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The Adoption of Mobile App for Automating Gas Meter Reading in Industry 4.0 †

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Abstract: The term "Industry 4.0" refers to a new phase of the Industrial Revolution that emphasizes interconnection, automation, machine learning, and real-time data. Reading gas meters is not an easy job and walking to and from the meter can be inconvenient. The process of reading gas meters is manual, which is time consuming and may lead to human error. To automate this system, an android application is presented that reads gas meters automatically through a mobile camera and analyzes the digits of the meter using optical character recognition technology to obtain the consumption units. This proposed application prototype was tested for 50 gas meters, and it gave 99.89% accuracy results for both digit reading and barcode reading.

Keywords: automation; gas meters; computer vision; android application; optical character recognition; barcode reader; Industry 4.0; SSGC

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1. Introduction

Industry refers to the sector of the economy that generates highly mechanized and automated material items. A gas meter is a specialized flow meter, used to measure the volume of fuel gases such as natural gas and liquefied petroleum gas. Gas meters are used at all residential, commercial, and industrial buildings that consume fuel gas supplied by a gas utility [1]. Reading this gas meters is not an easy job and walking to and from the meter can be inconvenient. Depending on the route, the job of a meter reader can be quite challenging. Meter readers need to be knowledgeable in a certain set of skills in order to carry out the job correctly. Meter readers also need to find a way to access the meter, regardless of obstacles.

A meter reader can usually read approximately 500 m a day [2]. It takes a significant amount of time to note each meter reading manually, which may result in human error and can also bring conflict between consumers and service providers due to incorrect records, and no appropriate data management system currently exists to help accurately calculate and correct documents. Meter reading requires processes that can give different problems; calculation failures, program upgrade delays, and issues with fault detection are major problems for which industries find it hard to obtain answers. The current procedure related to the gas consumption billing process and gas meter reading system is not fully automatic. It includes manual procedures from the moment the meter reader begins reading the meter until the latest meter reading updates the device. A meter reader visits a house, reads the meter, and notes the gas units consumed. The meter readings are manually entered into the device by a data entry officer in the office. This procedure is inadequate and has the potential for human error.

In November 2002, Pakistan's large-scale gas company, Sui Southern Gas Company (Karachi, Pakistan) introduced computerized meter reading called Handheld. The handheld weighs 340 g and has 18 h battery backup. It can operate in a temperature between 10 and 55 degrees Celsius. The software was developed with C language and works on a

DOS system. In this system, the meter reader enters the reading in the device manually, and it is sent to the server automatically. However, this process is not practical and is semi-automated and restricted. Furthermore, it can only be used by the company itself [3].

These situations therefore warrant an automated system that will help in the generation of accurate gas bills while also allowing for an easy checking of records of gas bills against customers. The system is also focused on the elimination of problems and errors that often occur with the computation and generation of gas bills, providing efficient instant updates to gas billing records.

2. Literature Review

A detailed study showed that there is currently no such fully automated gas meter reading system with significant functionality. Here are some of the papers discussed.

Ref. [4] presents the idea of the combination of mobile and web applications. The meter reader has an android application with optical character recognition (OCR) technology. The reader captures the image of the meter, and the OCR extracts the data from the image. This data will then be sent to the server-side web application. The server then processes the data, generates the bill, and sends the bill to the consumer via email. Ref. [5] suggests providing an android application to the reader with a route map of the meters. When the reader captures the image, the meter blinks a red point on the map. The image is then processed through the OCR and sent to the server, and the server then generates and sends the bill to the consumer. Ref. [6] suggests using an android application with an OCR system accessible to the meter reader. The reader captures the image extract data using OCR and sends the data to the server. The server will generate and send the bill to the consumer. Here, the server can receive complaints from consumers and can broadcast any relevant information. Ref. [7] uses an automated meter reading system using Global System Mobile Communication (GSM), Zigbee, Supervisory Control and Data Acquisition (SCADA), Power Line Communication, and Worldwide Interoperability for Microwave Access (WiMAX) Technology. The technology gathers data from the meter and sends it to the server for billing. This idea will help the energy provider to access the most efficient data from the meter and helps the data experts to build a model to predict future energy demands. Ref. [8] used two mobile applications for both the meter reader and the customer and a website for the server. The reader provides a route map of the meters. When the reader captures the image, the meter blinks a red point on the map. The image is then processed through OCR and is sent to the server, and the server then generates and sends the bill to the consumer. The customers can also calculate the bill using a consumer mobile application.

