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Research Article

m-TOPP-UML: An Extension to UML for the Modeling of Mobile Tracking on Patient Progress System

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Abstract: The Unified Modeling Language (UML) is a language for the specification, visualization and documentation of object-oriented software systems. Mobile systems are gaining more and more importance; nevertheless the means for their specifications are still underdeveloped. Existing UML diagrams can be used to conveniently model behavior, but these diagrams can be hardly used to model mobility. However, UML cannot describe in an explicit manner the mobility requirements needed for modeling mobile tracking on patient progress software systems. In this study, we present (m-TOPP-UML), our proposed extension to UML covering the use case diagram, sequence diagram, activity diagram and class diagram aspects of mobility at the various views and diagrams of UML. The use of m-TOPP-UML is illustrated using a mobile tracking patient progress system example. The purpose of this study is to showcase the system analysis and design of concept of system and a precise form of system-level operation specification and an operation schema declaratively describes the effects of a system operation by using case model, actors, use case, relationships between the actors and the use case, interaction between the prototype and its user, sequence diagram and class diagram of m-TOPP as defined by the Unified Modeling Language (UML).

Keywords: Diagrams, mobile, specification, system, unified modeling language

INTRODUCTION

The Unified Modeling Language prescribes a standard set of diagrams and a notation for modeling object oriented systems and describes the underlying semantics of what these diagrams and symbols mean (Booch *et al*., 1998). Whereas there has been to this point many notations and methods used for object-oriented design, now there is a single notation for modelers to learn. UML can be used to model different kinds of systems: Software systems, hardware systems and real-world organizations.

The invasion of software-intensive systems into nearly every domain of our life has seen the practice of software development stretched to combat the ever-increasing complexity of such systems and to meet the increased demand. In such a development environment, the transformation from concept for running implementation needs to rapidly meet the market demand, but at the same time the software should exhibit the necessary qualities of robustness, maintainability and meet other requirements, such as usability and performance demands.

Smart phones have recently overtaken PCs as the primary consumer computing device in terms of annual unit shipments. Given this rapid market growth, it is important that mobile system designers and computer architects analyze the characteristics of the interactive applications users have come to expect on these platforms. The market and application of portable computational devices is expanding more and more rapidly. Handheld computers have been adopted in the medical environments over the last decade, mainly as a lightweight format for reference literature, but also as a time manager and easy access to other information sources such as the Internet (McAlearney and Medow, 2004; Lu *et al*., 2005). Health care workers have to see more patients and do more with each patient than ever before. Without improving their equipment and technology, this would be virtually impossible. Therefore, health care administrators are always looking for the latest technology that will continue to increase output. In the hospital setting, one complication that slows down the work place is trying to keep track of what is occurring throughout the healthcare system with every patient. Their orders, lab, radiology and other pertinent results and even general information such as nurses assigned to them on a particular shift is necessary to keep the flow of care moving. Delaying this flow can cause costly wastes in the overall process of their care. That is why software companies are always looking for new and improved ways to assist healthcare providers in better managing personnel and time constraints.

Mobile systems are gaining more and more importance; nevertheless the means for their specifications are still underdeveloped. Existing UML diagrams can be used to conveniently model behavior, but these diagrams can be hardly used to model mobility (Wienberg *et al*., 1999).

Therefore having meaningful and standardized behavioral specifications of mobile tracking on patient progress system would make it feasible to determine the properties and enable more thorough and less costly. Unfortunately such specifications are rarely used. Even less frequently is there a correspondence between a specification and the software itself. Currently in industry much of what would be loosely classified as system specification is performed with use cases. The use cases are an excellent tool for capturing behavioral requirements of software systems. They are informal descriptions, almost always written in natural language and consequently they lack rigor and a basis to reason about system properties.

In this study, we look at bringing the benefits of behavioral specification techniques to mobile tracking on patient progress system by showcase the system analysis and design as defined by the Unified Modeling Language (OMG, 1999). It reviews the diagrams that comprise UML and offers a Use-Case-driven approach on how these diagrams are used to mobile tracking on patient progress system. We present (m-TOPP-UML), our proposed extension to UML covering aspects of mobility at the various views and diagrams of UML. The use of m-TOPP-UML is illustrated using a mobile tracking patient progress system.

LITERATURE REVIEW

In this section, we provide some background information on the Unified Modeling Language (UML) standardized by the Object Management Group (OMG) and mobile tracking and their applications in healthcare domain.

