DEPTH ESTIMATION OF A CLAY-MADE HOME USING MACHINE LEARNING APPROACH

BY

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/internship titled **"Depth Estimation Of Clay-made Home Using Machine Learning Approach"**, submitted by Md. Imon Bhuiya, ID No: 161-15-6973to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 06-12-2019.

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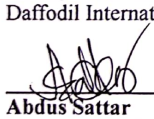

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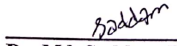

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We hereby declare that, this project has been done by us under the supervision of **Md. Azizul Hakim, Lecturer, and Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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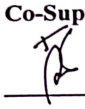

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ABSTRACT

Depth Estimations a crucial technique to get rid of sudden failure of a Clay-Made Home. It can happen for many reasons such as poor construction, temperature changes suddenly, extra loaded etc. Automatic detection of cracks is an important task to maintenance for safety life. It's a challenging task due to intensity of cracks and complexity of the background. A supervised deep convolutional neural network is trained to detect the cracks. After that Naive Bayes is used to calculate the depth based on height and width .For research here I have taken 600 images of size 720*480, collected by smart phones. Manual crack detection is takes more time and accuracy is low. It is one of the simplest way to detect a crack and estimate the depth. It is very important to detect and estimate the Depth. If we cannot detect the crack, crack will make a serious damage. The objective of this research is to develop a simple model based on crack image. Firstly, Ihave taken cracked images, after that prepressed the images. Prepressed images convert into Gray images and improve contrast.

TABLE OF CONTENTS

CONTENTS

PAGE

LIST OF FIGURES

FIGURESPAGE NO

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Cracks are one of the most serious defects in Clay-made home. It occurs for many reasons. Main reasons are due to shrinking, earthquakes, low quality of construction, poor construction knowledge, changing weather condition, porosity and over loaded. A huge amount of water absorb by the mud partials. During the time of formatting wet to condition the volume of mud shrinking by the evaporation of water which are absorb by the mud partials. Different types of cracks can be seen in the clay-made home, but not all cracks cause damage. Some cracks that are too small, which do not damage the house now but can do later. Particularly large cracks cause more damage to the house. Consequences of cracks in our houses are low strength infrastructure, low durability, low sustainability, increase cost for repairing and many others. We will first identify a fracture with this system. Later measure the height and width of the cracks. We'll find out the depth through the height and width. Merazi-Meksen et al. [1] have demonstrated a model to detect the crack by ultrasonic sensor and characterized the cracked structure. The hyperbolas were used to detect the crack position and Randomized Hough transform is used to detect the crack. But they did not measure height and width. Rodriguez Matrin et al. [2] used Infrared (IR) thermography method based on image processing. It detects the cracks and geometric characters. PatrikBroberg et al. [3] used Thermography. This technique is used in normal condition. But in heat condition it doesn't work. The drawback of this technique is if the depth is too long it is unable to give the accurate result. Yiyang et al. [4] have developed Threshold method to detect the crack in glass surface image. Then they calculate the area and perimeter of the roundness index to check the crack.

1.2 Motivation

We must sustain the Clay-Made home. Sometimes there are cracks in the clay made house for various reasons which are not auspicious. Overgrown trees and shrubs, cracked drains, leaking rainwater goods, Floods, storms, tides etc. To reduce the crack in clay made home we must take some step that decreases cracks. If cracks are not detected, it will carry larger size day by day. After that it will make a sudden failure. So, we should detect the crack. In rural area clay made home is common and popular so our system will be helpful for those people. Because of this many houses are broken down every year. As a result, people are losing interest in these things. By this system they can get a ride from this problem. By using our system we can detect the crack and calculate the height and width of cracks. Through our system we can detect the crack and calculate the height and width of cracks that can find out the solution to reduce cracks. So we want to relieve them of this problem. It will be possible to reduce damage any house. By our system maximum people will be benefited they can save their money and know the damage level before.

1.3 Rationale of the Study

The clay house is comfortable for the winter season and hot weather .so we think all kinds of people will take advantages via our system. People who uses clay made house they can be benefited by our system. Rural people take benefit by this system. Now -a -days many countries built their house with clay. Some people build clay made houses for refreshment.so they will be benefited through this system. By our system we can detect the crack of clay made house and the waste of money will be less. Floods, tides, earthquakes can cause damage to the clay made houses. If people can detect the previous cracks the next damage level will decrease. If we can detect the depth of crack previously, we can reduce the amount of damage, the loss of people home will be less during

1.4 Expected Outcome

Crack is a major problem for Clay-Made Home. Because it can cause a serious problem for later. So, detection a crack is very important to get rid of this problem. It is not possible for us to detect a small crack is in a vacant eye. It is also not possible to measure height and width. This system will help to get rid of sudden failure. Now a days we use it in various purposes. Some aspects come from our projects are given below. Its height and width cannot be measured.so, we have developed a system that can detect a crack from the image. Then it will measure the height and width in pixels. After that it will calculate the depth on base of height and width. By this system we can reduce our valuable time. This system also save money for rural area people who live in the Clay-Made home.