Table 1 shows the major similarities and dissimilarities of the related gas meter reader papers, and Table 2 shows comparisons of different gas meter reading applications.

Table 1. Related papers on gas meters.

App Name	Billing History	Register Complaint	Save/Print Bill	Current Billing Information	Self-Billing	Self-Meter Read
SNGPL BILL [9]	✓	✓	×	✓	×	×
SSGC CUSTOMER CARE [10]	×	✓	✓	✓	×	×
SMART METERS [11]	×	×	×	×	×	✓
METER READING (brothers-gas) [12]	×	✓	×	✓	✓	×
GAS METER READING [13]	×	×	×	✓	×	✓

Table 2. Related applications on meter reading.

Papers	Android and Web Based	Implement OCR System	Admin Provides List of Houses to Be Covered	Customer Meter Map	Self-Meter Read by Consumer	Bill Send via
[4]	✓	✓	✓	×	×	Email
[5]	✓	✓	✓	✓	×	Email
[6]	✓	✓	✓	×	✓	——-
[7]	✓	×	✓	×	×	——-
[8]	✓	×	✓	✓	×	SMS

3. Methodology

3.1. System Design

The system comprises a meter reader who reads the meter through a mobile application and a consumer who checks the consumption units at home through a mobile app. This helps in monitoring the usage of gas in a month. A mobile application is designed to support both meter reader and user. The application works by utilizing OCR technology. The admin panel is a website that has complete access to a large database, which is responsible for data manipulation, bill generation, and report maintenance, as well as many other tasks as shown in Figure 1.

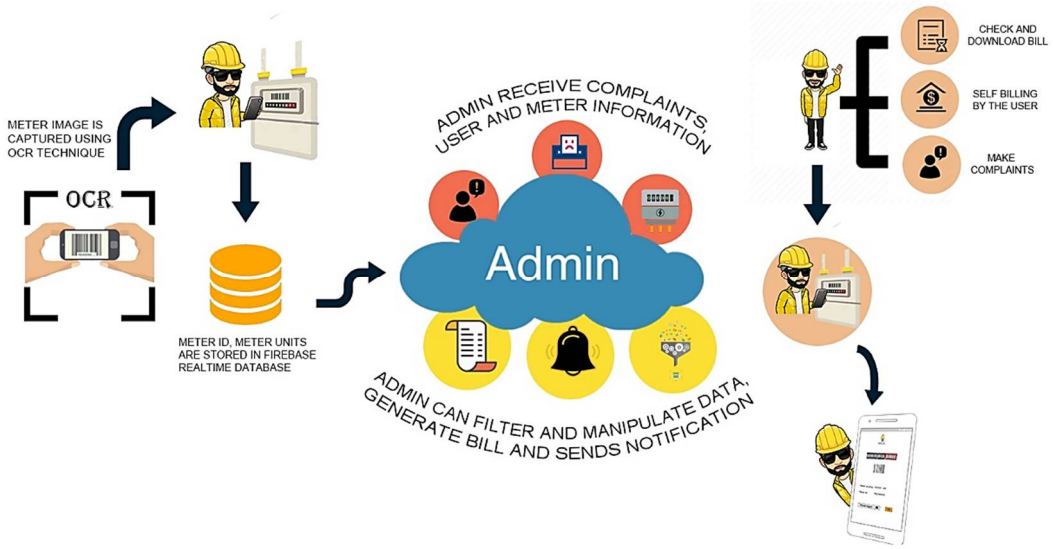

Figure 1. System Design.

3.2. System Architecture

Bill Calculation

It is important to take accurate gas meter readings on a regular basis; if you do not know how to use your meter correctly, you cannot be sure you are being billed correctly [14]. Chart 1 shows the bill calculating method.

