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Advanced Attendance Management Systems: Technologies and Applications

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Abstract

The attendance management of the organization is an essential activity of their mundane life, has necessitated the need for revolutionary automatic attendance record-keeping and tracking systems. Paper surveys the emerging automated tools and applications which are popularly dominating this activity and fulfilling the requirement of accurate attendance marking systems. The technological era has gravitated more towards biometric attendance systems, but there are myriad other technologies that have been neglected thoroughly. The author identifies, extract, classify, and highlight all the evolving AMS (Attendance Management System) and have analyzed and compared their performances precisely and conscientiously. This survey identifies assorted AMS as biometric, NFC (Near Field Communication), RIFD (Radio Frequency Identification), Bluetooth, and cloud computing-based attendance systems. This article not only provides the literature review on the earlier work, but also provides an analytical report related to cloud-based AMS, discussions, and future recommendations.

Keywords: Attendance, AMS, RIFD, NFC, Bluetooth-based attendance, Biometric, Cloud-based attendance applications.
Abbreviation: AMS-Attendance Management System, NFC-Near Field Communication, RIFD-Radio Frequency Identification.

Introduction

Right from the manual marking systems to the automatic biometric marked attendance portals, the attendance management systems have evolved significantly over the years. Based on the types of operations and input mode, the attendance systems can be classified as manual systems and automatic systems. The AMS is playing the most critical role in the organization to maintain the records of employees, workers, and educational institutes to keep the record of the students, faculty, and other staff associates. Attendance is maintained to analyse the presence of the employee or any person. Earlier, the attendance was maintained manually by providing their names, unique ID, department, date, time, signature, etc. making it a very time-consuming and tedious practice for both the employees who are marking attendance and others who are analysing the presence.

In a manual attendance system paper and pens are used to maintain the records, which lead to the generation of long queues of the employees for marking it. After that, it calls for a separate team for its verification, leading to more overhead on the task force of any organization. Many a time, there have been instances of proxy and mismarked attendance, which profoundly bothers the reliability of the attendance systems. Attendance is considered to be an essential factor in evaluating any employee performance, punctuality, and salary. Thus, it becomes a crucial aspect as the dissemination of wages and stipends are decided based on the attendance of the employees. Inaccurate and inefficient manual systems could create a state of overpaid and underpaid wages, which is an absolute significant concern for any organization. The manual attendance system has many limitations, such as being time-consuming, misplacement of records, and computation of salary, bonuses, rewards, and compensation. Many public and private sectors still follow the manual attendance system due to lack of resources, unawareness of automatic tools, uncomfortable with technology, and many. To overcome these problems in the manual attendance system, organization change their strategies and shift to automated AMS. Likewise, attendance also correlates with employee performance and also it provides the relationship between student attendance and their academic performance. Poor attendance by employees and students leads to depletion of performance.

The automatic attendance system is followed by many organizations because it solves many problems as automated systems use electronic tags, fingerprint, face recognition, RF card system, touch screens, and many more. When employees mark their attendance in the automatic mode, it automatically stores in some storage device, and managers or management can see in their system the present/absent list of employees. The motivation behind this change from a traditional manual system to an automatic system is since marking electronic attendance aids the maintenance of the record electronically and abolishes the proxy cycle and thus, keeping the accuracy intact.

Moreover, the traditional manual system has no backup plan if we lost our attendance register or where the records are maintained. The automatic system is helping organizations to generate reports regularly in a very efficient manner to analyse the salary, and they can back up plans for records.

Automatic Attendance Management System

Today we are living in the digital era where every minute the technology is changing concerning the requirement of growth. In past years manual attendance systems are following by the organization and in the current scenario organizations changed their approach towards biometric technology like a fingerprint, face recognition, digital signature, iris, palm prints, etc. as a biometric expression which remains the same for any individual throughout the life [1]. Biometric technology uses the physical data of individuals for authentication, which is a more convenient method than passwords and RIFD methods. Wide varieties of tools are available in the market to mark attendance for students or employees, so it becomes crucial to analyze the best practice out of them. Apart from the biometric methods, RIFD, Bluetooth, barcode reader, and NFC are the other tools that are available to mark attendance. Still, these tools are costlier and not reliable. Barcode technology is mostly used in the shopping centre or other stores to identify the item and its price [2]. **Figure 1** discusses the different evolving technologies used for marking automatic attendance.

Figure 1: Types of Biometric Technology [3].

Biometric Characteristics

Any human physiological or behavioural characteristic could be biometrics provided it has the following [4]:

- **Universality:** Humans are different from others in their features like face, fingerprint, voice, physical appearance, behaviour, etc. A person must possess some unique universal features for their authentication. For verification and authentication, one must have some unique biometric characteristics.
- **Permanence:** Human characteristics should not be variable; if the nature of the feature is variable, then that cannot be considered as a biometric characteristic, for example, signature. As we all know, nothing is permanent in this universe, but in biometric authentication, one must consider only those features which are stable by nature. Authentication of a person can be done through algorithms, and for that, one should identify only those biometric feature which long lasts for some years.
- **Uniqueness:** Uniqueness is a significant factor when we consider features for the authentication of a person. Based on features, we can identify a person's uniqueness. If the characteristics of the person are not unique to another person, then it's impossible to differentiate two persons from each other.
- **Measurability:** Feature extraction of a person is an important factor in context to verification of a person. Each biometric method has its way of extracting the feature for verification and authentication. It becomes essential to select a suitable device to record the function, and recorded data has to be processed for extracting valid features. Features that we want to extract from the source must be presented in a good form to the device for the selected method.
- **Performance:** When we consider the accuracy factor, then the performance of the selected devices becomes essential. The performance of the system is related to its speed of recognition, quality, processing and visualization. The recognition accuracy and the resources required to achieve that accuracy should meet the constraints imposed by the application.
- **Acceptability:** The system extracts features for authentication purpose of any person should be accepted by the person. The willingness of any person to show their biometric feature to the system is much required to extract the specific feature. For example, some people hesitated or feel uncomfortable getting close clicking pictures of Iris or eyes.
- **Circumvention:** Numbers of problems are encountered during the recording of data like mismatching of fingerprint, a wrong scan of a finger, tag scanning problem, use of contact lens, etc. An appropriate algorithm or device should be used to overcome or detect these problems. It is dependable on the application used in the system as a single feature is not competent to work on all the applications to authenticate or verify any individual.