1.5 Report layout:

Chapter 1: Introduction

In this part we explain about introduction, motivation, Rationale of the Study, research question, expected outcomes, report layout of this project.

Chapter 2: Background

We will discuss background part in this chapter. We will explain introduction, related works, research summary, scope of the problem, challenges of this project.

Chapter 3: Research Methodology

In this chapter we include overall procedures that we have used to build this proposed system. Methods are explained here step by step.

Chapter 4: Experimental Results and Discussion

In this section we have discussed about the Experimental Results and Discussion.

Chapter 5: Summary, Conclusion, Recommendation and Implication for Future Research

In chapter 5 we have discussed about Summary, Conclusion, Recommendation and Implication for Future Research.

CHAPTER 2

BACKGROUND STUDY

2.1 Introduction

Depth estimation for clay-made home where we have developed the system by using OpenCV and python language. It enables to detect the crack and measurement height and width. On the basis of height and depth we estimate the depth using Naïve Bayes classifier. Using Naïve Bayes classifier we can predict the depth.

For developing our system OpenCV is used for crack detection. An open source computer vision library namely OpenCV is an open source platform that everyone can freely use the library. OpenCV is built by using of C++ and its basic interface is in C++ but there are capturing Python, Java and MATLAB. OpenCV, generally, may provide two methods for have to know the height and width and location the crack.

Crack process is categorized into two steps which are crack detection and estimate depth. Crack detection generally holds some rules like position of the crack. We collect and note information about height, width and depth of the image. Some particular issues are faced by the process of crack detection. During imaging for incommodious situation create a problem to differentiate foreground from the background. We use a larger and better training samples for the resolution of this problem. This proposed method based on the use of RGB camera without complex information and cannot distinguish a real crack. In this cause, in this process, an ordinary camera cannot testify a real crack.

2.2 Related Works:

Merazi-Meksen et al. [1] have demonstrated a model to detect the crack by ultrasonic sensor and characterized the cracked structure. They have described sparse matrix for alternate the image information. They used TOFD image processing technique. The hyperbolas were used to detect the crack position. Randomized Hough transform is used

to detect the crack. This method describes the human intervention. In future they want to perform the SSP method for two close signals.

Rodriguez Matrin et al. [2] used Infrared (IR) thermography method based on image processing. It detect the cracks and geometric characters of the cracks. This method predict the crack point. The main advantages of this method is that it makes accurate result.

PatrikBroberg et al. [3] used Thermography. This technique is used in normal condition. But in heat condition it doesn't work. This method is easier than other methods by using Flash map. The resolution of an image is 64*512 pixels. Artificial method and Real Surface method is used. 12 crack images is used to detect the crack by this method. It was successful to detect all the cracks. But in the heat condition it doesn't detect the crack. The drawback of this technique is if the depth is too long it is unable to give the accurate result.

Yiyang et al. [4] have developed Threshold method to detect the crack in glass surface image. This algorithm works based on digital image processing technique. By this technique the observed image segmentation and feature extraction. Then they calculate the area and perimeter of the roundness index to check the crack.

Adhikari et al. [5] demonstrated an open model they represent the crack numerically. They model has two parts first they detect the crack and classify the characters of the crack. They calculate the width of the crack and then compare it with the actual width.

Alam et al. [6] have used digital image correlation and acoustic emission technique to calculate the cracking reinforced concrete. DIC and AE techniques were used by the author. They get exact measurement of the surface displacement. For getting the accurate result they used the acoustic emissions result. K means method was used to identify the different the different types of cracks.

Iyer et al. [7] proposed a robust approach for automatic crack detection and segmentation. This paper presents three types of technique. They used morphology and curvature evaluation to detect the crack.

Will S. M. Brooks et al. [10] proposed a method of crack detection in crystalline Si solar cells and it is a real-time based project. In this method 7.5-13-μm wavelength used to detect image of the source specular reflection of an IR. Norma local surface and phenomenon the appearance of a crack shifting taken by IR thermal image. The system has been found in visible wavelength. Experiment environment and technical equipment found to detect to temperature range. They used silicon (Si) wafer-based photovoltaic (PV) whiff to manufacturing and the module cost 40%. In 2013 they installed PV retention of 37 GW and protective cell defect rate which is 5% equal to 0.5 billion Si cells that would be essential to defect detection. They used four Crystalline Si solar cells to photographs and analogous long wavelength infrared (LWIR) thermal images.

D. Dhital& J.R. Lee et al [11] they appeared a novel completely non-contact crossbred ultrasonic propagation imaging (UPI) system that usually used to scanning incentive and piezoelectric air-coupled learning. To compost damage shape they used ultrasonic frequency tomography and wavelet transformed ultrasonic propagation algorithms and to demonstrate their experimental result they used air-coupled transducers (ACTs) for hybrid UPI system. Wavelet-transformed ultrasonic propagation imaging (WUPI) algorithms successfully substance the defect-sensitive form and used to de-noise ultrasonic signals and material sensitivity.