UML in brief: The UML is a de facto software industry standard modeling language for visualizing, specifying, constructing and documenting the elements of systems in general and software systems in particular (Booch *et al*., 1998). UML has a well-defined syntax and semantics. It provides a rich set of graphical artifacts to help in the elicitation and top-down refinement of object-oriented software systems from requirements capture to the deployment of software components.

The Unified Modeling Language (UML) has become the de-facto standard for building Object-Oriented software. UML builds on the already highly successful standard, which has become an industry standard for modeling, design and construction of software systems as well as more generalized business and scientific processes. UML has a well-defined syntax and semantics. It provides a set of graphical artifacts to help in the elicitation and top-down refinement of object-oriented software systems from requirements capture to the deployment of software components. The Object Management Group (OMG) specification states that "The Unified Modeling Language (UML) is a graphical language for visualizing, specifying, constructing and documenting the artifacts of a software-intensive system. The UML offers a standard way to write a system's blueprints, including conceptual things such as business processes and system functions as well as concrete things such as programming language statements, database schemas and reusable software components."

UML defines thirteen basic diagram types, divided into two general sets: Structural modeling diagrams and behavioral modeling diagrams. This study will deal with Use case diagram, Sequence diagram, Activity diagram and Class diagram for mobile tracking on patient progress system.

UML diagrams: A diagram contains model elements such as classes, objects, nodes, components and relationships, described by graphical symbols. Moreover, a diagram can be used to describe certain system aspects at different levels of abstraction. For example, a use case diagram in our mobile tracking on patient progress system specifies the functionality of the mobile tracking on patient progress system has to offer from a user's perspective and defined what should take place inside the our system by doctor and nurse. The UML diagrams used in this study are briefly described below:

- **Use case diagram:** The use case diagram defines the functionality inside the system and determines the functions of a system and its users. It shows the external users/actors and their connection to the functions/use cases that provided by the system. It also, a specific way of using the system by performing some part of the functionality and to capture behavioral requirements of software systems. This diagram is used to model the static behavioral aspects of the use case view of the system to model.
- **Use case specification:** Use case specification shows the detail of the use case. The main purpose of the use case specification is to specify any pre-conditions that should be met in order to start the use case specify any business rules related to the use case steps and specify any post-conditions that will be present after executing the use case.
- **Sequence diagram:** This diagram describes how the blocks communicate and describes how each use case is offered by communicating objects. It shows how the participation objects realize the use case through their interaction. The interaction takes

place as blocks send stimuli between each other. The main purpose of the use case design is thus to define the protocols of the blocks. It also, describes a scenario involving various interacting objects.

- **Class diagram:** This diagram shows the static structure of classes and their possible relationships (i.e., association, inheritance, aggregation and dependency) in the system. The class diagram shows the building blocks of any object-orientated system. It depict a static view of the model, or part of the model, describing what attributes and behavior it has rather than detailing the methods for achieving operations. Class diagrams are most useful in illustrating relationships between classes and interfaces.
- **Activity diagram:** This diagram shows activities and actions to describe workflows. In the unified modeling language an activity diagram represents the business and operational step-by-step workflows of components in a system. It also, shows the overall flow of control.

