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A real-time prototype of a water level monitor and wide area early flood warning

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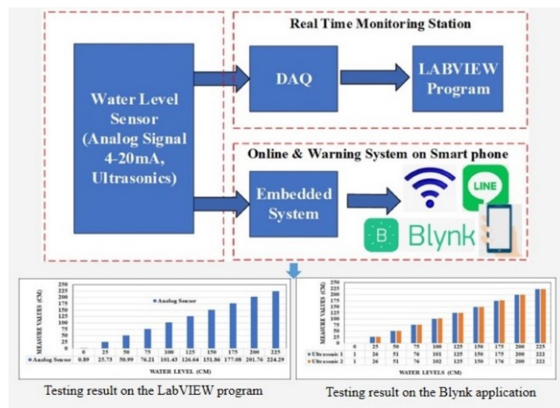
Abstract

This article presents a real-time prototype of a water level monitor and wide area early flood warning. The prototype consists of two systems: the first is designed to provide real-time display and alarm alerts on a lab view program; the second is designed to measure water levels and display results via applications on a smartphone in real-time using the Blynk application, as well as to alert users of impending floods via the LINE application using Internet of Things (IoT) technology. The target user in this research study is Sado Phong Community, Khao Kho District, Phetchabun Province. This case study was designed for a stream with a water depth of 200 cm and a three-tiered alarm system: 140 cm, 150 cm and 170 cm of water height. The study results showed that when simulating each set level increase, the prototype could display real-time water level changes and give an alarm in both systems. The error value of the meter for the system displayed in the lab view was ± 1.11%. In comparison, the error value for the system displayed via an application on a smartphone for ultrasonic sensor 1 was ± 0.60% and ultrasonic sensor 2 was ± 0.80%, including the ability to notify a group of community members via the LINE application.



Keywords: Real time; Water level monitor; Flood early warning system; LINE application

1. Introduction

At present, the news of natural disasters occurs very often, whether it is a flood, earthquake, the threat of pollution due to forest fires, or even the perils of the storm. The target area in this research study, the Sado Phong community area, Khao Kho District, Phetchabun Province, is especially natural disasters from floods. It is surrounded by forests, with small and large streams flowing in the area and the number of forests that have decreased. There is a risk of flash flooding if rains or storms occur in this area. While avoiding the rain is difficult, having a warning or alarm system can help prevent or mitigate unforeseen disasters. The researchers developed a flood warning system [1, 2] with wireless technology and a real-time flood monitoring and alarm system. In addition, [3, 4] water levels detection and impending floods SMS alerts were designed with [5, 6] notification system via LINE application and Internet of Things (IoT) system. Additionally, the researchers [7] applied the IoT system to detect water levels in conjunction with the LabVIEW programs, including [8] developed a LabVIEW program to detect water levels.

In this research, the design and development of a water level monitor were designed with a display on the LabVIEW program in combination with the Data Acquisition (DAQ) and displayed through a mobile application that featured a wide area flood warning system. Generally, there are two types of water level measurement sensors: contact liquid level sensor and non-contact liquid level sensor. A hydrostatic level sensor with a 4 – 20 mA transmitter which it is the contact liquid level sensor was used in this research and it was designed using the LabVIEW program. At the same time, a mobile display system used an ultrasonic level sensor, which is advantageous since it does not need to be in direct contact with the liquid. The flood warning system will alert through the LINE application on a smartphone using IoT technology, which that people in the area can receive information and set up members to send information to various responsible and mitigation agencies. Therefore, this is an advantage in mobile data transmission via the LINE application.

2. Materials and Methods

This research aimed to develop a system of instruments for early warning of flood disasters. The area in this research study is Sado Phong community area, Khao Kho District, Phetchabun Province. The research method begins with a survey of upstream residential or agricultural areas that may impact the community. Then, using the data to design the prototype of the disaster alert measuring instrument, investigate the internet signal transmission level [9, 10] and connect to the Wi-Fi signal in the Sado Phong Khao Kho community area, where the streams flow, to determine the point and suitable installation style from the actual site condition. There are 3 main steps in this real-time prototype of a water level monitor and wide area early flood warning system research: 1) Survey the watershed area in the Sado Phong community area. 2) Survey the internet signal level to connect to the Wi-Fi signal in the Sado Phong community area, which testing area for this study has the data upload rate in the range of 9.50 Mb s^{-1} and the data download rate is in the range of 43.54 Mb s^{-1}. 3) Design and build a prototype to alert the early flood through the LINE Application system, collect data, and summarize the research results. The schematic diagram of the research procedure and method is shown in Fig.1, and the working diagram of this prototype is shown in Fig. 2.