FábioCelestino Pereira et al [14] proposed a method use of Unmanned Aerial Vehicle (UAV) in civil construction autonomic review of building impassioned and they implement substitute of image processing algorithms for cracks detection in building facades. Image processing algorithms for crack detection and ramification were choose different embedded computing by UAVs and also used MATLAB. To capture image and video they

used RUAVs to track individual target objects. The primary idea was to raise the C / C++ and VHDL code used similar MATLAB toolboxes like CODEGEN C and CODEGEN HDL.

Cuixiang Pei et al [15] proposed a method on surface crack in first wall (FW) it is very important to fusion reactors. This paper laser impatient thermography used laser spot array for surface cracks imaging and appraisal in the FW and it can reconnoiter relatively large area at one mensuration. To inquire the method a numerical code risen on finite element method (FEM) developed to heat flow and crack geometry thermal images wave fields. Laser spot thermography (LST) used to laser produce a highly localization heating spot and infrared camera to detect the heat distribution and also they used consecutive (NDT) method. They simulate crack step by step.

Hiromi Shirahata et al [18] on this reports based on frazzle cracking of steel bridges, particularly old bridges such as construct in the 1970s. Here they biased between frazzle crack and weld defects by ultrasonic non-deleterious test and ultrasonic elements was set up by repercussion height were surveyed. Crack localized was successes when subtraction of the captured images are encumbrance and non-loading situation. They used tandem array ultrasonic testing system made of same piezoelectric pottery and the frequency was 5MHz and angle revocation was 70 degrees. They used 230,000 circles, image reformation of crack point to detection.

Talab et al. [22] have used a new method for image processing. Their method has three parts 1st parts is convert the image to Gray images, 2nd part is used Sobel's method to detect the crack. After that they used threshold method. Sobel's filtering used to remove noise. Then they used ostu's method for detecting the crack.

TABLE 1: COMPARISON TABLE

Author	Feature	Method
1. Merazi-Meksen et al.	Ultrasonic inspection	Randomized hough

2. Rodriguez Matrin et al	IR image rectification	Photogrammetric technique
3.Patrik Broberg et al	Infrared thermography	Reconstruction technique
4.Yiyang et al	Image pre-processing technique	Photogrammetric technique
5. Adhikari et al	Image based retrieval	Morphological approach
6.Alam et al.	Image correlation and acoustic	PA technique
7.Iyer et al	Robust Approach	Digital image correlation
9.D. Dhital& J.R. Lee et al	Non-contact ultrasonic	Wavelet transform
10.Fábio Celestino Pereira et al	Using UAVs	Percolation

2.3 Research Summary:

We gave an effort to gather as much knowledge as we can regarding project. We almost followed every paper written on Crack detection and depth estimation.

We studied almost hundreds of papers written on Crack detection and depth estimation. Then we selected the papers need. We then thoroughly read the papers again and again to understand the core things. Tried to make the summary of each and every paper to make it easy for us. We can recall some papers as an example to make it clear.

We took the help of about 20/25 papers to reach our ultimate goal. We gathered the knowledge, analyze them and then applied in our project. These studies were a must for us. We wouldn't be able to come this far without the help of these papers.

2.4 Scope of the Problem:

The clay house is comfortable for the winter season and hot weather .so we think all kinds of people will take advantages via our system. People who uses clay made house they can

be benefited by our system. Rural people take benefit by this system. Now -a -days many countries built their house with clay. Some people build clay made houses for refreshment.so they will be benefited through this system. By our system we can detect the crack of clay made house and the waste of money will be less. Floods, tides, earthquakes can cause damage to the clay made houses. If people can detect the previous cracks the next damage level will decrease. If we can detect the depth of crack previously, we can reduce the amount of damage, the loss of people home will be less during.

2.5 Challenges:

Our project "Depth Estimation Of A Clay-Made Home Using Machine Learning Approach" is very challenging work for us. In our system we have to detect crack and measure the height and width as well which is very challenging for us. To detect a crack in a proper way we need image perfectly which is more challenging for us.

Requirement

Creating a dataset by saving captured crack images. Showing Crack proper information which is detected is so challenging that we had needed the proper images features for detecting. We also need a dataset in csv format. Dataset has also Id, height, width and depth.

Time Scheduling

Time scheduling refers to a set of techniques used to develop and offer schedules that says when the whole work will be done. Our main concern was about time scheduling to complete this project in the meantime. If the experiment was not prepared on time it will be a big trouble for us. We divided our working time and project work among us to complete whole projects.

Cost reducing

Every decision in project development affects cost so it was another challenging task to reduce cost and increase our profits.

Increasing Communication

During the time of developing our project we had faced many questions. For achieving solution we communicated with supervisor and cosupervisor. In this case, increasing communication, it was a little challenging for us.

Skills for the projects

Required skills to complete our whole project work were taken properly.

CHAPTER 3

METHODOLOGY

3.1 Introduction:

To make something properly work we need to research on that particular topic. If we do a proper research on a particular topic then it becomes easier to make it work.

Research methodology is something like that.

In the previous chapter we discussed about the related works of face detection and estimate the depth. We have also explained about some difference types of procedure that were used in previous. In this chapter we will discuss about our procedure that we have used to develop this system. When we study about related works of our system then we came to know about some difference algorithm which can be developing crack detection and estimate the depth. After that study we decided to select a specific algorithm. We used Threshold method, ousts method and Naïve Bayes Classifier.