Mobile application in healthcare area: Small and portable devices, such as mobile phones, PDAs and the like, have recently been pushed on the marked and have allowed for complex cooperation and communication patterns that were not foreseeable some time ago. The ability to carry these devices, share the content using communication networks, possibly wireless and synchronize their content with more standard devices have been seen as essential features. Nowadays, with the increasing growth in technologies, mobile devices being used in many fields such as agriculture, medical, tracking and learning. Mobile devices have become widely used technology. The main aim is to enable communication and information access anywhere and anytime (Fischer *et al*., 2003). Portable device is accompanying users most of the time. Thus, makes it an interesting platform for building convenient applications that can display output any part in the world (Wienberg *et al*., 1999). Mobile devices are used commonly in daily life to communicate, coordinate and to access information. For the majority of mobile device strategy for developing healthcare, mobile device companies have to design and provide a system which is helpful and easy access the information in health care databases. Moreover, in the fact the cell phones started using computers (applications such as PDA) to facilitate mutual feedback on the health care environment effectiveness such as clinical skills evaluation, support continuous quality improvement initiative, provide treatment and monitoring services. According to Suomi (2003) pharmacist is arguing to use computers and mobile applications with transactions through the internet. The patients put pressure on health care providers such as contacted through phone or via the internet. Portable devices have proved to be popular in medical practices, its most popular because it able to store a vast amounts of information in the pocket (Lu *et al*., 2005). A mobile client allows remote access to reference material, clinical lab data and patient health states via a wireless connection. Berglund *et al*. (2007) have indicated a study among the staff at a Swedish county hospital where doctors and nurses had high expectations of mobile information support systems. The study is conducted of interviews which showed that physicians need a mobile tool for accessing such information about patients, a knowledge database and functions to ease and standardize everyday tasks. It also, is being able to understand the patient's case and to decide quickly for a patient's condition. Thus, there is needed for mobile access to the information. The study also showed that the nurses are concerned about not interfering with the interaction between the staff and patient. The tool should be easy to use so that the treating staff focus can remain on the patient and not to the Personal Digital Assistance (PDA). The physicians/doctors and nurses state that access to test results and reference values has the highest priority when looking in patient information. In Fischer *et al*. (2003) it is stated that the main resources to improve medical work would be mobile accessible. Particularly, in the treatment information databases, patient health tracking cost tracking and prescription of pharmaceuticals. Suomi (2003) and Berglund *et al*. (2007) has both conducted research programs to produce review studies on handheld computing used in medical environments up until 2004. The main source for both studies is Medline and other medical reference libraries. The studies do not discuss gains in mobility or collaboration to the extent that would be found in Human Computer Interaction (HCI), Computer Supported Collaborative Work (CSCW) or mobile informatics research fields. The studies reviewed were mainly focused on the practical use of mobile medical applications. Mobility and communication are mentioned the benefits of the retrieval and use of patient and medical information are the main theme. Accessing to medical information where and when needed is the common denominator which would make handheld devices a valuable contribution to medical work.

MOBILE UML BY EXAMPLE

In this section, we describe the extensions made in each of the UML diagrams to allow the explicit representation of the mobility aspect. We first introduce informally our mobile system we want to model. Then we introduce our modifications to the UML.

Example: A mobile tracking on patient progress system with unified modeling language: Mobile tracking on Patient Progress system is consists of two interacting users, Doctor and Nurse. Via Mobile tracking on patient progress system doctor able to assist in crucial clinical decisions 24/7 and available on call wherever doctors to manage their care process from start to finish and from inside and outside the hospital. In this

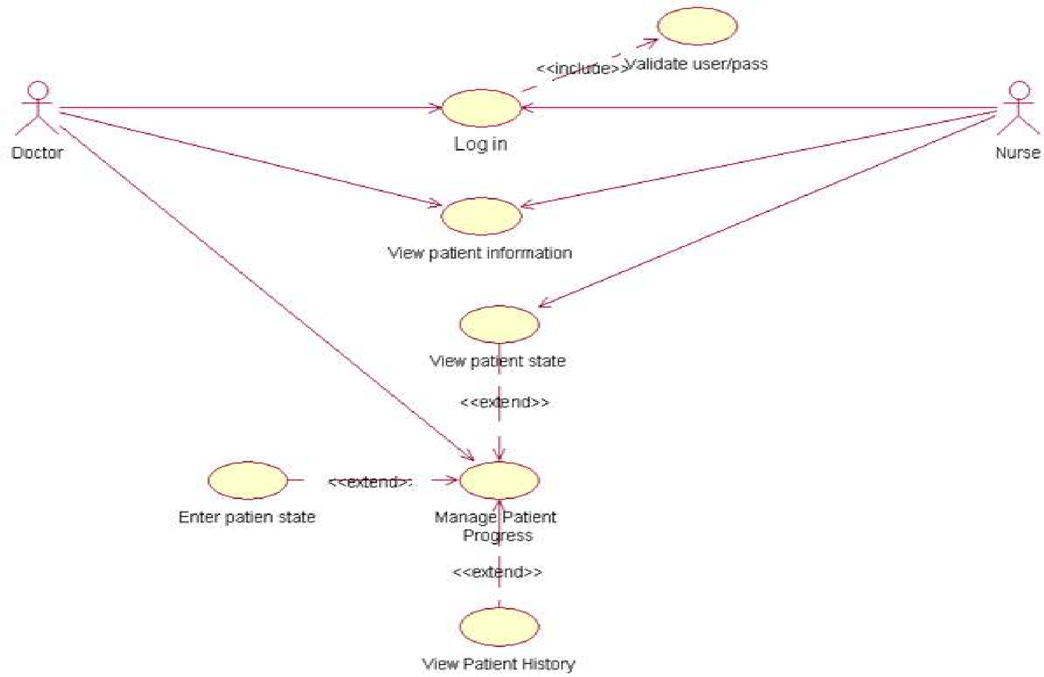

Fig. 1: Mobile tracking on patient progress system use case diagram

section, we describe m-TOPP-UML by going through of the Use case, sequence, activity and class UML diagrams and explaining the modifications and extensions needed to describe the mobility aspects.