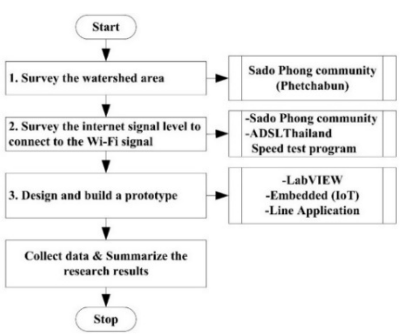


Fig. 1 Research procedures and methods in the studying.

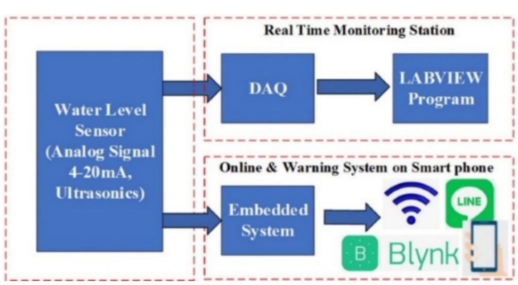


Fig. 2 The working diagram of a real-time prototype of water level monitor and wide area early flood warning.

From Fig. 2, a real-time prototype of a water level monitor and wide area early flood warning can are divided into two systems: The first system is a stationary water level monitoring system using LabVIEW. A hydrostatic level sensor with a 4 – 20 mA transmitter was selected for one DAQ to convert analog signal to digital signal for connection to a computer for processing real-time level values are displayed and alerted on LabVIEW program. The second system is the monitoring system on a smartphone, chosen to use the ultrasonic sensor due to the ability to measure the level of objects in liquid and solid state, which can measure the level of objects both in point and work without touching with liquid. In the study, two sets of ultrasonic sensors were used to compare the values and support the damage of the sensor device if one of them failed to work. This monitoring system on a smartphone was designed for real-time monitoring on the BLYNK application. Additionally, if the water level rises to a certain level, members will be notified through the LINE application, a broad area messaging system.

Survey the upstream in areas Sado Phong community

Survey of upstream and streams in the Khao Kho Ban Sado Phong community area, which the survey found that mountains would surround the community agricultural area. The survey found both reservoirs and small streams, size 1 – 3 meters wide and 1 – 2 meters deep, flowing through both community areas and agricultural plots in many areas. Moreover, Some streams have water flowing throughout the year. In the rainy season, it may overflow the banks at some point, as shown in Fig. 3.

Fig. 3 The streams that flow through community and agricultural plots.

Survey of internet signal levels in Sado Phong community area, Khao Kho, Phetchabun

For the internet signal level survey, a random survey was conducted to test the speed of the internet system in the Khao Kho Sado Phong community area and in the nearby community area for the notification usage, which was conducted in both of the community area, the agricultural plots, and the surrounding hilly areas. The measurement diagram is divided into 10 points surrounding Khao Kho Sado Phong community, as shown in Fig. 4.
The internet speed was tested with the ADSL Thailand speed test program. The testing results is shown in Fig. 5.

According to the results of this study, internet speeds varied significantly across areas. The data uploading is in the range of 0.75 – 16.08 Mb s^{-1} and the data downloading is in the range of 0.78 – 72.35 Mb s^{-1}. Therefore, from the study results, the suitable location for installation is in area 1 – 5, with a data upload rate of 1.95 – 16.08 Mb s^{-1} and a data download rate of 20.89 – 72.35 Mb s^{-1}. The study was installed to working test at point 1 because this area has the upstreams that flow through community and agricultural plots and this area has suitable internet speed with the data upload rate is 9.50 Mb s^{-1} and the data download rate is 43.54 Mb s^{-1}.