We tried our best to make a proper research on the methods. It helped a lot to build our system and make our project happen as we wanted.

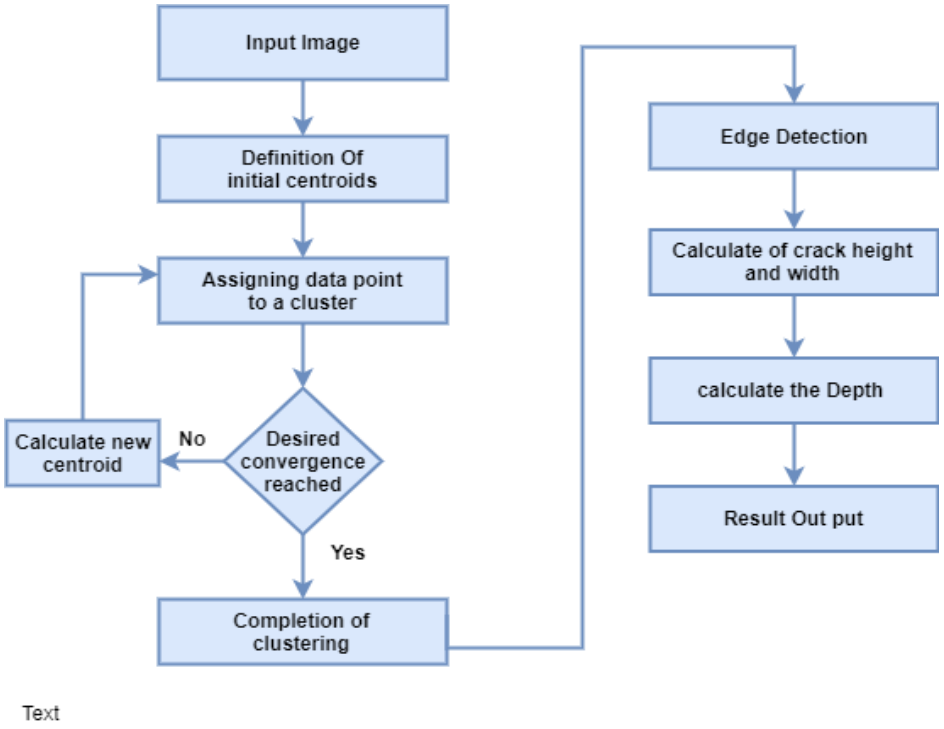


Figure 3.1: Flow chart diagram of whole system

3.2 Research Subject and Instrumentation:

In our system we detect a crack and estimate the depth. We need a crack image dataset. We also need a CSV format dataset. Firstly, we crack image to detect the crack. After that we will measure depth using Naïve Bayes classifier.

3.3 Data Collection Procedure:

We want to solve a problem we need to collect data on this problem. We face a problem then we discuss about it. When we saw that data is available then we collect data. After that we analyzed the data.

At first we need to find a crack. Then we measure height and width by a scale. We also measure the depth with sonar sensor. After that we input the height, width and depth in our excel sheet. Finally, we take a photo by smartphones. We collect 800 images.

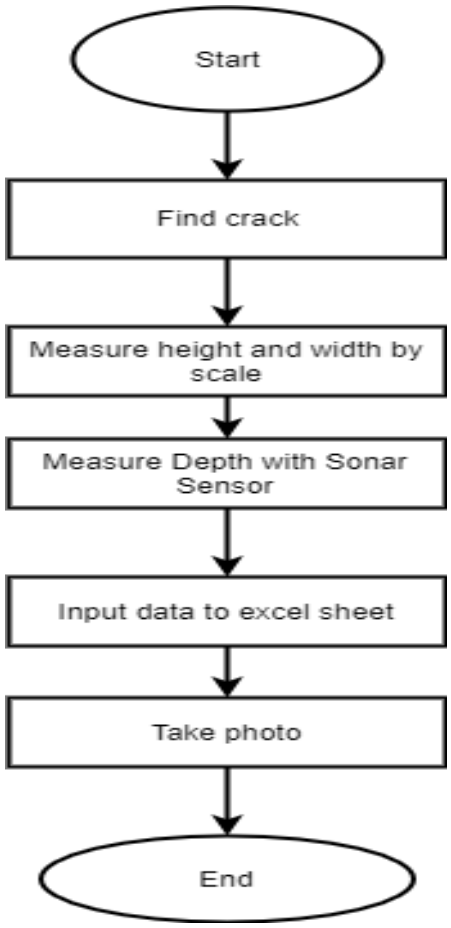


Figure 3.2: Flow chart diagram of data collection

Figure 3.3: Cracked Image

3.4 Statistical Analysis:

Statistical analysis means represent the data in figure. For statistical analysis we calculate the average, minimum and maximum value of height, width and depth in the following figure.