Assessment of Different Attendance Management Systems

Computerized Attendance System: In 2008, Nucleus Research Company from Boston, Massachusetts, proposed to use the computers to maintain attendance. In a manual attendance management system, there is wastage of paper, the chance of mistakes, difficulty in maintaining the records, and many more. The proposed method reduces human involvement, cost but the problem with this system is in data entry. Data entry of the user is done in a computer by any individual, so the chance of wrong entry may occur [3]. Jain SK, et al. (2011) [5] proposed the advancement of this computer-based technology in which application is developed with a list of all registered students of offered course and professor have an effective solution to the different problems arises in an automatic attendance management system. Computer-based attendance management systems solve some limitations of manual systems and use technology to store the data in a well-structured format. It helps the department to generate a report in the required format. Software is explored using the website of the company [6].

Bluetooth Based Attendance System: proposed Bluetooth based attendance management systems that allow the user to take and maintain attendance through Bluetooth technology [7]. Faculties of offered courses have to install the application software in their smartphone which accesses the student's MAC addresses in the presence of the student in the class. Accesses MAC addresses are stored against the student name and present is marked for the student in the database. Reports can be generated for the students by the end of the lecture. The limitation of the proposed system is firstly every student must carry their smartphone with them, as maybe some students don't have a smartphone. Secondly, in case if the student is not present in class and the smartphone is carried by another student still the present is marked for that student. In this case, the physical presence of the student is not mandatory only a smartphone is required which is the biggest drawback of the system. **Figure 2** depicts the template of the Bluetooth based attendance management system.

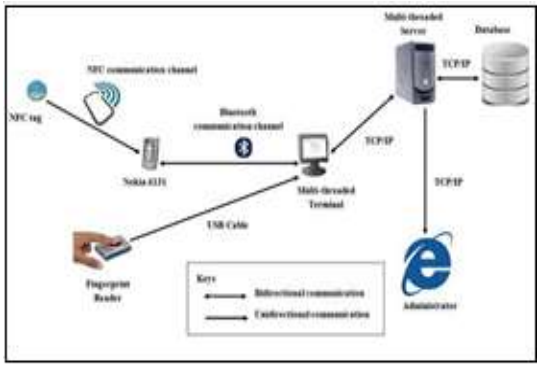

Figure 2: Bluetooth Based Attendance Management System [7].

NFC Based Attendance System: NFC is near field communication system (wireless technology) which can be used to mark the attendance for the students and employees and its setup time is 0.1s and range is up to 10 cm as shown in **Figure 3** [8]. In the current era by the year 2020, approximately 3.5 billion users are using the smartphone around the globe. Users with a smartphone are growing very fast so it is very easy to implement an NFC tag on the smartphone. There are two types of NFC tags one is active and the other is passive. Those tags which generate its own RF field is known as active tag and if tag used the power of another device is known as a passive tag. Tag which starts the communication with other devices is considered to the initiator of communication, this is possible inactive tags only and one initiator have many targets (active or passive) for communication. Active tag initiator can only read the information from the other device. An initiator can communicate with one target at a time as the broadcasting feature is not possible in NFC technology. NFC technology is based on RIFD technology. For example, today credit cards are enabled with NFC tag and in just one smart tap users can pay their amount at different stores [9]. proposed Bluetooth and NFC based attendance management system to mark the attendance. NFC is enabled in the smartphone of the user and the Bluetooth address of the NFC enabled smartphone is fetched for the user authentication. Further GUI based applications will receive the tag ID and other relevant information of the user to mark the attendance. All users must have NFC enabled smartphone which is the biggest drawback of the proposed system.

Figure 3: NFC Technology [10].

Fingerprint Based Attendance Management System: The fingerprint is the very unique feature of humans that can be used for authentication purposes in many fields for many decades. The accuracy rate in matching the fingerprint is extremely well. The fingerprint is a pattern combination of ridges and valleys on a fingertip. No two people have the same fingerprint even twins also have different fingers print. In finger-based systems firstly all user multiple fingers print are recorded through the scanner and stored in the database for future verification. Ramakrishnan J, et al. (2012) [11] proposed fingerprint based attendance system in which users fingerprint is recorded in a database and when the user scans their finger in the scanner it will pre-process the fingerprint and reconstruct the scanned image. If the scanned fingerprint match with the stored database then it will send the details of the user to the GUI based application. GUI based application allows the host to generate reports in the required format. Rao S et al. (2013) [12] proposed the same technique to mark the attendance but in their study for verification purposes, they used the extraction of minutiae technique. Layout of the fingerprint is shown in **Figure 4**. Numbers of researchers are working on these techniques and all researchers are facing the following limitation of the fingerprint system.

- Long queue for scanning the fingerprint.
- Time Consuming
- Scanner internal storage memory
- The sensor of the scanner stops working frequently
- Multiple attempts by the user to scan fingerprint

Figure 4: Finger print [13].

Palmprint: Palm print is similar to the fingerprint as this is also a pattern combination of ridges and valleys. The major difference between fingerprint and palm print is the area they cover; the palm area is much larger than the fingertip depicted in **Figure 5**. The scanner needed to scan the palm area is much bigger as compared to another scanner so it is heavier and costlier. The human palm area has more feature than fingertip like it include principal line and some wrinkles that also have to capture through the scanner. A high-resolution scanner must be used to scan all the features of the palm for better accuracy. Bayoumi S, et al. (2015) [14] proposed palm-based attendance management system that scans the veins of the palm through a camera or scanner as every individual has a unique pattern. Scanned data is pre-processed to extract the feature using the PCA algorithm and further match with the database to mark the attendance. The author achieved a 70% of accuracy rate with the proposed system and in future, they are working on enhancing the accuracy rate.

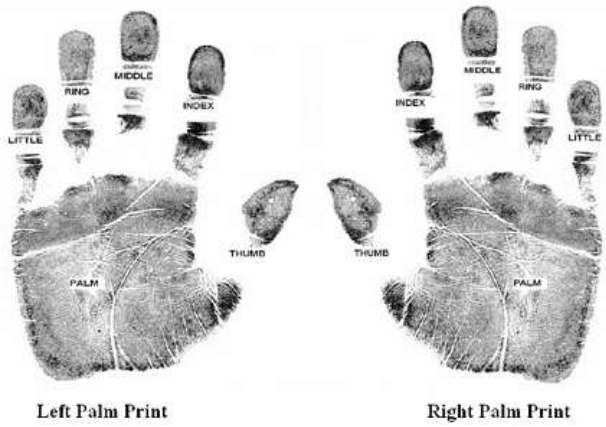

Figure 5: Palm Print [15].