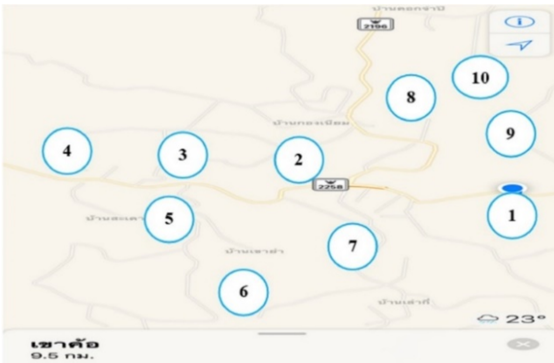


Fig. 4 Map of the survey of Internet signal transmission capability 10 points surrounding the Sado Phong community.

Design of water level monitoring system and early flood warning system

The prototype design can be divided into topics of study results: Model system to monitor the water level and give an alert with a LabVIEW program and a water level monitoring system with a mobile application with an early warning of the flood with the LINE application. The LabVIEW program is designed to work with the data acquisition NI6008USB module, which is designed to be used with a set of the hydrostatic level sensor (4 – 20 mA). If the measured value exceeds the value set in the system, it will send an alarm to the LabVIEW program screen. Two ultrasonic level sensors were utilized in the water level monitoring system with a smartphone application in the research, which used the Blynk application that works with the integrated ESP8266 and IoT technology. It can connect to a Wi-Fi signal to be used to transmit data and alert through the LINE application. In the program, the notification was designed into 3 levels as mentioned above. This is the number used for testing at the test point only. The altitude that may affect the community has to be checked as the area at each point has a different slope and these values can be changed. The operating circuit of the water level monitoring system with the LabVIEW program is shown in Fig. 6(a) and the display on the LabVIEW program is shown in Fig. 6(b). The smartphone display is shown in Fig. 7, the overall picture of the prototype test of the water level monitor and the flood alarm can be shown in Fig. 8(a) and the installation picture of the actual area measurement is shown in Fig.8(b).

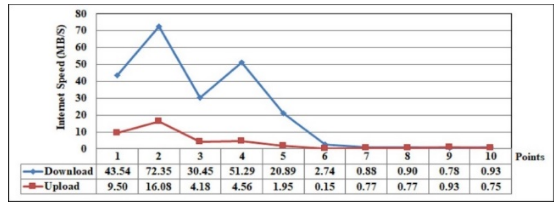


Fig. 5 The results of the survey of all 10 internet signals points.

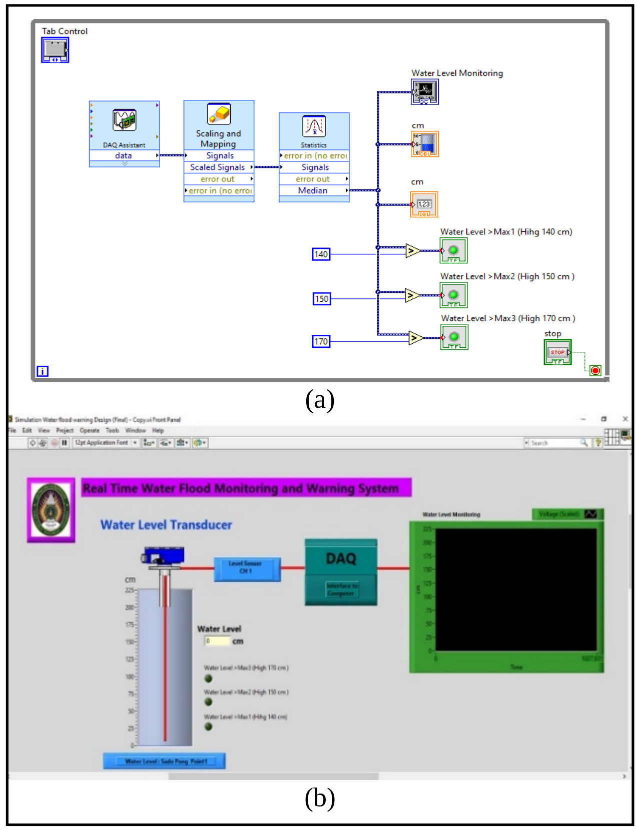


Fig. 6 Measurement program (a) and water level monitoring screen on LabVIEW program (b).