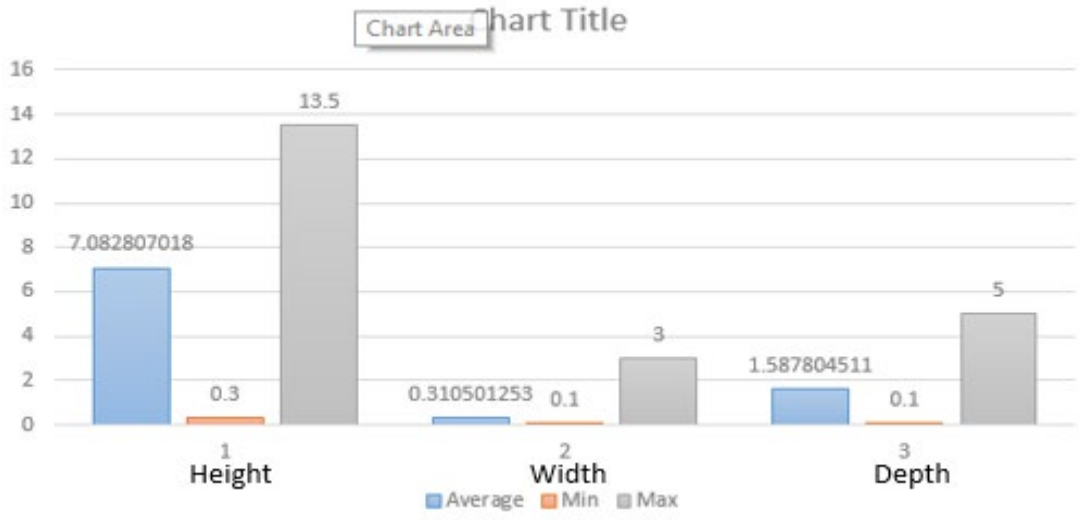


Figure 3.4: Height, width, Depth (Average, minimum and maximum)

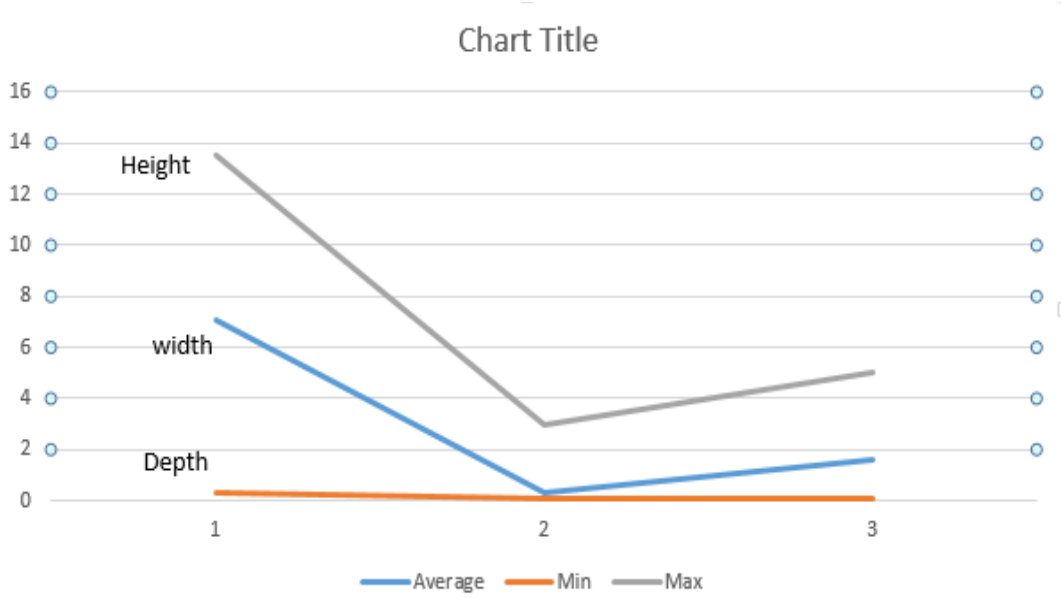


Figure 3.4.1: Height, width, Depth (Average, minimum and maximum)

3.5 Implementation Requirements:

Implementation requirements means the software and hardware tools we need to build up this project. It was one of the hardest parts of our work. To manage the parts were most challenging actually.

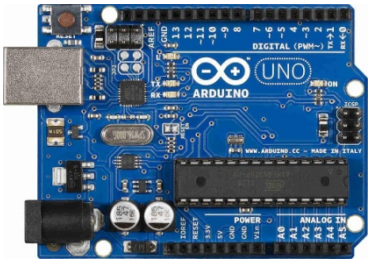
The software related things we needed are:

TABLE 3.1: EQUIPMENT TABLE

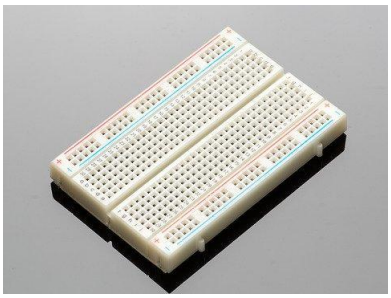
Software Name	Description	Functionality	Figure
Python	Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. [21]	Python is a multi-paradigm programming language. Object-oriented programming and structured programming are fully supported, and many of its features support functional programming and aspect-oriented programming (including by metaprogramming and met objects (magic methods)). Many other paradigms are supported via extensions, including design by contract and logic programming.[21]	

Anaconda Navigator	Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. Package versions are managed by the package management system conda. The Anaconda distribution is used by over 15 million users and includes more than 1500 popular data-science packages suitable for Windows, Linux, and MacOS.[22]		

The Hardware related things we needed are:

Device Name	Description	Functionality	Figure
Arduino Uno	The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the	We use the Arduino Uno in our project to connection with Sonar Sensor.	

	USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. [23]		
Jumper Ware	A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.[24]	We use jumper ware to connect devices to each other.	

Breadboard	A breadboard is a construction base for prototyping of electronics. Originally the word referred to a literal bread board, a polished piece of wood used for slicing bread. In the 1970s the solderless breadboard (a.k.a. plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these.[25]	We use Breadboard to connect devices to each other.	
Bluetooth module	Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in	We control sonar sensor by Smartphone.	

	the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables.[26]		

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction:

Experiment is the most important part of any kind of work or invention. No work can be done perfectly at its first attempt. First it needs to be experimented. From experiment we can find out if there is something wrong with the project. We can find out the problem and fix it.

Experiment gives us the opportunity to make any work, project or invention perfect.

We made experiments with our device. During the experiment many things happened. At the beginning of the experiment we found out that our device is getting heated.

Indeed, we faced problems with almost every part of our project. So, experiment gave us the chance to fix all the problems we were having. If the experiment did not take place and everyone supposed to present their project or any kind of work, they did at the first attempt then almost all the works would be collapsed.

4.2 Experimental Results

The experiments we made with our device gave us some results. We analyzed the results, measured them and make sure that the final outcome come out correctly. As there is no equational measurement in our project so we are trying to give the results briefly.

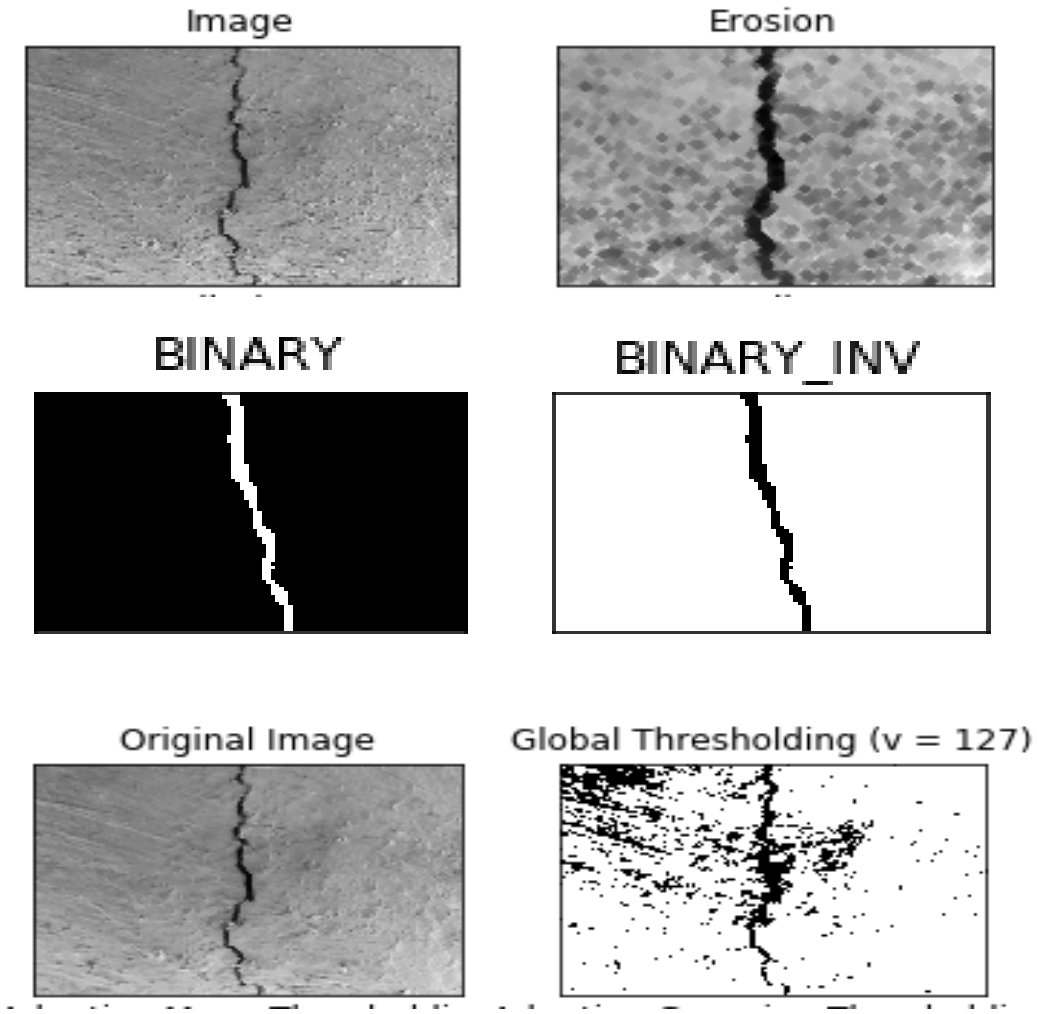


Figure 4.1: Crack Extraction

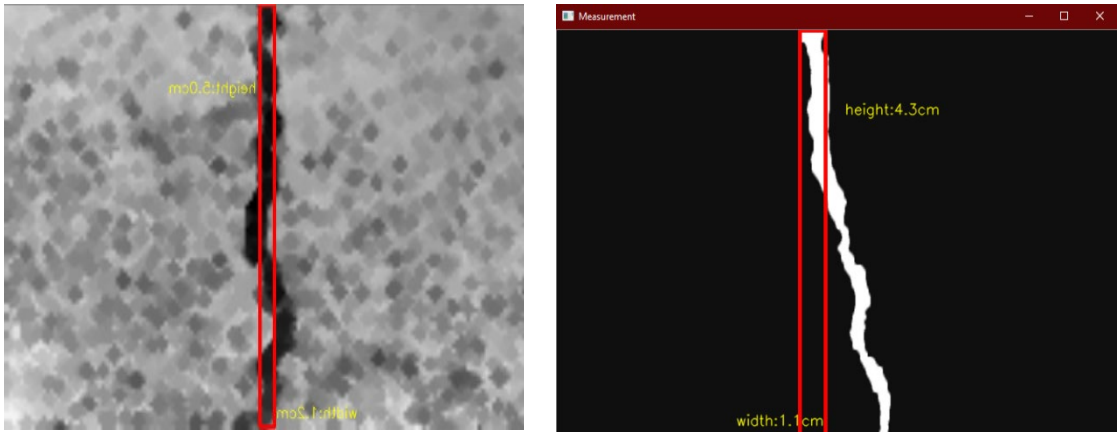


Figure 4.2: The results of crack height and width measurement

4.3 Descriptive Analysis:

In system we have developed a system that will detect a crack and estimate the depth on the basis of height and depth. Here we take a crack image as input. Our system will detect the crack first. After that it will measure the height and depth. Finally, it will show the depth.