Signature: Signature is one of the behavioural identification methods of any individual used for their authentication purpose. A signature is a way of writing an individual name in a unique style with the help of a writing instrument. In the manual attendance system signature is the only key factor for any person authentication. In manual system attendance is maintained in a register or files having all details of the person like name, department, course, ID etc. and the only sign is the factor that authenticates all details of the person. Signature is also used to make sure that whatever information or details written in any hardcopy are read and verified by the person. Signature is a biometric method that changes with time as this is dependent upon the person physical and emotional conditions.

There is no such rule that a person can't change their signature. Limitation of the signature-based attendance system; there is a chance of forgery by another person if they know the signature style of another person and other is a change in signature style over time [16]. proposed the solution to the mentioned limitation. The author proposed a new style of attendance system in which students will provide a unique code with the help of the MD5 hashing algorithm each day to mark their attendance. **Figure 6** depicted the sample of signature.

Figure 6: Signature.

Voice: Voice or speech is one of the features to verify any person as every human being has their voice style. It is a combination of both physical and behavioural combinations of any person. Today smartphones are coming with voice recognition features that allow the user to open their phones through their voice pattern. Soewito, B et al. (2016) [17] proposed attendance management system using fingerprint and voice recognition. In their experiment fingerprint is taken 20 times for each student and 100 samples (student have to speak 26 characters of alphabet randomly) of voice has been taken from 40 students; achieve 95% accuracy rate with both the methods. Voice is the feature related to human changes with time, age, medical aspect, emotional state, intensely etc. This feature is not considered a unique feature of a person when it implements on large scale. There is a chance of the addition of noise factor while speaking. The Voice recognition method is only appropriate for telephone and personal communication authentication. Sample of voice is shown in **Figure 7**.

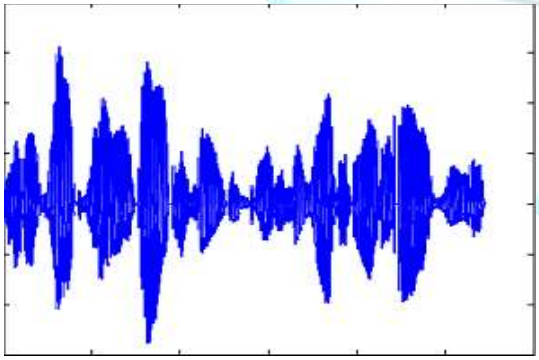

Figure 7: Voice-Based Technology [18].

Iris Based Attendance Management System: Iris is one of the best methods of biometric identification which uses pattern recognition techniques for any individual authentication as represented in **Figure 8**. It uses eyes feature or retina scanning using the camera for their verification and authentication. Iris is the internal organ of the human body which is well sheltered from any type of damage as compared to fingerprint. Fingerprint can be damaged due to labour work or change its impression with age. It is very difficult to prove that iris features are unique as there is no parameter to prove the same. In the recognition of iris, there is no need for the person to come in touch with any type of scanner just they have to come in front of the camera to click the picture. Some person goes under the surgery but that will not affect in the recognition of iris. It is easy to detect the contact lenses used by the user. Kadry S, et al. (2010) [1] proposed iris based attendance management system which scans iris through eyes scanner of individual, extract minutiae and stored in a database for future matching. When a user picture is taken from the scanner it will check with the stored database, if the match is found for clicked iris image it will mark attendance against them. The author experiment on 300 iris samples and achieve a 98.3% of accuracy rate on verification.

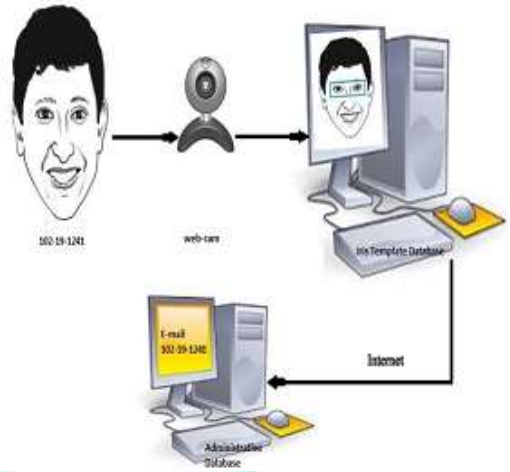

Figure 8: IRIS Technology [19].

Face Recognition: Face recognition is the interference-free method of recognition in which face geometry is used to recognize any human being like eyes, ears, nose, lips and their relationship with each other shown in **Figure 9**. The facial feature is used to remember any face in peer to peer connection and when this is analyzed through some algorithm then all features are extracted to match with the stored faces in the database. Face recognition work majorly under two environments one is a constrained environment and the other is an unconstrained environment. A constraint environment is that environment in which an image is clicked with user cooperation like passport photograph on the other side in unconstraint environment there is no user cooperation in clicking the photographs like candid images of crowded images. Facial recognition depends upon the condition in which perception is clicked.

Varadharajan E, et al. (2016) [20] proposed automatic attendance management system using face detection in which high definition camera is fixed in the classroom, and it will detect faces and capture the images of detected faces; all detected faces are further sent for verification with the database. Matched faces will mark present, and information about absent students will be sent to their parents through SMS service. MuthuKalyani K, et al. (2013) [21] proposed attendance management system using face recognition in which CCTV camera is used to capture the faces enter in the classroom, and captured images is further matched with the database. Proposed system helping in two ways one it will mark attendance for detected faces and the other it will also identify the unauthorized person to the environment.

Figure 9: Face Recognition.

