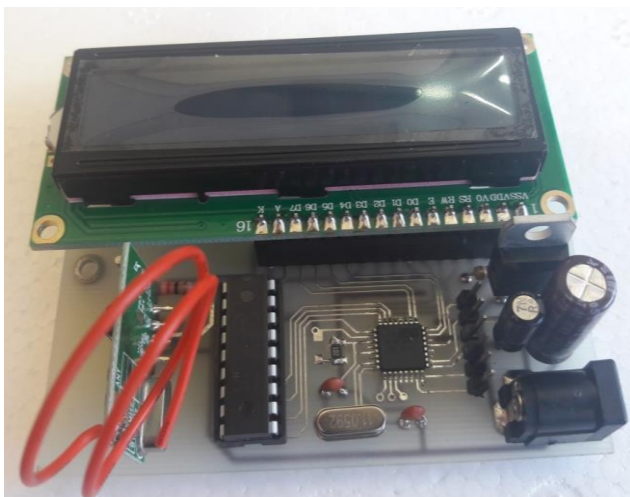


Fig. 9. Main board.

#### PROPOSALS

In order to correct and optimize the above mentioned system, it is possible to record better results from changes in the way communication between the radio system and the use of Bluetooth protocols and the use of photovoltaic cells instead of laser receivers.

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