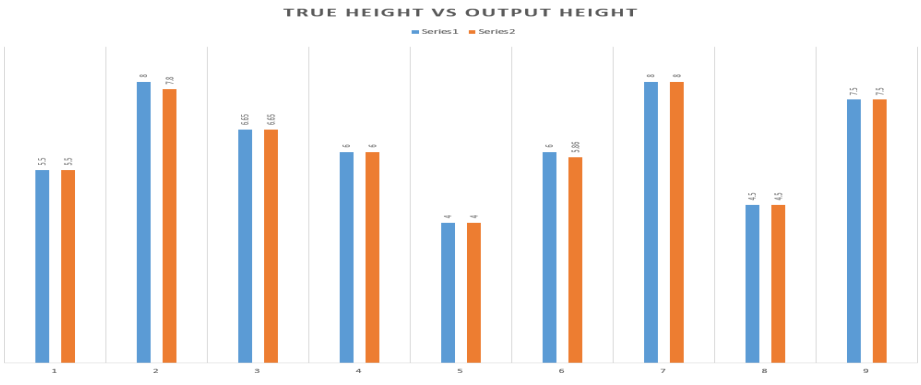


Figure 4.2: Graph of True height Vs Output height

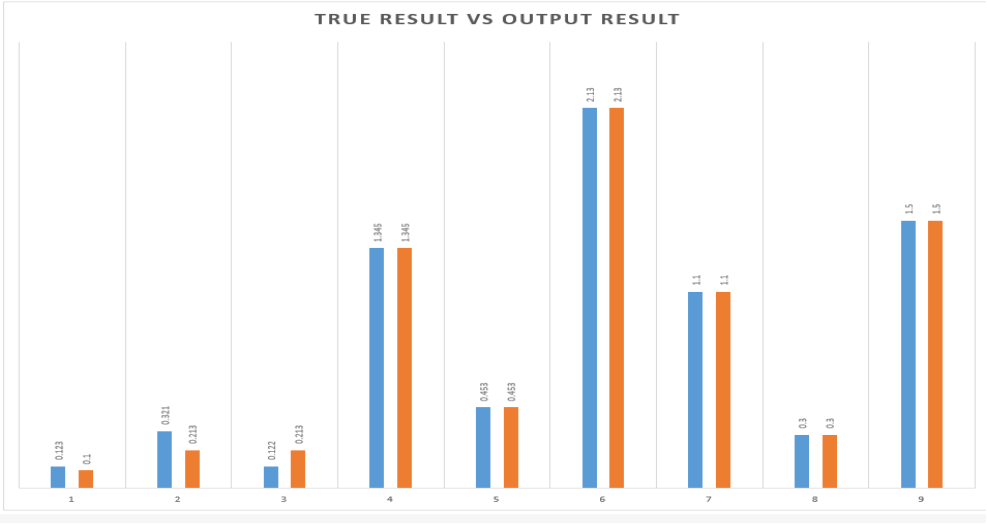


Figure 4.2.1: Graph of True width Vs Output width

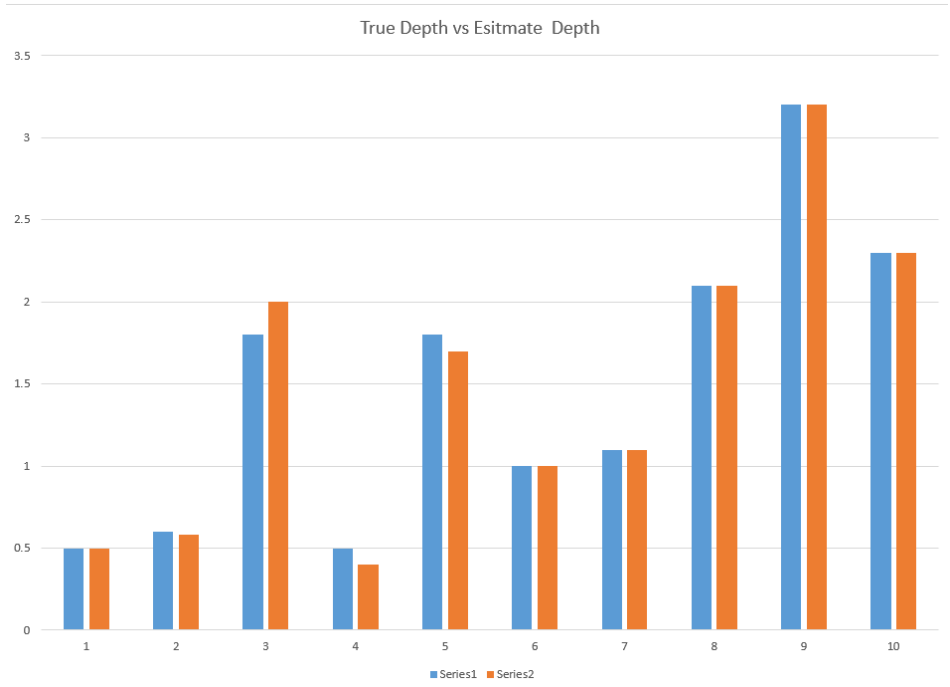


Figure 4.2.1: Graph of True Depth Vs Output Depth

At first we need to take input. To the input we need a crack image. Then it will convert the image to RGB images. After that we will apply Pixel calibration to increase the resolution

of cracked area. We will remove crust line. We will apply Threshold to detect the crack. Gaussian filter.

4.4 Summary

There is a saying by an English poet named William Blake “The true method of knowledge is experiment.” So, the more experiment happens the more perfection takes place. Nothing is perfect in the world at the beginning. We make sometimes perfect. And to make something perfect we need to work on it. Try with the project/ product or that can be something else if that is at the beginning stage, we need to make that we are working hard on it. Only then a god will come out.

Here we tried to give our projects experimental instructions properly. We tried to explain how experiment works and how works experiment and how it affects any work.

Then the experimental results, it shows the way of perfection to any work.

No one can just take birth and run. First, he needs to learn how to crawl. Then he learns standing, then walking and then he finally learns to run.

Just like the above example this experiment, its results and the discussions show us the steps and way of perfect.

Chapter 5

SUMMARY, CONCLUSION, RECOMMENDATION AND IMPLICATION FOR FUTURE RESEARCH

5.1 Summary of the Study

In this whole process of our work we learned such things we had no idea before. Before this project we had a little idea about Depth estimation of clay made home. We just knew it like an image processing technique. But it plays such a huge role for the people who live in the clay Made home. We came to know about all this after working on this project.

In this project we worked with quite a lot of software and hardware. We were not well aware of all these before.