RIFD Based Attendance Management System: RIFD technology is not related to biometric technology but it is widely used for the automatic identification of a person. User data is stored in the electronic device known as RIFD tag and to retrieve the stored data from the tag RFID readers are used. In this technology students just have to scan their card in the reader, it automatically fetches all the information of the student and marks their attendance in the database. Through the GUI module, one can retrieve all the attendance and make a report as per their requirement. RIFD technology is costlier than other technologies as it requires better infrastructure. Lim ST, et al. (2009) [22] proposed RIFD based attendance system which is used in the schools, colleges and universities to mark the student's attendance in real-time scenarios. This system can also be useful to mark the employee's attendance. All students and employees are issued RIFD tag-based identity cards which everyone has to scan for the reader then their attendance is marked to the database with their details. The RIFD system is attached to the computer from where the admin can analyze and reports can be generated as per the requirement shown in **Figure 10**. Various biometric technologies are compared on the basis of their characteristics is represented in **Figure 11**.

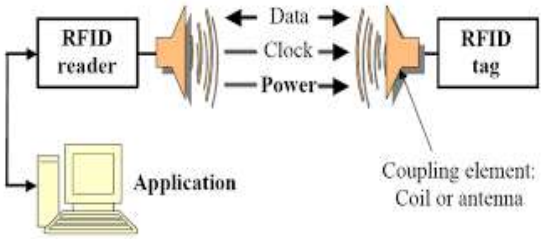

Figure 10: RIFD Technology [23].

Biometric Technology	Universality	Permanence	Uniqueness	Measurability	Performance	Acceptability	Circumvention
Face	HIGH	MEDIUM	LOW	HIGH	LOW	HIGH	LOW
Finger Print	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	MEDIUM	HIGH
Palm	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM
Voice	MEDIUM	LOW	LOW	MEDIUM	LOW	HIGH	LOW
Iris	HIGH	HIGH	HIGH	MEDIUM	HIGH	LOW	HIGH
Signature	LOW	LOW	LOW	HIGH	LOW	HIGH	LOW

Figure 11: Comparison of Biometric Technology on Characteristics Basis [24].

Literature Review and Related Work

Shoewu O, et al. (2012) [25] proposed the attendance management system with the help of biometric for the school and university students. Several researchers are working in this field to overcome the limitations of the manual attendance system. The manual attendance system has a limitation of computation like there is a chance of errors and a lot of time wastage in the compilation of attendance. The proposed system uses the biometric sensor to record and authenticate the user data stored in the database. The author compared the results of the manual system and their proposed system on 80 users and the results show an accuracy rate of 94% besides this they compare the processing time of the manual attendance system with the proposed system result in 17.83 seconds for manual attendance system and 3.79 seconds for biometric attendance system.

Nwoye CI (2016) [26] proposed OOADM (Object-Oriented Analysis and Design Methodology) system which is a fingerprint enabled cross-platform based automatic attendance system to record and maintain the attendance for different organizations. In this research matchless feature (fingerprint) of humans is taken through a fingerprint device and stored in their internal server to authenticate the fingerprint through an automated system. According to the author, the traditional attendance system is a very inefficient method due to the different challenges in the manual recording of attendance. The proposed work is developing computer literacy among the user which helps the organization in training the skills set.

Mittal Y, et al. (2015) [27] proposed two application models of fingerprint biometric; one is Access Control System (ACS) and Classroom Attendance Management System (CAMS). ACS is used for authentication and assessing the door system used in organizations while on the other side CAMS is used to mark the class attendance in schools and colleges. Proposed systems are recording the user fingerprints using the fingerprint scanner and storing the recorded fingerprints in a database to generate the different types of reports like day wise, month wise, late coming etc. Author experiment the systems on 20 students of IIIT Chittoor by punching their fingerprints in different timeslots and achieved 87% of recognition accuracy rate for ACS system and 92% of recognition accuracy rate for CAMS. Through these systems only preregistered users are tested and user which is not pre-registered they are not recognized by the system result in false identification. The study is compared with the RIFD technology in terms of feature and security. In future, they are trying to deploy the system in real-time in high-security areas so that only authenticate or reliable persons can access the secure areas.

Ezema LS, et al. (2015) [28] proposed the fingerprint-based attendance system to overcome the limitation or problems with manual attendance systems and impression problems in RIFD technology. The author proposed the system to use through the standalone and handheld system without connecting to the computer. User is registered through their unique fingerprints then recorded fingerprints are processed to authentication by the system. In future work the author is going to connect modules through wireless mode so that authorized personnel can access the attendance remotely along with that they want to connect the system with GSM service so that admin can receive SMS on each unauthorized access.

Noor S, et al. (2016) [29] proposed the android based attendance management system to record the attendance for the students in school, college and universities. The author compares their study with RIFD and biometric technology in the context of their hardware and maintenance costs. In today's era, everyone is carrying a smartphone with many applications installed in their smartphones, here the author using the smartphone application to record the attendance of the students. Once the user installed the application on their device, through this application one can download the student list and analyze the record of the students. In organization student as well as employee is provided ID cards as an identity proof so these ID cards are used to mark the attendance. The device camera is used as a scanner to read the barcode printed on the ID card and the same recorded attendance is stored in the database.

Joshi R, et al. (2015) [30] proposed the idea of the project to record and maintain the attendance for institutions using android technology. The study shows that apart from the attendance record proposed system can be used to access study material, examination schedule, personal information, student performance, communication to parents etc. The system allows teachers to take attendance with the help of a smartphone and allow them to keep a check on every activity of students. The proposed system as some validation factor by which if any student has attendance mentioned criteria it will activate the SMS module through which SMS is sent to parent's number already added in the database. The system allows the teacher to send bulk messages to students on the number mentioned in the database.

Hajime (2005) [31] proposed the system for E-learning and low-cost attendance system. The author worked on majorly three challenges (Time, Place and Person) which come into their consideration from the past research, for that they develop a new system using the mobile

phone. The study is taken from Japan where according to the author 67% of the total population is using the smartphone as of 28 February 2005 and approximately 86% of mobiles users are using different services like email, digital camera etc. The student has to take the picture from their camera of faculty teaching in the class, E-mail that picture to the faculty using the class code which is already shared with the students before the class and as the class end faculty will receive the emails from the students with class code from where faculty can maintain the attendance. If faculty wants to cross-check the student attendance then faculty can see the image properties like date, time, location etc. This system is helping to maintain attendance through the existing resources students carry.