Use case diagram: A use case encapsulates actors and use cases. Actors are external entities interacting with the mobile tracking on patient progress system through use cases. The functionality of a system or subsystem to model is described by a group of use cases. It represents a functional requirement that may involve one or more interacting actors. The doctor actor can be interacting with the mobile tracking on patient progress system by pressing <<Log in as Doctor>> button from home page. Then, the system display Login as Doctor Page to enable the doctor to entire username and password. Thus, enables to use the functions of the mobile tracking on patient progress system by the doctor actor such as: View Patient Information, Manage Patient Progress, View Patient State, View Patient History and Enter Patient State. The second actor Nurse can be interacting with the system by pressing <<Log in as Nurse>> button from home page. Then, the system display Login as Nurse Page to enable the nurse to entire username and password. Thus, enables to use the functions of the mobile tracking on patient progress system by the nurse actor such as: view patient information and view patient state. Figure 1 shows a use case of the mobile tracking on patient progress system containing two actors.

Sequence diagram: A sequence diagram is one kind of interaction diagrams that shows the interactions among system while time progresses. Time is represented by a vertical timeline. We describe how the blocks communicate after identify the system architecture. This is done by designing Use case, which were described earlier. They define the external requirement on the blocks and they will be the basis for preparation of the manual. The interaction diagram describes how each use case is offered by communicating objects. The diagram shows how the participation objects realize the use case through their interaction. The interaction takes place as blocks send stimuli between each other. The main purpose of the use case design is thus to define the protocols of the blocks (Booch *et al*., 1998; Rumbaugh and Jacobson, 1999; Oestereich, 2001; Scott, 2001). Nurse is less interaction with the system, because it will use some functions of the system while the Doctor is used all functions in the system. Therefore in Fig. 2 we describe the sequence diagram for the doctor user. Figure 2 shows after matched the username and password that entered by the doctor in the database. Then, the system displays patient ID page. The doctor should enter patient ID, the system verifying the patient ID and if it match, will move the doctor to the page contains patient information and manage patient progress, if not message box well appear “Error patient ID”.

Activity diagram: It shows the control flow between actions or complex actions called activities. The doctor actor uses all functions in the mobile tracking on patient progress system, for reason that, Fig. 3 describes the activity diagram for the doctor actor with mobile tracking on patient progress system.