We actually started working with this project knowing almost nothing. We just aimed to do the project properly at any cost. So, we started working and slowly started to discover about the things we need. One of our parts were not even available in our country. We somehow managed it from internet.

So, here in our whole project report we tried to explain about what we are doing in our project. We made it clear that we developed a system which is able to detect a crack and estimate the depth.

We described our working procedure, methodology, and the problems we faced to do this project. We have analyzed our work and made experiment with this system to make it perfect.

5.2 Conclusion

In this research work, we have analyzed and tested with the required rules necessary for our project. As there is no such a project like this, People are less known to this kind of things. We have to make sure that people are understanding what we are presenting, how perfectly this works.

The people around us used to think that clay made is a useless think things. But it is not true. Clay made home is useful for many reasons.

That's why we want to decide that we developed a system that will detect the crack and estimate the depth.

5.3 Implication for Future Study References

Depth estimation is a kind of topic that everyone is not aware about it. It’s getting blowout day by day. It’s really nice to see that people are now starting to think about it. The system we made is especially for the clay made people. It will help them in many ways. It will make their daily life much easier than before.

As this is our first made system so there are some lacking in it, we feel. We have some planning with these systems in the near future.

This system is now a model. We are using it as prototype. We want to improve it in the future. A fully functional well wrapped system we will be out there.

We want to develop a mobile application for the future. So, rural people can us

We’ve got these few ideas and features for our project. We couldn’t do it now because of the shortage of time. And also, for the shortage of funding.

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