Abas MA, et al. (2014) [32] proposed AMS system which maintains and monitor student attendance in classes. According to the author, faculty faces problems in calling the roll numbers in the class and facing a lot of problems in the compilation of the attendance. They create a new system using RFID technology and ASP.net is used for the data analysis of attendance. Every student in the class is given RIFD enabled cards, when students enter the class they will touch the RIFD reader with the card provided to them and within 15 seconds they have to enter the class for final authentication. There is one movement sensor which ensures that student enters the class and they did not just touch the card, no student is allowed to touch the card twice. When the class is over the particular faculty read the data through the application and analyze all the information regarding the students. The proposed system is in progress to add some more modules to helping the faculties.

Nguyen KH, et al. (2017) [33] proposed automatic attendance system for large gatherings like conferences, workshops, symposiums, seminars etc. to check the ins and outflow of the participants to analyze the gathering in future events. Each participant who is attending the event is given a participants card, at the entrance participant have to touch that card to the RIFD reader which collects the participant information like name, date, time etc. and is stored in the remote database. The server used by the organization will collect the data and process the data to display it through GUI. Shukla S (2013) [34] proposed RFID based attendance management attendance system for students and staff members of the universities. Users have to scan their cards through the reader and the system will record the user information in its database. Software associated with the technology will provide reports as per the user requirement to analyze the report generated. In the future author is enhancing the system by using an LCD light screen and IP camera to indicate the wrong card or wrong person is detected.

Arulogun OM, et al. (2013) [35] proposed the RFID technology for attendance management system in which they used the passive tags or cards. Students are given the passive tags to enter the class and when they entered the class they have to scan their tags at the entrance to the RIFD scanner, as the scanner read the tag the information is saved in SQL server which is attached with the application used to record the data. Through the application or software, faculty can generate the report accordingly. The current study is done for Nigerian higher institutions. In the future author proposed to replace the passive tags with high-frequency active tags for better performance along with that, they want to incorporate the face recognition system to add more features and security.

Rjeib DH, et al. (2018) [36] considered RFID (Wireless Technology) for this study, which is used to record and identifying student information. This study applied RFID and web-based application together to store and extracts the student information like name, class, time table, grades, address etc. The extracted information is displayed on the screen or LCD of a particular staff. In the future author proposed to implement this system with face recognition for staff and students so that no person can use others cards to mark wrong attendance.

Agrawal A, et al. (2013) [37] proposed the new attendance management system using an active RIFD tag and object counter, in which they installed an RIFD reader in the centre of the class with an object counter. When all the students enter the class reader will read all the tags present in the class and if detected tags match with the object counter (used to detect the number of a person present in the classroom) then all data will save in the central database which has unique tag ID, name, date, time, classroom id etc. when all data matches with the required data it will mark attendance for the students. In the future author proposed to connect the system with a library, canteen and another department for better performance and to fetch authenticate details of the students.

Lodha R, et al. (2015) [38] proposed Bluetooth based smart attendance system using the electronic chip embedded in students ID cards. According to the author in RIFD technology students or users have to scan the card with a reader which takes the almost same time as a manual system. The proposed technology uses low energy consumption compared to other RIFD technology. Students are given the electronic chip embedded ID cards which students have to carry during the class as the electronic tag can be read during motion and no need for line of sight. When the professor moves in the class Bluetooth will automatically detect all the tags present in the class and send information to the database. The database has all information regarding the students as the tag detected by Bluetooth it will mark present automatically. Bhalla V, et al. (2013) [7] proposed the automatic attendance management system using the RIFD and Bluetooth technology. Student matrix card information is scanned through RIFD technology and stored the information in a computer database which is further sent to the instructor mobile phone through Bluetooth.

Geng S, et al. (2012) [39] proposed the attendance system for an organization having a large number of departments. Organizations facing problems with a manual system for calculating the working hours, overtime and bonuses of employees based on their attendance. Employees are given smart IC cards to mark their attendance through an RIFD reader which is installed in every department of the organization. Employee personal information with unique IC card numbers is stored in the database. When the card is detected by the reader it will send information to the database in encrypted form. This study will help the organization to calculate the working hours, overtime etc. of the employee's inefficient manner.

Shirodkar M, et al. (2017) [40] proposed the RIFD and location-based attendance system for employees of the organization. Employees are provided unique ID smart cards which are scanned through an RIFD scanner. A unique ID is stored in the staff mobile phones and the same data is also stored in the organization database. Employees have to install the required APK file on their mobile phones. When an employee will enter the campus it automatically connects to the organization internet and immediately records are sent to the server with an employee ID, date, time and employee location. When office hours will over an employee leave the campus immediately message is sent to the server with all details. This system will help organizations to maintain the attendance record of all employees inefficient manner. Khatun A, et al. (2015) [19] proposed attendance management system through iris recognition and MATLAB. Iris is a unique pattern of a human-like biometric, fingerprint, eyes, face etc. In this study author introduced iris recognition in which the user has to take his picture through a device webcam and that picture is automatically stored in the database for localization. The eyes portion of the image is extracted for authentication purposes through MATLAB. Next time when user clicks their picture that will match with the stored database and an E-mail is sent regarding their attendance to the concerned department. The author achieved 82.2% accuracy from the proposed system.

Shirodkar M, et al. (2015) [41] proposed attendance management system using the face recognition method in which captured faces are matched with the face database of the students and mark attendance

accordingly. Student images are captured in different poses during the admission process and stored in the college database. Cameras are already installed in the system which captures the only frontal image of the student and matches captured image with the database if the image matches then the system automatically mark the present for that particular student. Reports can be downloaded by the authorities at any time from the front end. The author achieved an accuracy of 83.2% from the proposed system. Jayant KN, et al. (2016) [42] proposed attendance management system using hybrid face recognition techniques. In this study author installed high definition camera above the whiteboard of the class which capture all students three times in the whole duration of the class because of variations in the pose of the students. Viola-Jones algorithm is considered by the author for face detection in their study due to the fast feature selection procedure. The system will capture and process data in three frames and the frame gives the highest detection rate that frame will be considered by the system to mark the attendance in excel format.

COVID-19 and Cloud-Based Attendance Tracking System

Introduction to Cloud: In the current decade, the Internet becomes the most powerful and essential service to users. People are using several services through the Internet to solve their many problems, basically today Internet has the power to solve user's problems. Cloud service is one of the services which people are using to make their work easier and secure. Cloud is the type of server where software and databases are running to store and process the data; which can be accessed through Internet services. Data centres are the place where all cloud servers are stored and all data centres are placed in different locations of the world. Cloud computing will allow the user to access their data from anywhere and any device like a smartphone, PC, laptop, tablet etc. In cloud computing, user or organization don't have to run any type of software in their local machine or servers [43].