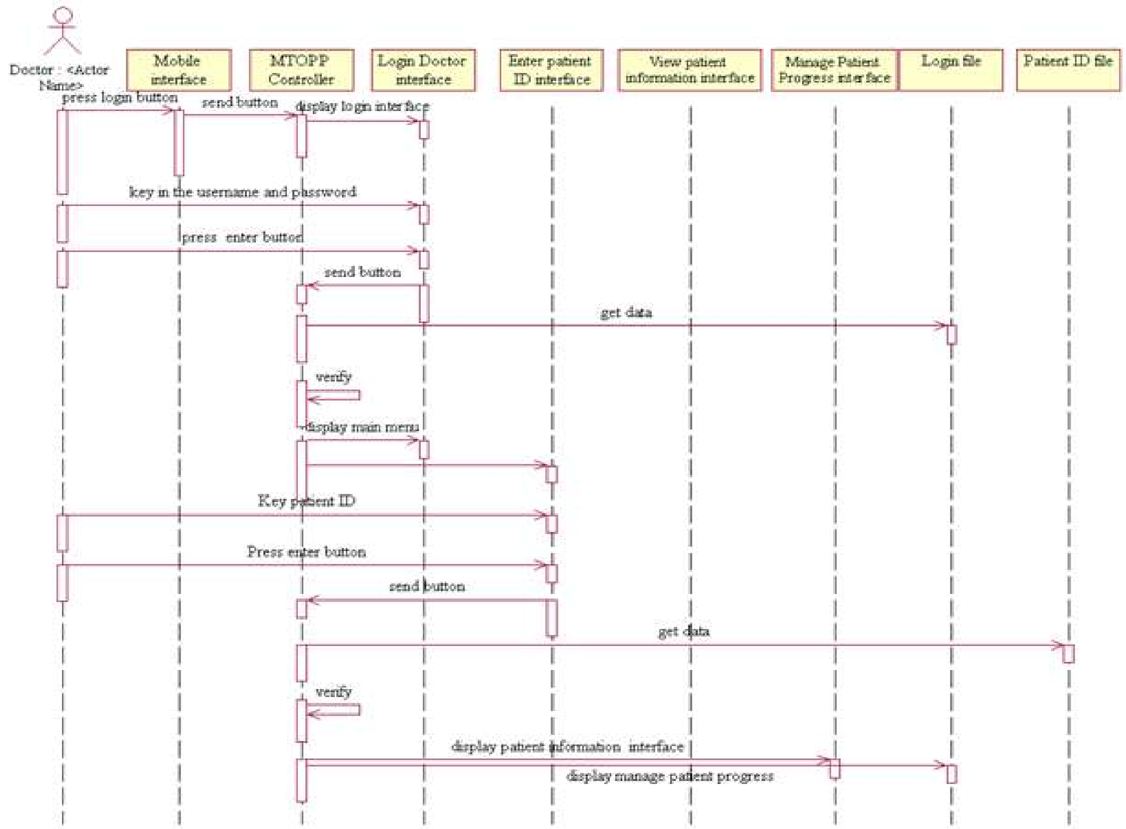

Fig. 2: View patient information and manage patient progress sequence as doctor

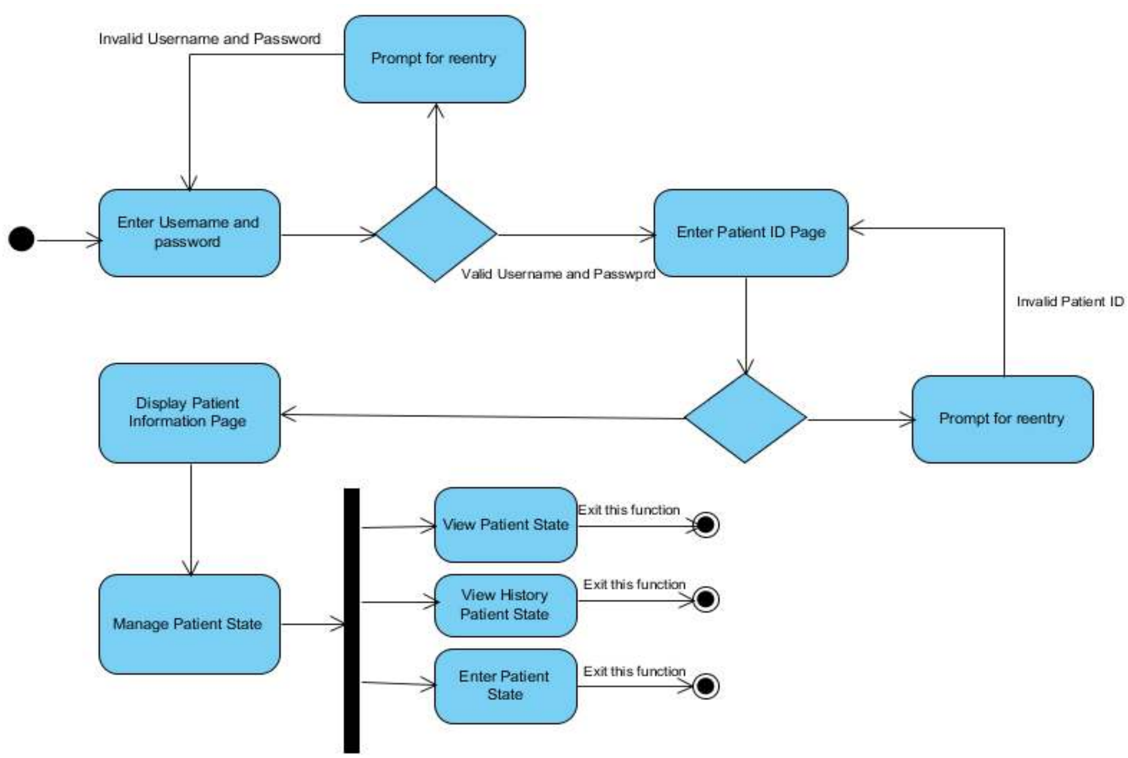

Fig. 3: All activity for doctor actor in the system

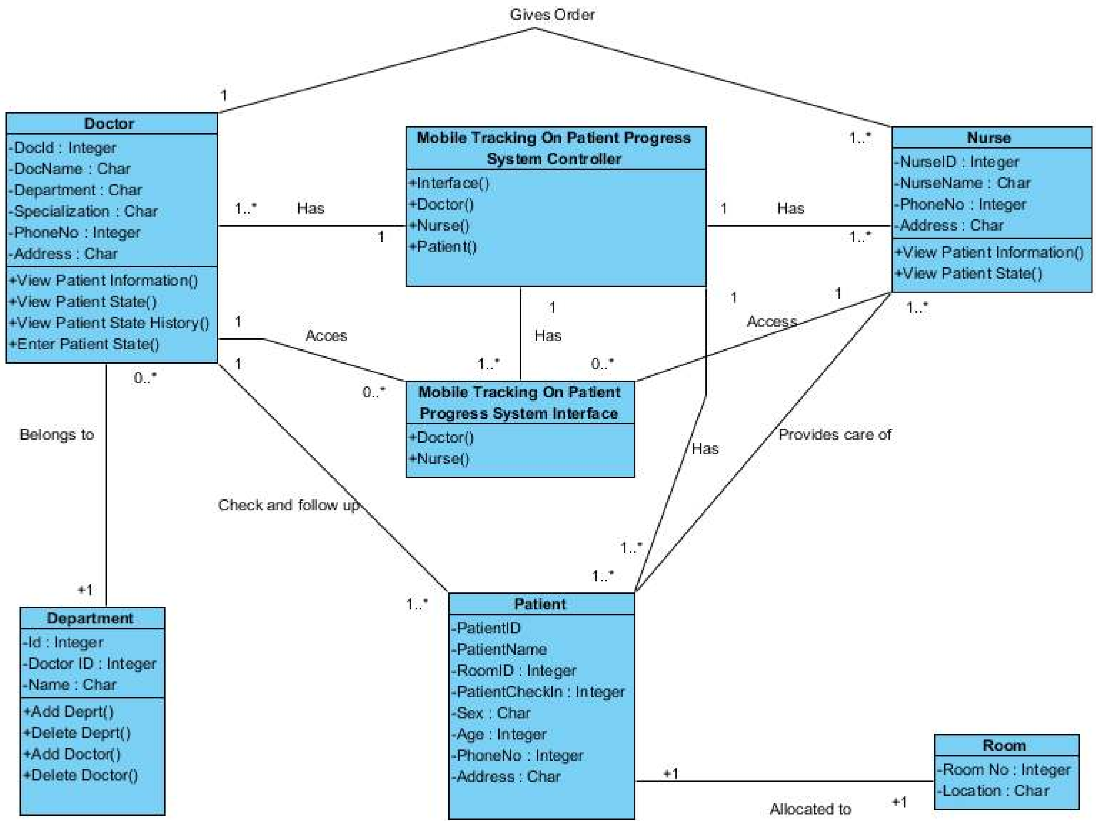

Fig. 4: Class diagram for mobile tracking on patient progress system

Class diagram: The class diagram shows the static structure of the system's software classes and describes all relationships among those classes, including the association, aggregation and generalization relationships. Below is a high-level class diagram for the Mobile Tracking On patient Progress system. This diagram depicts the relationship between different classes within the system, as well as the relationship between the doctor and the nurse with the patient and the m-TOPP controller and m-TOPP interface. One can see the functionality each class has by looking at the associated functions. The multiplicity is also shown to help understand the system better. It is evident that the mobile tracking on patient progress system itself plays a central role in the overall diagram. Most of the functionality passes through it.

UML Class diagram for Mobile Tracking on Patient Progress System is shown below. The various Classes involved in the system are: Classes: Doctor, Nurse, Patient, m-TOPP Controller, m-TOPP system interface. The class diagram for mobile tracking on patient progress system is shown Fig. 4.

CONCLUSION

Currently, in industry much of what would be loosely classified as system specification is performed with UML diagrams. The Unified Modeling Language (UML) prescribes a standard set of diagrams and a notation for modeling object oriented systems and describes the underlying semantics of what these diagrams and symbols mean. In this study, we presented m-TOPP with UML, an extension to UML covering the main aspects of mobility at the various views and diagrams of UML. The use of m-TOPP-UML was illustrated using a mobile tracking on patient progress system example.

In this study illustrated m-TOPP-UML using a mobile tracking on patient progress system to have meaningful and standardized behavioral specifications of mobile tracking on patient progress system would make it feasible to determine the properties and enable more thorough and less costly. Mobile tracking on patient progress system-UML help to figure out what really need for analyzing, designing and modeling mobility and figure out how to take something that is complicated, even messy and turn it into something precise enough that can do.

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