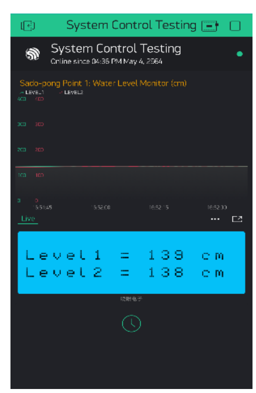
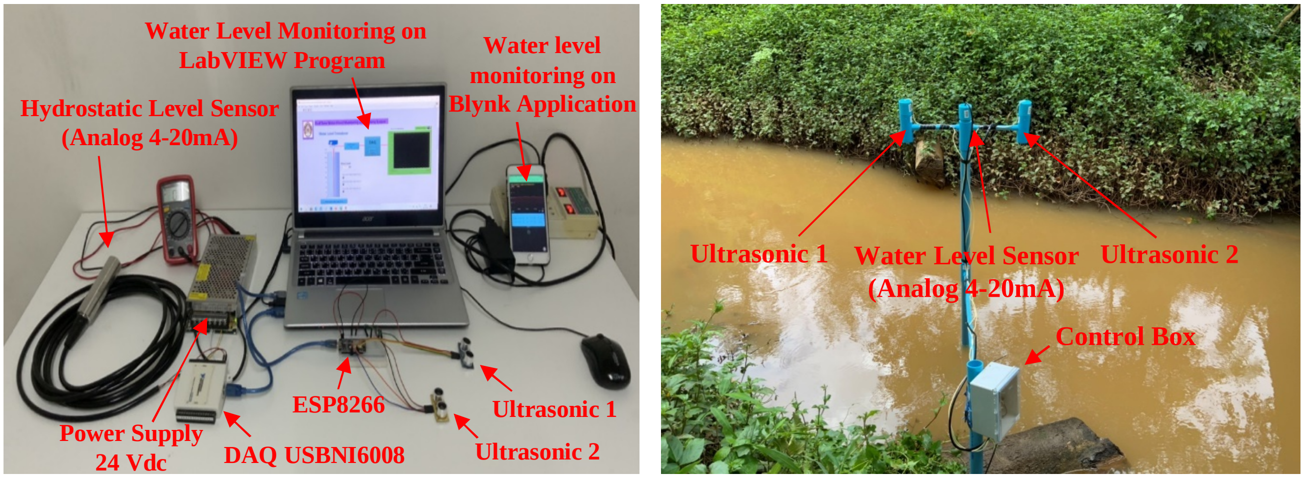


Fig. 7 Screen of water level monitoring system on Blynk application on smart phone.



(a) (b)

Fig. 8 Overall picture prototype of water level monitor and flood alarm (a) and testing installation (b).

3. Results and Discussion

This research study was conducted to study and design a prototype of an early flood warning system in wide area through LINE application for Sado Phong community, Khao Kho District, Phetchabun Province. The results consist of the results of error test result of measuring instrument, the results of the real-time display with a notification via the screen on the LabVIEW program [11], and the study results of the display through an application on a smartphone with impending floods alert through LINE application using the IoT technology.

Error testing results of measuring instruments

The instrument error testing of the real-time monitoring on the LabVIEW program system with hydrostatic level sensor (4 – 20 mA) were tested and compared by the water level pipes with level measurement marks in cm. The test results were tested at elevation 0 – 200 cm. The study results are shown in Fig. 9 and the error value is ± 1.11%. The real-time monitoring on the smartphone system with two ultrasonic level sensors was tested and compared with elevation with level measurement marks in cm. Both ultrasonics used module HC-SR04, which working frequency is 40 kHz and measuring distance is 0.02 – 4 m. The test results were tested at elevation 0 – 200 cm. The study results are shown in Fig. 10 that the error value of ultrasonic sensor 1 is ± 0.60% and ultrasonic sensor 2 is ± 0.80%.

Display results and notifications via the screen on the LabVIEW program

As shown in Fig. 11, the results of the measurements are shown on the screen of LabVIEW program by displaying results and alerts. The display consists of a number, bar, and graph. While, the alarms on the screen are divided into 3 heights: at altitude 140 cm, 150 cm and 170 cm.