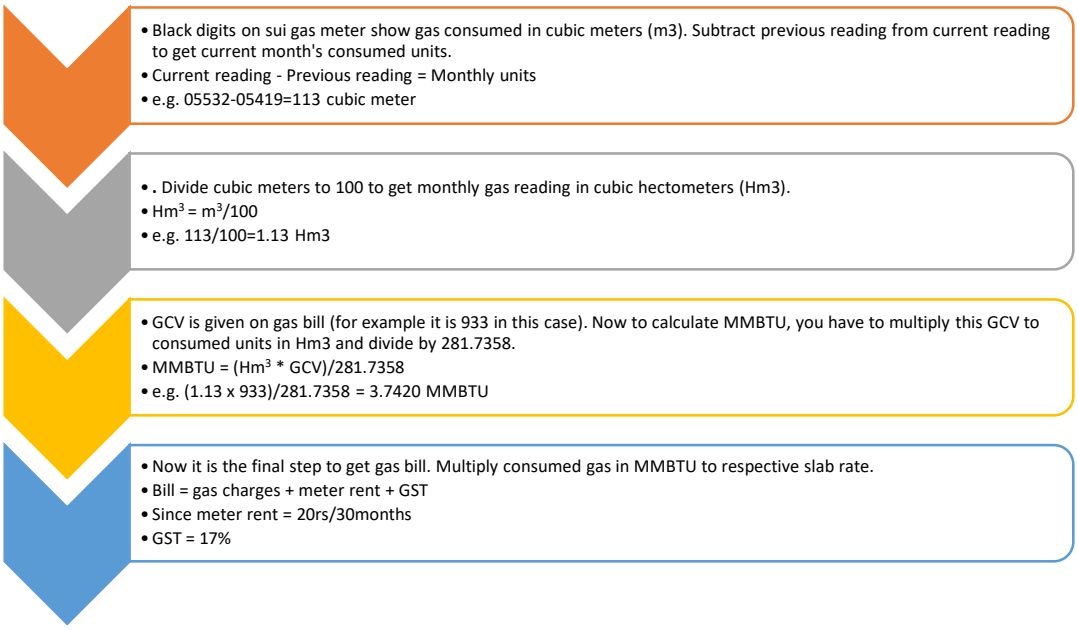

Chart 1. Bill Calculating Method.

To calculate the bill accurately for domestic consumers, various tariffs and slabs have been set up by SNGPL [15]. Furthermore, in the final bill, many other factors are also included, such as GST, meter rent, etc. Table 3 shows that there are seven slabs that determine rates. A minimum rate has been set with reference to lower consumption and a maximum rate has been set for consumers who utilize a high volume.

Table 3. slabs.

Usage of Gas	30 Days/Hm^3	Per MMBTU (Rs)
1 slab	Up to 0.5	121
2 slabs	Up to 1	127
3 slabs	Up to 2	264
4 slabs	Up to 3	275
5 slabs	Up to 4	780
6 slabs	Up to 5	1460
7 slabs	More than 5	1460

3.3. Demonstration

3.3.1. Android Mobile Application

The application contains two modules: meter reader and consumer. A meter reader logs in with a unique code assigned to them, then the app will allow them to read the meter by taking the image of the barcode on the meter, as shown in Figure 2. It tells the reader the meter number and the consumption units of that meter. The data is then sent to the admin database. A consumer login will show two options, one for bill calculation and one for complaints, as shown in Figure 2. In bill calculation, the consumer is asked to enter previous and current readings, and the total bill is then generated, and can also be downloaded.