Let's understand the concept through example; If any person has a smartphone with a lot of social media application installed and due to any damage or theft person buy a new phone and installed all application again like Facebook, Instagram, WhatsApp; as they log in to any social media account using their username and password all data associated with their account is automatically retrieve from the cloud. Another best example is Gmail account and Google drive where any person can store their data and from anywhere any time they can access their data without failure. These all things happen with the help of cloud computing. Before the cloud, computing organization has to invest money to buy servers and maintaining the servers but after the evolution of the cloud, computing organizations don't have to invest in updating and maintain their servers. Every organization or person is not able to afford the large infrastructure to maintain IT services for that cloud is the best solution; they just have to buy cloud services and use the existing infrastructure or services [44,45].

How Does Cloud Computing Work? : Cloud computing is working on the concept of virtualization in which people can feel that as they are working on a physical device with their hardware. Technically this is known as a virtual machine. Virtual machines are machines that behave like a physical machine to any person. Virtual machine helping organization or person to access many servers at a time from many data centres and in case any cloud server getting down than cloud vendors provides backup servers to access the data and services. Users can access cloud services through browsers or applications. Architecture if cloud computing is shown in **Figure 12**. Cloud provides the following service models to store and access the data.

- Software-as-a-Service (SaaS)
- Platform-as-a-Service (PaaS)
- Infrastructure-as-a-Service (IaaS)
- Function-as-a-Service (FaaS)

There are three types of cloud is provided by the different vendors of the cloud services.

- Public cloud (open to all users and organizations)
- Private cloud (dedicated to a single organization or user)
- Hybrid cloud (combination of both public and private)

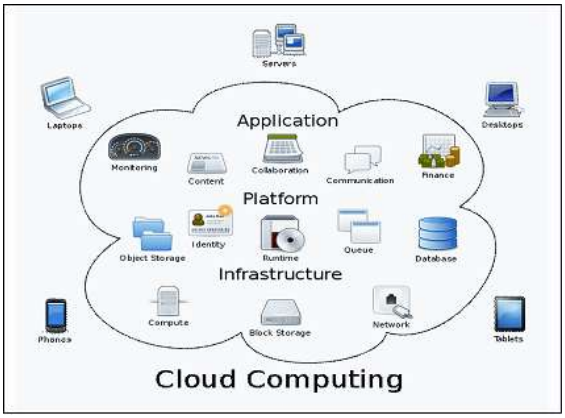

Figure 12: Cloud Computing [46].

Application-based Attendance Management System on Cloud Technology

Kaizala: Kaizala (www.web.kaiza.lap) is founded in 2017 and developed by Microsoft (United States) based company. Kaizala is working on secure messaging among large groups and work management applications. The application allows users to send and receive messaging, task assignments among groups and submit invoices. The application is also providing the feature to mark attendance with photographs and the exact GPS location of the user. After marking the attendance admin or authorities can download or analyze the attendance of each user in the form of sheets, graphs and reports. Kaizala is using by both private and public sector organizations; Andhra Pradesh (India) is the first public sector that is using the application to mark attendance for their more than 30 departments. In the private sector YES bank, Apollo telemedicine etc. are using this application to manage the attendance of their employees.
Version: Application is coming with two version one is which is free with fewer features and other is paid version which come with all professional features. Application is available with both android and ios platforms which further can be explored from the link [47]. Applications features has been shown in **Figure 13**.

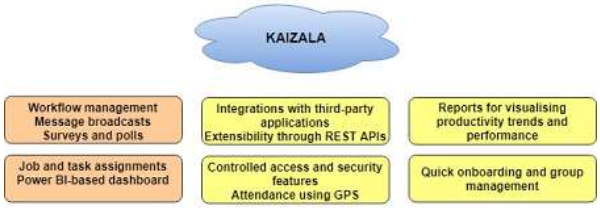

Figure 13: Kaizala Features [47].

Zoho People: Zoho people (www.zoho.com) is founded in 1996 and developed by a United States-based company. Zoho people is a cloud-based attendance system used in organizations to maintain the attendance of employees. This system helping in smoothing the HR process through their web portal. The system is helping the HR department to maintain the salary record, leave record, timetable, documentation, payroll, recruitment, resume management etc. for their employees. In this employees can mark their attendance through a web portal or Zoho application and the application will fetch the exact location and time of the marking attendance. Hr department is getting the exact check-in and checkout time with the location of every employee; further, they can download the report on a daily, weekly or monthly basis as per their requirement.

Version: The application is coming with two versions one is the trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms.
Features: The application is providing the customization features to the admin so that they can easily define the modules and processes through the application dashboard to analyze the report and documentation which can be explored from their link [48] and application feature is shown in **Figure 14**.

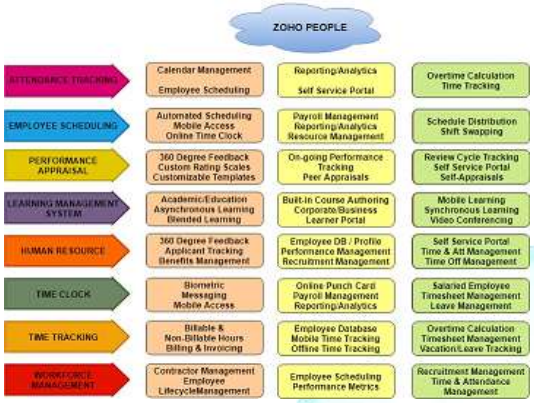

Figure 14: Zoho People Application Features [49].

Isolved Time: iSolved Time (www.isolvedhcm.com) is founded in 1992 and developed by a United States-based company. iSolved Time is a cloud-based attendance system used in organizations to maintain the attendance of employees. This application is providing the solution to the medium based organization where they have approximately 50+ employees on average. This application replaces the manual punch system with an employee time tracking system. They are using SaaS technology to manage employee attendance and time of work in the organization.
Version: The application is coming with two versions one is the trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms [50]. Applications features has been shown in **Figure 15**.

Figure 15: iSolved Features [50].