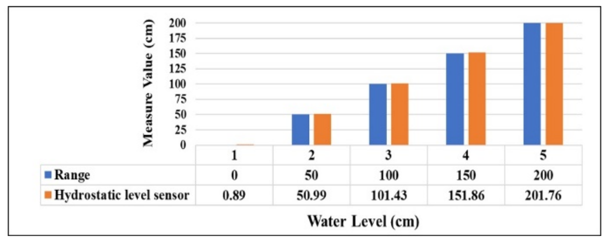


Fig. 9 The results of each water level reading of the measuring tool for displaying on the LabVIEW program with the measurement kit (Analog sensor 4 – 20mA).

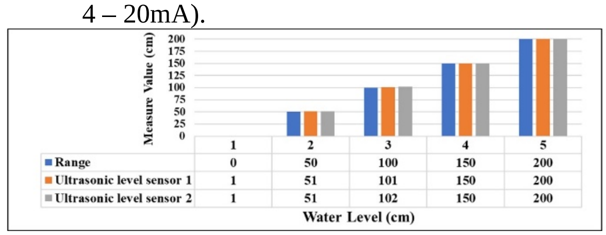


Fig. 10 The results of each water level reading of the measuring tool displayed on the Blynk application on a mobile phone with ultrasonic1 and ultrasonic2 measurement kits.

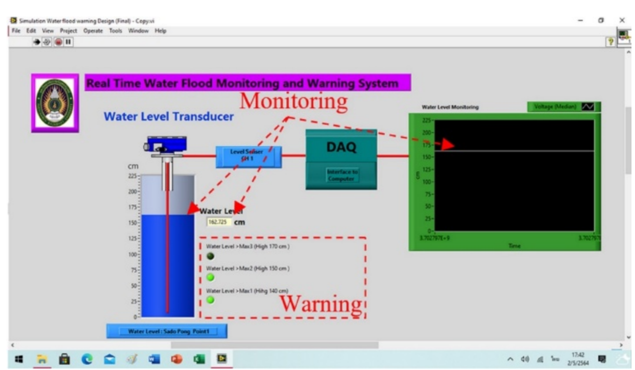
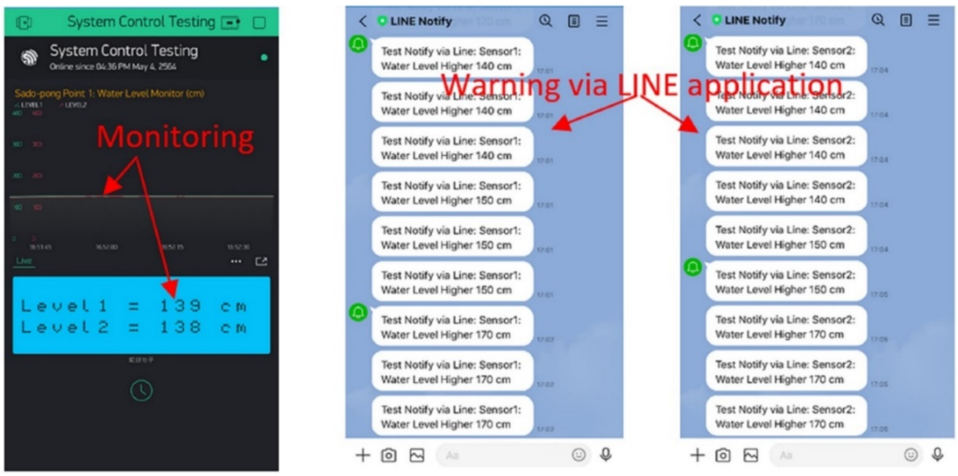


Fig. 11 Display and notification on the screen on LabVIEW program.

Display the results and notification via mobile phone application

The measurement results and notification on the screen via mobile applications are shown in the example in Fig. 12. The display consists of a number and graphs, while the notifications through the LINE application are divided into 3 heights, at altitude 140 cm, at altitude 150 cm and at altitude 170 cm. However, all the altitude levels and notification messages of this prototype can be changed for consistency with each of the installation areas and the severity of the flooding, such as Point 1 water level higher at 140 cm (Surveillance), Point 1 water level higher at 150 cm (Prepare to Evacuate), Point 1 water level higher at 170 cm (Evacuate).



(a) (b) (c)

Fig. 12 Display results via: Mobile Screen (a) with notification on LINE application of ultrasonic1 (b), and ultrasonic2 (c).