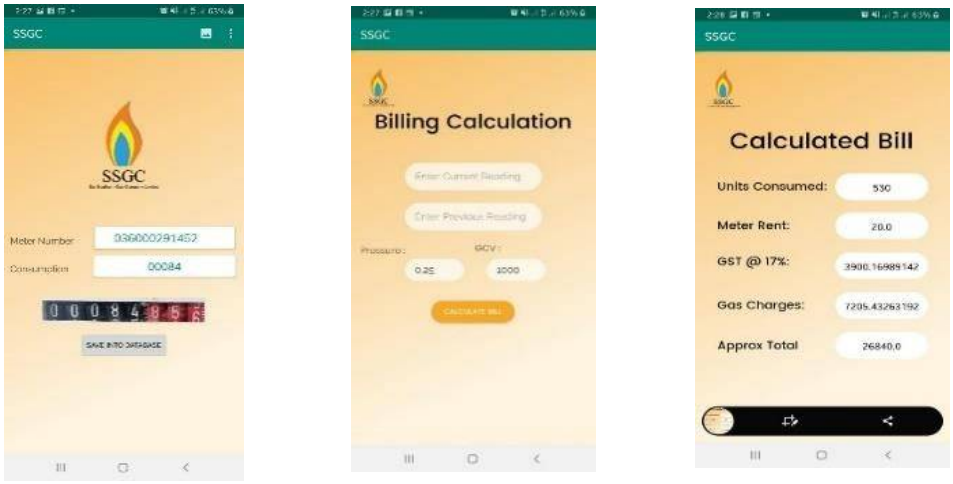

Figure 2. App screens for meter reading and bill calculation.

3.3.2. Admin Website

Administrators control all user activities. They log in with secure credentials and will navigate to the page of account details, as shown in Figure 3. Account identifications (unique to each consumer meter) will show the details of the respective consumer meter.

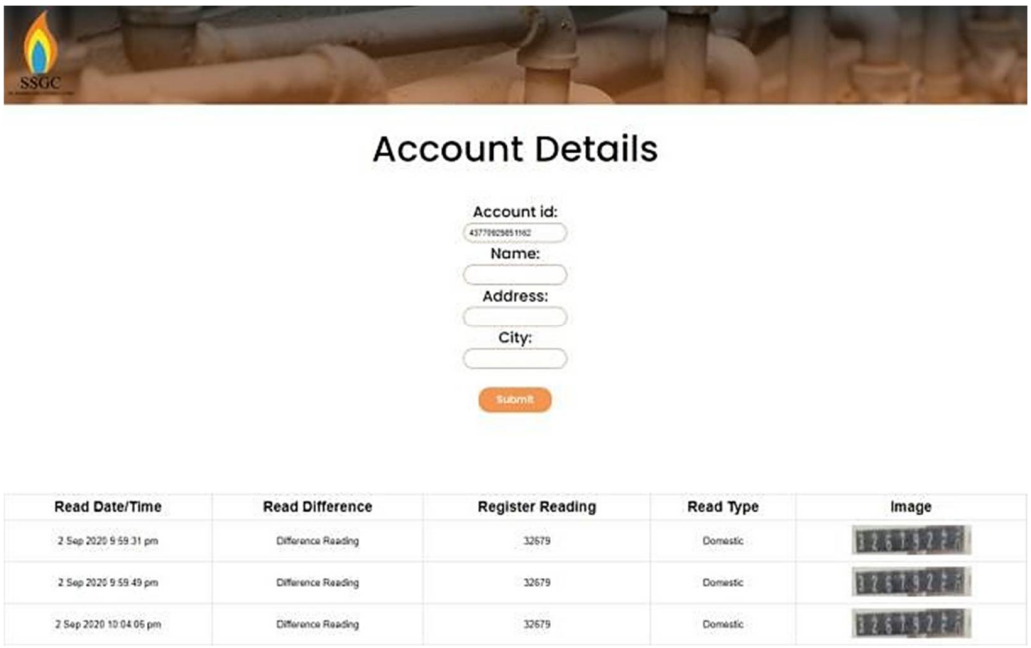

Figure 3. Admin website—Account details.

4. Results

The application uses new technology that has a low development cost, low working costs, more information security, and less labor required. The proposed application prototype was tested on 50 gas meters, and it gave 99.89% accuracy results on both digit reading and barcode reading.

5. Conclusions

Since the beginning of the Industrial Revolution, technological breakthroughs have led to tremendous increases in industrial productivity. This study gives a solution for problems related to the manual gas meter reading system. It reduces the errors made by

humans in noting the reading, and it also automates the system from the server side as well as from the meter reader and customer side. In this way, the meter readers have less burden, and they can easily and more accurately collect the readings from a greater number of meters. In addition, customers also have the facility to look up their gas bills through the mobile application and can make online payment of the bill. Administrators can also easily perform their tasks through the web-based application.

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