Clock It: Clockit (www.clockit.io) is founded in 2009 and developed by a United States-based company. The clock is a cloud-based attendance system used in organizations to maintain the attendance of employees. This application is best suited for small and medium business platforms. Clocks help organizations to mark attendance with GPS location and cloud-based timing of the employees. It also helps employee as well as organizations to access the dashboard and allow to maintain their leaves, yearly calendar of holidays, GPS tracking and many more.
Version: The application is coming with two versions one is the trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms [51]. Applications features has been shown in **Figure 16**.

Figure 16: Clock it Features [48].

Attendance Bot: Attendance bot (www.anaek.com) is founded in 2016 and developed by a United States-based company. Attendance bot is a cloud-based attendance system used in organizations to maintain the attendance of employees. This application is best for businesses that use collaboration platforms for communication purposes. Organizations can use this application to maintain employee attendance, leave applications and time tracking. Through this application, organizations can generate the bill of their client based on the number of hours spent on the project. Employees can apply for leave; remote working or they wish to work from home, all types of leave with their previous record can be maintained by the system.
Version: The application is coming with two versions one is the trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms [52]. Applications features has been shown in **Figure 17**.

Figure 17: Attendance Bot Features [48].

Webwork Time Tracker: Webwork (www.webwork-tracker.com) is founded in 2015 and developed by Armenia based company. Webwork time tracker is a cloud-based application for time tracking and employee monitoring software for the employees. This is best suited for remote teams of any size. The application provides a platform to calculate the working hours, time spent on the task assigned etc. in the form of screenshots, graphs and online reports in the employee dashboard. Employees can share their task performance with their clients for whom they are working and with their department head. The application will take random screenshots of employee work and all the reports related to work will be downloaded in visual form. This application helping the organization in increasing the productivity of the employees as this also generates the working time and non-working time report of each employee.
Version: The application is coming with two versions one is the trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms [53]. Applications features has been shown in **Figure 18**.

Figure 18: Webwork Time Tracker Features [48].

Jibble: Jibble (www.jibble.io) is founded in 2016 and developed by Malaysia based company. Jibble is used to mark attendance for the employees and they are providing applications free of cost. Organizations can track their employees at work for their payroll, attendance etc. Application is providing a helping hand to the organization to track their employee's check-in and checkout time with their GPS location. The system is allowing the official to generate timesheets and reports as per their requirement [54]. Applications features has been shown in **Figure 19**.

Figure 19: Jibble features [48].

Calamari: Calamari (www.calamari.io) is founded in 2014 and developed by Poland based company. Calamari is using cloud-based technology to mark attendance for the employees. Application is best suited for small and medium type business organizations looking for solutions for remote work and absence tracking. Calamari is providing a solution to managing the people in a very efficient manner and all users can plan as well as track all types of leaves. Application is helping organizations to analyze the attendance of the employees with role-based security features.

Version: The application is coming with two versions one is a trial basis which is free and the other is paid version which comes with all professional features. Application is available with both android and ios platforms [55]. Applications features has been shown in **Figure 20**.

Figure 20: Calamari Features [48].

Conclusion and Future Recommendations

This paper investigates the diverse systems for recording and maintaining attendance electronically and in a computerized way. Apart from the scrutinized study of the emerging technologies for AMS like Biometric-based AMS, Bluetooth based AMS, RIFD, and NFC based AMS, the authors have identified distinct applications under cloud-based AMS. These applications have been elliptically outlined and articulated. Though there are 200 and more applications under this head, the authors have endeavoured to identify and highlight a few of the recommended AMS applications based upon their ease of usage and availability. The highlight of this review study is the fact that it picks out all the dominating technologies and brings to the limelight the entire growing pool of technologies for AMS. From this review, we concluded that this shift from manual to automatic has a lot of dimensions to grow, and more technologies and applications need to be explored and implemented. Being dependent on a few of them is still diminishing the progress of the organizations, and the authors recommend the need and direct well to all other reliable and implementable solutions to attendance management and record-keeping. Our future scope includes a more in-depth insight on other cloud-based applications and works on hybrid tools and technologies to bring out better and more enhanced application solutions in this challenging domain.

References

1. Kadry S and Smaili M. Wireless attendance management system based on iris recognition (2010) Sci Res Essays 5: 1428-1435.
2. Kizildag M, Basar E, Celikag M, Atasoylu E and Mousavi S. An automated attendance monitoring and registration system for EMU's SPIKE seminar series (2011) Proc Acad edu.
3. Research Note, Automating Time and Attendance: Low Hanging ROI, (2008).
4. Clarke R. Human identification in information systems (1994) Inf Technol People. https://doi.org/10.1108/09593849410076799
5. Jain SK, Joshi U and Sharma BK. Attendance management system (2011) Masters Proj Report, Rajasthan Tech Univ Kota.
6. Computerized Maintenance Management System (CMMS).
7. Bhalla V, Singla T, Gahlot A and Gupta V. Bluetooth Based Attendance Management System (2013) Int J Innov Eng Technol 3: 227-233.
8. Haselsteiner E and Breitfuß K. Security in near field communication (NFC), in Workshop on RFID security (2006) 12.
9. Ahmad IB and Ayu AM. TouchIn: An NFC supported attendance system in a university environment (2014) Int J Inf Educ Technol 4: 448-453. https://doi.org/10.7763/IJIET.2014.V4.448
10. Karsen M, Kurniawan Y, Cassandra C and Juwitasary H. "NFC Design for Attendance System in The University (2018) Int J Mech Eng Technol 9: 566-571.
11. Ramakrishnan J and Ramakrishnan M. An Efficient Automatic Attendance System Using Fingerprint Reconstruction Technique (2012) Int J Com Sci Infor Secu 10.
12. Rao S and Satoa KJ. An attendance monitoring system using biometrics authentication (2013) Int J Adv Res Comput Sci Softw Eng 3: 379-383.
13. Rowe KR, Nixon AK and Butler WP. Multispectral fingerprint image acquisition (2008) Adv biometrics 3-23. https://doi.org/10.1007/978-1-84628-921-7_1
14. Bayoumi S, Aldayel A, Alotaibi M, Aldraihem M, Alrashed S, et al. Class attendance system based-on palm vein as biometric information (2015) J Theor Appl Inf Technol 77.
15. Kant C and Nath R. Reducing process-time for fingerprint identification system (2009) Int J Biometric Bioinforma 3: 1-9.
16. Zhi TJ, Ibrahim Z and Aris H. Effective and efficient attendance tracking system using secret code (2004) IEEE 108-112. https://doi.org/10.1109/icimu.2014.7066613
17. Soewito B, Gaol FL, Simanjuntak E and Gunawan FE. Smart mobile attendance system using voice recognition and fingerprint on smartphone (2016) Int Semi Intelli Tech App 175-180. https://doi.org/10.1109/isitia.2016.7828654
18. Ajgou R, Sbaa S, Ghendir S, Chamsa A and Talebahmed A. Novel detection algorithm of speech activity and the impact of speech codecs on remote speaker recognition system (2014) WSEAS Trans Signal Process 10.
19. Khatun A, Haque AKMF, Ahmed S and Rahman MM. Design and implementation of iris recognition based attendance management system (2015) 2nd ICEEICT 21-23.