4. Conclusion

This research examined at and designed a real-time two-measuring system prototype for a water level monitor and early flood warning system that could be used over a wide area. The first system is a water level monitor, displaying and notification on the LabVIEW program, which works with the DAQ. The second system is a water level monitor that can be accessed through a mobile application. It can also provide real-time data, allowing monitoring level changes at any point in the area where the system is linked to a Wi-Fi connection. Suppose the water level changes to a certain level. In that case, the LINE application will send an alert using Internet of Things (IoT) technology, allowing local people to receive information and members of the LINE group to be set up in the configuration to send information to the responsible and mitigating agencies. The delivery of information through the LINE application is regarded as a broad area notification for alerting users. The real-time monitoring system on the LabVIEW program system has an error value of ± 1.11%, whereas the real-time monitoring system on a mobile phone system has an error value of ± 0.60% for ultrasonic sensor 1 and ± 0.80% for ultrasonic sensor 2. In addition, this prototype can also be applied to water level measurement in irrigation.

5. Suggestions

When considering installing a real-time prototype of a water level monitor and wide area early flood warning system, it is necessary to inspect the water sources and potentially hazardous locations and the depth and width to be utilized in the design of the installation with notification of the water levels. Most importantly, areas should have a sufficient internet signal transmission and reception level through a Wi-Fi connection to enable alerting via the LINE application. Additionally, there should be a power supply capable of powering the machine at all times and capable of resolving issues via the use of solar energy generation and a power backup system.

6. Acknowledgement

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7. References

[1] J. G. Natividad, J. M. Mendez, Flood Monitoring and Early Warning System Using Ultrasonic Sensor, International Conference on Information Technology and Digital Applications, Yogyakarta, Indonesia. 8 – 9 November 2017, 012020.

[2] W. Indrasari, B.H. Iswanto, M. Andayani, Early Warning System of Flood Disaster Based on Ultrasonic Sensors and Wireless Technology, IOP Conf. Series: Materials Science and Engineering, Padang, West Sumatera, Indonesia. 25 April 2018, 1 – 7.

[3] R. Sujono, H.A. Sulistyowati, A.K. Musthofa, Design and Field Test Equipment of River Water Level Detection Based on Ultrasonic Sensor and SMS

Gateway as Flood Early Warning, The 3rd International Conference on Engineering, Technology, and Industrial Application, Surakarta, Indonesia. 15 June 2017, 1 – 7.
[4] S. Banakar, K. Sree Vani, K.Y. Shruthi, G. Rajini, Flood Monitoring System with SMS Notification, JETIR. 6 (2019) 383 – 386.
[5] P. Kongtongnok, P. Jomsri, Monitoring and Alert System for Using Computer Laboratory via LINE Application, The 2019 International Academic Research Conference in Amsterdam, Amsterdam, Netherlands. 8 – 10 May 2019, 140 – 144.
[6] N. Srirajun, P. Vantavee, The Development of Theft Notification System with Vibration Sensor on Internet of Things Technology, VESTSU. 6 (2019) 30 – 44.
[7] A. Charles, C. Ayylusamy, J. Deepak Raj, K. Keerthi, T. KE. Thiruvarasan, IOT Based Water Level Monitoring System Using LabVIEW, IJPAM. 118 (2018) 9 – 14.
[8] A. Venkateswara Rao, C. Drakshayini, R.N. Kumar, K. Abhishek, G. Sharmila, M.S. Sai, LabVIEW Based Flood Monitoring System, MSJ. 9 (2020) 254 – 260.
[9] N. Gunantara, P.K. Sudiarta, A.A.I. Prasetya, A. Dharma, I. N.G. Antara, Measurements of the Received Signal Level and Service Coverage Area at the IEEE 802.11 Access Point in the Building, J. Phys.: Conf. Ser. 989 (2018) 1 – 8.
[10] S. Dolha, P. Negirla, F. Alexa, I, Silea, Considerations about the Signal Level Measurement in Wireless Sensor Networks for Node Position Estimation, MDPI. 19 (2019) 1 – 20.
[11] M. Ahmed, H.S. Taha, A. Saaid, M. Tarek UGUENIN, A Real Time Control System Simulation Model Based on LabVIEW Graphical Programming Language, IJERT. 7 (2018) 277 – 282.