https://doi.org/10.1109/ICEEICT.2015.7307458
20. Varadharajan E, Dharani R, Jeevitha S, Kavinmathi B, and Hemalatha S. Automatic attendance management system using face detection (2016) IC-GET 1-3. https://doi.org/10.1109/get.2016.7916753
21. MuthuKalyani K and VeeraMuthu A. Smart application for AMS using face recognition (2013) Comput Sci Eng 3: 13-15. https://doi.org/10.5121/cseij.2013.3502
22. Lim TS, Sim SC and Mansor MM, RFID based attendance system (2009) IEEE 2: 778-782. https://doi.org/10.1109/isiea.2009.5356360
23. Saparkhojayev N and Guvercin S. Attendance Control System based on RFID-technology (2012) Int J Comput Sci 9: 227.
24. Jain A, Hong L and Pankanti S. Biometric identification (2012) Commun ACM 43: 90-98. https://doi.org/10.1145/328236.328110
25. Shoewu O and Idowu OA. Development of Attendance Management System using Biometrics (2012) Pacific J Sci Technol 13: 300-307.
26. Nwoye CI. Enhancing attendance management in firms and industries using fingerprint biometric recognition technique (2016) IOSR J Mob Comp App 3: 15-22.
27. Mittal Y, Varshney A, Aggarwal P, Matani K and Mittal VK. Fingerprint biometric based Access control and classroom attendance management system (2015) 12th IEEE International Conference Electron Energy, Environmental Communication, Computer Control (E3-C3), INDICON, India 1-6. https://doi.org/10.1109/INDICON.2015.7443699
28. Ezema LS, Eneh JN and Amanze I. Fingerprint based attendance management system (2015) Int J SciEng Res 6: 1623-1628.
29. Noor S, Zaini N, Latip MFA and Hamzah N. Android-based attendance management system (2016) IEEE Conference System Process Control ICSPC, Malaysia 118-122. https://doi.org/10.1109/SPC.2015.7473570
30. Joshi R, Shete VV and Somani SB. Android based smart learning and attendance management system (2015) Int J Adv Res Comput Commun Eng 4: 256-260.
31. Hajime Shibata. Faculty of Letters (2005) Kansai University, Japan 590-592.
32. Abas MA, Tuck TB and Dahlui M. "Attendance Management System (AMS) with fast track analysis (2014) International Conference Computer Control Informatics Its Applications (IC3INA), Indonesia 35-40. https://doi.org/10.1109/IC3INA.2014.7042597
33. Nguyen HK and Chew MT. RFID-based attendance management system (2017) 2nd Work Recent Trends Telecommunication Research (RTTR), New Zealand 2-7. https://doi.org/10.1109/RTTR.2017.7887874
34. Shukla S, Shah S and Save P. RFID based attendance management system (2013) Int J Electr Comput Eng 3: 784-790. https://doi.org/10.11591/ijece.v3i6.3961
35. Arulogun MO, Olatunbosun, A, Fakolujo OA and Olaniyi. RFID-based students attendance management system (2013) Int J Sci Eng Res 4: 1-9.
36. Rjeib HD, Ali NS, Al Farawn A, Al-Sadawi B and Alsharqi H. Attendance and information system using RFID and web-based application for academic sector (2018) Int J Adv Comput Sci Appl 9: 266-274. https://dx.doi.org/10.14569/IJACSA.2018.090137
37. Agrawal A and Bansal A. Using RFID with object counter (2013) Int J Inf Comput Technol 3: 131-138.
38. Lodha R, Gupta S, Jain H and Narula H. Bluetooth smart based attendance management system (2015) Procedi Comput Sci 45: 524-527. https://dx.doi.org/10.1016/j.procs.2015.03.094
39. Geng S, Li G and Liu W. Design and implement of attendance management system based on contactless smart IC card (2012) International Conference Computer Science Electronic Engineering (ICCSEE) China 3: 290-294. https://dx.doi.org/10.1109/ICCSEE.2012.196
40. Shinde H and Raul G. GPS based attendance management system with RFID technology (2017) Int J Eng Res and Techno 5: 1-3.
41. Shirodkar M, Sinha V, Jain U, and Nemade B. Automated attendance management system using face recognition (2015) Int Conf Work Emerg Trends Technol (ICWET) 975: 23-28.
42. Jayant NK and Borra S. Attendance management system using hybrid face recognition techniques (2016) Conference on Advances Signal Process (CASP) 412-417. https://doi.org/10.1109/CASP.2016.7746206
43. Wang H, He W and Wang FK. Enterprise cloud service architectures (2012) Inf Technol Manag 13: 445-454.
44. What is Cloud.
45. Baburajan R. The rising cloud storage market opportunity strengthens vendors (2011) infoTECH.
46. Khan N, Ahmad N, Herawan T and Inayat Z. Cloud computing: locally sub-clouds instead of globally one cloud (2012) Int J Cloud Appl Comput 3: 68-85.
47. Kaizala., Syvantis Technologies, USA.
48. Attendance Tracking Software, Prohance, India.
49. Zoho People, USA.
50. iSolved. [Online]. Available: https://cdn0.capterra-static.com/screenshots/2021284/116809.png. [Accessed: 23-Jul-2020].
51. Clockit, USA.
52. Attendance Bot, USA.
53. Web Work, INDIA.
54. Jibble, USA.
55. Calamari, Poland.